

The Punta Allen lobster fishery: current status and recent trends

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1. INTRODUCTION

After artificial habitats or *casitas* were introduced as a fishing gear to harvest spiny lobster in the late 1960s, fishers followed two divergent options in self-organizing practices pertaining to fishing cooperatives in the northern and central coasts of Quintana Roo, also known as the Mexican Caribbean (Miller, 1982a,b, 1989; Seijo, 1993; Briones-Fourzan, Lozano-Alvarez and Eggleston, 2000). In the north, fishers adopted an open access organizational scheme that potentially allowed the entire population of local fishers to use the artificial habitats deployed by only a fraction of the fishers, leading to the demise of that gear less than 15 years after (Miller, 1989; Briones-Fourzan *et al.*, 2000). In contrast, in Bahía de la Ascension and Bahía Espíritu Santo, two bays of the central coast of Quintana Roo, local fishers developed by themselves a unique system of individual marine plots or *campos*, formalized internally by the fishing cooperatives (Miller, 1989; Seijo, 1993). This system relied upon a set of simple rules, self-surveillance and rigorous enforcement by the fishing cooperative (Miller, 1989; Seijo and Fuentes, 1989; Seijo, 1993). Hence, after almost four decades (~36 years), their management approach has not only proven its advantage in the long run, as evident by the maintenance of the lobster fishery based upon *casitas*, but also has proven to be a successful organizational scheme, conducive to the sustainability of the fishery as a whole (*sensu* Charles, 2001).

A number of previous studies deal with various aspects of the Punta Allen fishery system, mostly focused on components such as the *casitas* and the *campos* systems (Miller, 1982a,b 1989; De la Torre and Miller, 1987), the spiny lobster resource emphasizing biological and ecological processes (Briones-Fourzan, 1994; Briones-Fourzan *et al.*, 2000; Lozano-Alvarez, Briones-Fourzán and Ramos-Aguilar, 2003), as well as descriptions of the fishery and their dynamics (Lozano-Alvarez, Briones-Fourzan and Phillips, 1991; Lozano-Alvarez, Briones-Fourzan and Negroto-Soto,

1993), including bio-economic analysis (Seijo and Fuentes, 1989; Arceo Briseño and Seijo, 1991; Seijo, Salas, Arceo and Fuentes 1991) and socio-economic issues (Cesar-Dachary and Arnaiz-Burne, 1989; Solares-Leal and Alvarez-Gil, 2003). While most of the previous studies highlight issues related to some specific component of the fishery, according to a disciplinary approach, a wider and multi-disciplinary approach to the fishery system has been lacking.

In the context of the pervasive crisis affecting capture fisheries worldwide, after the series of reports published since the 1990s (FAO, 1992, 2002), controversies and debates about symptoms and causes of these crises have arisen (Ludwig, Hilborn and Walters, 1993; Rosenberg *et al.*, 1993). Subsequently, attention has been paid to factors leading to the unsustainability in fisheries (Swan and Greboval, 2004) and we conclude that fisheries sustainability as a goal faces difficulties and challenges that are greater than have been anticipated (Hilborn *et al.*, 2001; Caddy and Seijo, 2005). An alternative is to look at fishery systems that can be considered successful according to some specified criteria (Hilborn, Punt and Orensanz, 2004; Hilborn, Parrish and Litle, 2005). A further step is to ascertain which factors are linked to success in fisheries management, in order to learn the lessons that could be valuable as guidelines or inspiring principles in different management regimes. In this context, some references to the Punta Allen lobster fishery in the recent literature on fisheries management have stressed the relative success of a self-organizing scheme developed by local fishers (Caddy, 1999; Castilla and Defeo, 2001; Hilborn *et al.*, 2004, 2005; Defeo and Castilla, 2005). This has prompted a renewed interest on the current status of this fishery system. Increased knowledge and awareness on the Punta Allen lobster fishery experience is particularly relevant in Latin America and other underdeveloped regions where coastal, artisanal fisheries predominate. Last, we think that important features of the Punta Allen lobster fishery, such as the nature of their governance, deserve further attention.

Governance issues are gaining attention in the recent literature of fisheries management, as an essential aspect of fishery systems to be considered regarding sustainability (Hilborn *et al.*, 2004, 2005; Kooiman and Bavinck, 2005). We adopt a wider definition of governance to include the whole set of interactions (public and private) taken to solve societal problems and generate societal opportunities (Kooiman and Bavinck, 2005). The purpose of this chapter is to provide an updated and brief account of the status and recent trends of the lobster fishery located at Bahia del Espiritu Santo in Punta Allen, Mexico.

2. DESCRIPTION AND HISTORY OF FISHERY

2.1 Fishery components

According to Charles (2001) a fishery system possesses three components: (a) natural, (b) human and (c), management. In this chapter we adopted a conceptual framework to describe the major features of each of component as identified in the lobster fishery of Punta Allen.

2.2 Natural component

The natural component includes the resource, the ecosystem where the resource inhabits, and the biophysical environment – the habitat, prey, predators and climate. The spiny lobster (*Panulirus argus*) is one of the most valuable resources in the Caribbean (Cochrane and Chakalall, 2001) and a vast amount of information is available on its biology and ecology (Arce and de León, 2000) and fisheries (Medley and Venema, 2000). Here we rely upon the previous synthesis in the publications cited above and additional regional studies (Briones, Lozano, Cabrera and Arceo, 1997; Briones-Fourzan *et al.*, 2000).

The Spiny lobster has a complex life history with five stages: adult, egg, larvae (phyllosoma), postlarval (*puerulus*) and juvenile (Lipcius and Eggleston, 2000).

Reproduction takes place in deeper waters through external fertilization and egg masses are released by females in deep waters. Phillosoma larvae experience a long larval drift in the sea currents and after 6–11 months in the open sea they metamorphose to postlarvae (*puerulii*). Puerulii swim toward the coast and settle on shallow vegetated seabottoms, preferably on the red algae, *Laurencia* spp. (Butler and Herrnkind, 1997). After settling, the puerulii become the first benthic stage, 6–7 mm carapace length (CL). Juvenile lobsters of 5–15 mm CL first occupy algal habitats and later, when they grow to 16–45 mm CL, shift to distinct habitats such as sponges, octocorales, crevices and hard-bottom. Sub-adult lobsters (>45–74 mm CL) are nomadic and move to reef areas in deeper waters as they approach maturity at 80 mm CL. Thus, each life stage has specific habitat requirements, which probably causes population bottlenecks due to the lack of suitable habitat, for instance when the young juveniles shift from vegetated habitats to hard-bottoms (Arce, Aguilar-Dávila and Sosa Cordero, 1997; Sosa-Cordero *et al.*, 1998). The consequences of this complex life history are relevant to management and include the open nature of local populations subject to fishing, and the high probability that local recruits are from upcurrent localities and the local reproductive stock is exporting recruits to down-current localities.

Based on results of tagging experiments in Bahía de la Ascension, Lozano-Alvarez *et al.* (1991) found that lobsters grow relatively fast in the bay; they estimated that one year after settlement a juvenile attains ~45 mm CL, and around 2.2 years after the settlement spiny lobster recruit to the fishery at ~74 mm CL. They also found there is an intense emigration of lobsters toward deepwaters outside the bay. This was corroborated when a deepwater stock of spiny lobsters was found outside the bay (Lozano-Alvarez *et al.*, 1993).

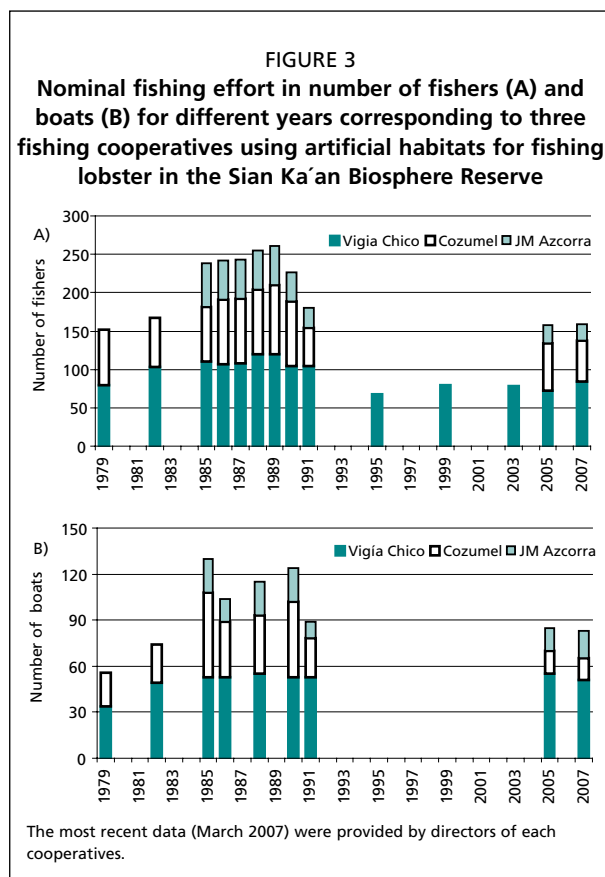
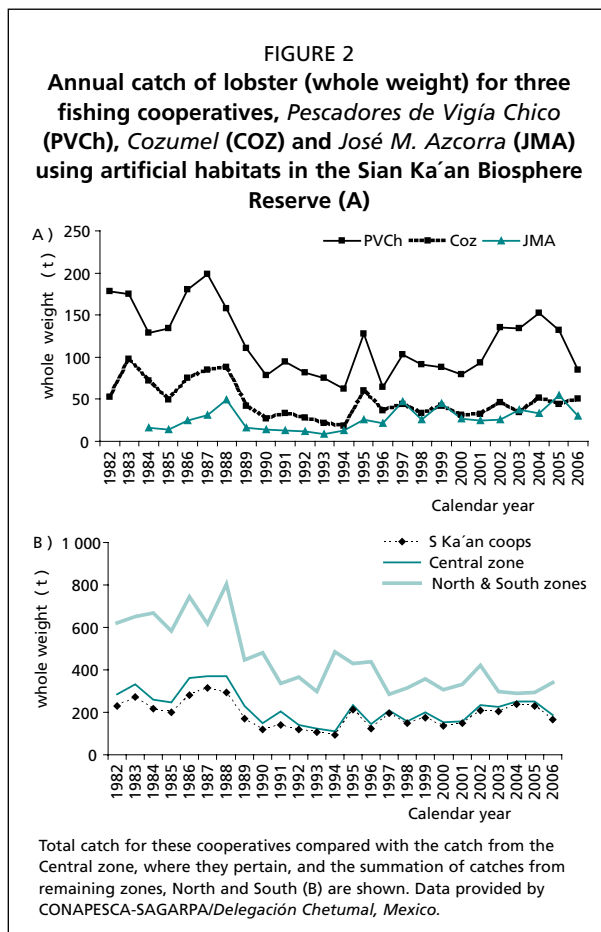
2.3 Human component

The human component consists of the fishers, their fleet and fishing gears as well a distinct groups in the fisher communities. Here we present a synthesis of the available information on the fishery (Miller, 1982a,b, 1989; Seijo and Fuentes, 1989; Seijo, 1993; Lozano-Alvarez *et al.*, 1991, 1993; Briones-Fourzan *et al.*, 2000) that emphasizes the major changes in the fishery and updated catch and effort trends.

In the Mexican Caribbean, three traditional fishing zones – North, Central and South – are recognized based upon physical habitat characteristics and development levels (Miller, 1982a; Figure 1). There are differences in the fishing gears employed in the spiny lobster fishery in each zone. In the central zone (Figure 1), which includes Bahía de la Ascension and Bahía Espíritu Santo, the use of artificial habitats or casitas as fishing gear to harvest lobsters predominates.

Annual volumes of lobster caught by three fishing cooperatives using artificial shelters in the Sian Ka'an Biosphere Reserve are dominated by the catch of the Pescadores de Vigía Chico cooperative that has fishing grounds in Bahía de la Ascension (Figure 2A). This cooperative takes the bulk of the annual catch from the Central zone (Figure 2B). When the catches of these cooperatives are compared with those of the remaining zones, North and South, it can be seen that the contribution of the Central zone has





increased during recent years (Figure 2B). Since 1982, the Pescadores de Vigía Chico has been the most productive fishing cooperative in the Mexican Caribbean (Table 1) and their catches of lobster represented almost 16 percent of the total catch. During the last years their catch amounted to 22 percent of the total (Table 1). The annual catch of this cooperative was also the most stable from 1982 to 1999 and the third most stable during the period 2000–2005 (Table 1).

Fishing boats in both bays are made of fiberglass and are between 6.4–7.8 m long, with outboard motors 40–60 hp. The harvesting operation is carried out by skin diving and the use of *jamo*, a hand-net used as a bag to catch lobster in Bahía de la Ascension. Until 1994, a gaff was used instead of the *jamo*. This change happened for economic reasons and the gaff was abandoned in 1995 when the market for live lobsters opened, and buyers preferred live lobsters without injuries (Briones-Fourzan *et al.*, 2000). In Bahía Espíritu Santo, the gaff is still used in the southern bay by the JM Azcorra cooperative, while in the northern bay fishers of the Cozumel cooperative use the *jamo*, the snear or *lazo* and, to a lesser extent, the gaff. SCUBA and Hookah are forbidden as fishing gears to capture lobster and fish by internal agreement of all the fishing cooperatives from Bahía de la Ascension southwards.

Nominal fishing effort indices, such as number of fishers and boats are available for the fishing cooperatives (Figure 3A, B). The number of fishers for the Pescadores de Vigía Chico cooperative from Punta Allen increased during the 1980s to more than 100 fishers, which was then followed by a decline in the 1990s (Figure 3A). The current number of members of this cooperative is 80 (Figure 3A). There was a similar trend in the number of boats, but the increase was lower (Fig. 3B). Currently, the Pescadores de Vigía Chico cooperative has 55 boats (Figure 3A). According to these indicators, the nominal fishing effort has been kept under control (Figure 3A, B).

In both bays, the fishing areas granted to fishing cooperatives are partitioned into individual campos or marine plots, internally allocated to members of the cooperative. In January–February 2006 a field survey was

TABLE 1
The ten most productive fishing cooperatives in the Mexican Caribbean according to their contribution to the total catch of lobster during three time periods

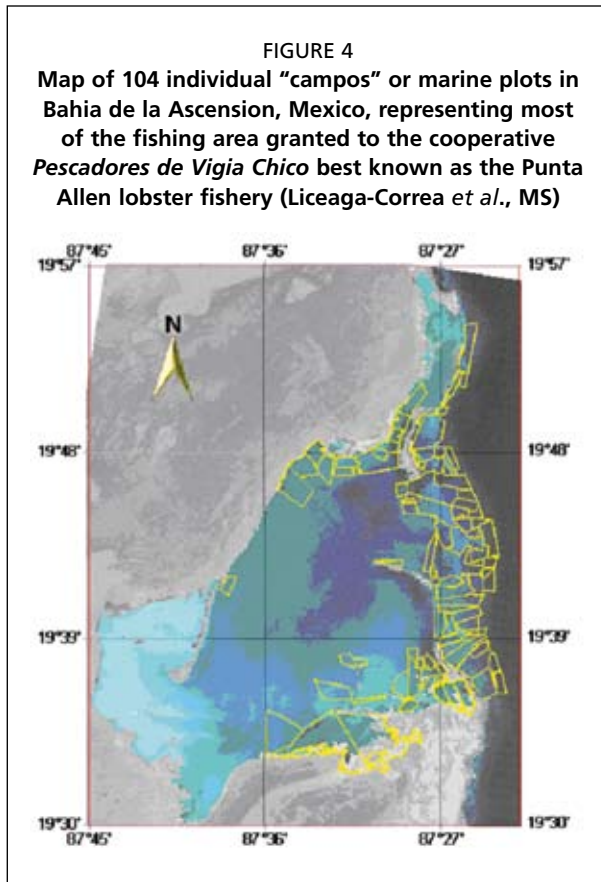
Fishing cooperative	n	Contribution to the lobster catch	Average catch (t-tails)	CV
Period 1982–1989				
Pescadores V. Chicoa	8	16.6 %	52.65	19.4 %
Patria y Progreso	8	16.4 %	51.77	36.6 %
Por la Justicia Social	8	10.3 %	32.74	40.6 %
Andrés Q. Roo	8	8.5 %	26.79	56.1 %
Cozumela	8	7.4 %	23.38	28.7 %
Vanguardia del Mar	6	6.3 %	26.52	24.2 %
Pescadores I. Holbox	8	6.1 %	19.34	38.2 %
Isla Blanca	6	4.9 %	20.73	41.5 %
Horizontes Marinos	8	4.8 %	15.34	42.1 %
Caribe	8	4.4 %	13.79	67.0 %
		85.7 % Cumulative		
Period 1990–1999				
Pescadores V. Chicoa	10	15.8 %	28.87	22.4 %
Patria y Progreso	10	10.6 %	19.35	35.3 %
Por la Justicia Social	10	9.8 %	17.86	41.0 %
Vanguardia del Mar	10	9.0 %	16.32	37.6 %
Caribe	10	6.7 %	12.22	46.8 %
Cozumela	10	6.3 %	11.40	35.5 %
Isla Blanca	10	5.7 %	10.41	45.5 %
Horizontes Marinos	10	4.5 %	8.26	38.7 %
José M. Azcorraa	10	4.1 %	7.56	61.5 %
Langosteros del Caribe	9	3.7 %	7.56	32.7 %
		76.2 % Cumulative		
Period 2000–2005				
Pescadores V. Chicoa	6	22.5 %	39.98	23.7 %
Por la Justicia Social	6	7.9 %	14.05	20.1 %
Patria y Progreso	6	7.7 %	13.70	42.3 %
Cozumela	6	7.5 %	13.30	21.6 %
Langosteros del Caribe	6	6.7 %	11.91	18.2 %
José M. Azcorraa	6	6.3 %	11.21	33.9 %
Vanguardia del Mar	6	5.5 %	9.76	36.6 %
Isla Blanca	6	5.1 %	8.98	33.7 %
Caribe	6	5.0 %	8.90	32.4 %
Pescadores I. Holbox	6	4.5 %	8.08	30.9 %
		78.7 % Cumulative		

Number (n) of annual catches, average catch, and coefficient of variation (CV %) of annual catch for each cooperative are given. Also shown is the cumulative catch for each period. The number of coops varied between 9 and 12.

Notes: a) This letter identifies the fishing cooperatives using casitas in the Sian Ka'an Biosphere Reserve.

Data are official statistics of catch provided by CONAPESCA-SAGARPA/Delegacion Chetumal, Mexico in some cases corrected with catch data available in files of the cooperatives.

conducted based on interviews to fishers. According to this there were 101 individual campos in Bahía de la Ascension pertaining to the Pescadores de Vigía Chico cooperative; in Bahía del Espíritu Santo there were 84 campos, 45 pertaining to the Cozumel cooperative and 39 to the J.M. Azcorra cooperative. During 2001–2002 a multi-institutional research team, together with the fishers of the Pescadores de Vigía Chico cooperative, mapped 104 individual campos out a total of 120 (Figure 4). Individual maps were delivered to both the cooperative authorities and every fisher owner of campos as a tool to solve boundary limits in the future (Liceaga-Correa *et al.*, unpublished ms). When the available records of the number of artificial habitats or casitas are observed over time (Table 2), it can be noted that this indicator also reached



a peak in the middle 1980s of roughly 26 500 casitas (Table 2). During the 1990s and in recent years the number of casitas has been slightly under 20 000 (Table 2). Thus, this fishing effort indicator also has decreased.

Members of one cooperative regularly form working teams varying in number from two to four fishers (Lozano-Alvarez *et al.*, 1991; Liceaga-Correa *et al.*, unpublished ms). In January–February 2006 there were 29 teams in the Pescadores de Vigía Chico cooperative, 12 teams in the Cozumel cooperative and 11 teams in the J.M. Azcorra cooperative. New teams are formed each fishing season, but the duration of a particular team varies from months to years. Not all members possess a campo, but all are taken into account when teams are formed as this provides access to the campos. In some instances, it is a matter of an individual's decision to possess a campo, due the implied investment needed to build casitas. A comparative bio-economical study conducted in several coastal localities in the Yucatan shelf found that fishers of Punta Allen made the large investment needed to get into this fishing activity, but they also obtained the highest economical returns

(Seijo *et al.*, 1991). According to a survey in progress, this previous result continues.

Lobster catch and effort records for a series of approximately 30 successive fishing seasons, from 1975–1976 to 2006–2007 are available for the Pescadores de Vigía Chico cooperative (Figure 5A, B). After a peak catch of 201.2 t whole weight during the season 1986–1987, the catch followed a marked decline, falling to a minimum of 58.2 t during the 1996–1997 season (Figure 5A). Afterwards, the catch recovered, but never

TABLE 2

Number of artificial habitats or casitas deployed for the fishing cooperatives Pescadores de Vigía Chico, Cozumel and Jose M. Azcorra fishing lobster in two bays pertaining to the Sian Ka'an Biosphere Reserve

Year	B. Ascension P. Vigía Chico	B. Espiritu Santo Cozumel	JM Azcorra	Author, methods and comments
1981	9 500	8 750	-- ^{a)}	Miller (1982b), 7-12 x 10 ³ for B Ascensión; 7.5-10 x 10 ³ for B. Espiritu Santo.
1985	>10 000	--	--	De la Torre & Miller (1987), Miller (1989). They report an area of 160 Km ² occupied by 150 "campos".
1986	20 000	--	--	Lozano-Alvarez <i>et al.</i> (1991), inter-views to fishers.
1988	26 526	--	2 500	Cesar-Dáchary & Arnaiz-Burne (1989); interviews to fishers.
1991	--	4 400	1 700	Sosa-Cordero <i>et al.</i> (1996), inter-views to fishers. Report 60 "campos" for Cozumel and 54 for JM Azcorra.
1995				
1999	16 950	--	--	Briones-Fourzan <i>et al.</i> (2000).
2002	17 600	--	-	Liceaga-Correa <i>et al.</i> (unpublished ms); interviews to fishers. Report an area of 246 km ² occupied by 117 "campos".
2006	18 600	2 300	1 900	This work, interviews to fishers in January-February 2006. Reporting 101 "campos" for Vigía Chico, 45 for Cozumel and 39 for JM Azcorra.

Notes: a) This cooperative was created in 1983.

Authors, methods and some related comments are included.

achieved the high levels of the middle 1980s (Figure 5A). Fishing effort tracks the catch trajectory, meaning that fishers adjusted to the low abundance and reduced costs when the resource was scarce (Figure 5B). Under these circumstances, the annual catch per unit effort is an index reflecting fishing efficiency more than resource abundance (Fig. 5B). The CPUE index reached high values during the last fishing seasons – closer to those registered in the middle of the 1980s when the catches were noticeably higher (Figure 5A, B).

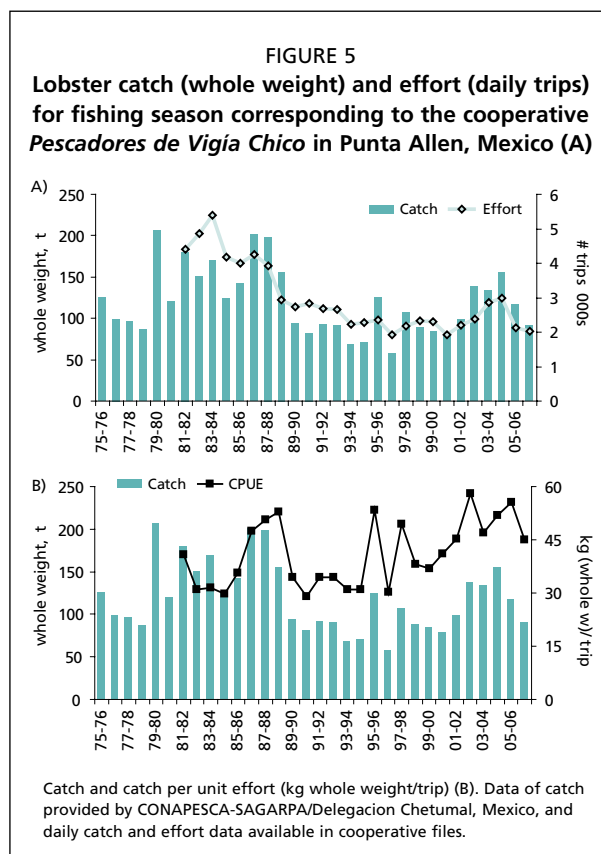
Most of the catch from the two bays is composed of immature lobsters (Lozano-Alvarez *et al.*, 1991; Sosa-Cordero, Ramírez González and Domínguez Viveros, 1996; Briones-Fourzan *et al.*, 2000). A recent survey carried out in Bahía de la Ascension during the fishing season 2005–2006 found that ~12 percent of the catch are of sub-legal sizes (Sosa-Cordero, unpublished data). Although this can be an anomalous percentage observed after Hurricane Wilma hit the coast (October 2005), it does represent an issue deserving further attention. There, fishers are catching lobster just when they reach the minimum legal size; hence, varying the size of first capture (L_c or $L_{50\%}$) is a question to be explored experimentally, through participative research.

Until the middle of the 1990s, the fishing activity was the only significant economic activity in the Punta Allen community, and there was almost an exact correspondence between fishing cooperative and the Punta Allen community (Seijo and Fuentes, 1989; Miller, 1989). This changed noticeably over the past decade, when tourism activities emerged as an alternative economic activity and increased sustantively (Briones-Fourzan *et al.*, 2000; Solares-Leal and Alvarez-Gil, 2003). In 1994 the first tourism cooperative was formed, and now there are four of these cooperatives and several private enterprises (Solares-Leal and Alvarez-Gil, 2003). The number of visitors, mostly from Europe, grew from 15 000 in 1996 to around 50 000 during 2001 (Solares-Leal and Alvarez-Gil, 2003). The major tourism activities are snorkeling, fly-fishing and wildlife observation, e.g. bird-watching.

Participation of lobster fishers in tourism activities is facilitated by the high complementary seasonality of both, lobster fishing having a peak in July–August; and tourism activity peaking in November–December (Briones-Fourzan *et al.*, 2000), (Solares-Leal and Alvarez-Gil, 2003).

2.4 Management

This component includes management regulation and plans, as well as research and development programmes. Application of federal laws related to fishing such as those for regulatory measures, concessions and permissions is the responsibility of the federal authorities pertaining to the national commission on fishing or *Comision Nacional de Pesca* (CONAPESCA), which is headed by Ministry of Agriculture, Cattle and Fishing or (*Secretaría de Agricultura Ganadería y Pesca SAGARPA*). The enforcement of the law corresponds to another office of the federal government, the *Procuraduría Federal para*



la Proteccion del Ambiente (PROFEPA). Officers of this department conduct regularly inspections at the docks of fishing boats and of processing plants. A persistent problem is the low number of inspectors and a lack of resources. The fishing cooperatives harvesting lobster in the two bays must regularly fulfill a series of requirements for CONAPESCA and fully observe the current regulations (see Section 3).

Further, the Sian Ka'an Biosphere Reserve (SKBR) was created in 1986 enclosing Bahia de la Ascension and the bay of Espiritu Santo. The management plan for the SKBR defines zones subject to different use patterns and restricts human activities related to fishing and tourism, affecting the fishers and people living in the SKBR. For instance, until the early 1980s, casitas were constructed mostly using logs of a local palm, *Thrinax radiata*. Consequently this palm was heavily exploited and in 1988 a ban was implemented on cutting this palm (Briones-Fourzan *et al.*, 2000). In response, fishers from the cooperatives first imported logs from distant areas and then developed alternative designs of casitas built entirely of ferrocement (Briones-Fourzan *et al.*, 2000). In some cases, internal rules or cooperative agreements has been included in the management plan, e.g. prohibition of SCUBA and Hookah as fishing gear. Hence, it can be concluded there is a strong interaction between fishers and SKBR authorities. Staff and authorities of the SKBR belong to the national commission of protected areas or *Comision Nacional de Areas Protegidas* headed by the ministry of environmental issues or *Secretaria del Medio Ambiente y Recursos Naturales* (SEMARNAT). A set of internal rules has also been developed by fishers belonging to the fishing cooperatives. The special case of the Pescadores de Vigia Chico cooperative is presented in detail in the next section.

The fishing cooperatives of the two bays are always open to collaboration in research. This has been a particular characteristic of the Pescadores de Vigia Chico cooperative since the late 1970s (Miller, 1982 a,b; Seijo and Fuentes, 1989; Seijo *et al.*, 1991; Lozano-Alvarez *et al.*, 1991; Liceaga-Correa *et al.*, unpublished ms). They provide information to any scientist interested in the fishery and its environment. The same applies to the other fishing cooperatives located in Bahia del Espiritu Santo, although there has been only a few studies there (Sosa-Cordero *et al.*, 1996). As a consequence the Punta Allen fishery is one of the most studied fishing locality in the Mexican Caribbean (Briones-Fourzan *et al.*, 2000).

3. A REGULATORY HISTORY OF THE FISHERY

The current regulations for fishing spiny lobster are contained in the federal law NOM-PESC-006-1993 (*Diario Oficial de la Federacion*, 1993) and are:

- i. a four-month closed season from 1 March to 30 June in effect since 1989 and previously (1967–1988) from 15 July to 15 March;
- ii. a minimum legal size of 13.5 cm tail length, equivalent to 74 mm of carapace length (CL) in effect since 1979; and
- iii. the catch of egg-bearing females is prohibited.

The law includes also a statement on fishing effort, that it must be controlled and stabilized.

A concession, granted by the federal government, is required in order to have access to the spiny lobster resource. This concession refers explicitly to a geographical area (bay or coastal tract) authorized as a fishing ground. From 1950 to 1992, fishing cooperatives in Mexico were by law the only organizations having access to the spiny lobster resources. In 1992, the law was changed and lobsters are no longer exclusively allocated to cooperatives. However, *de facto*, cooperatives are still the only organizations granted fishing concessions, due to their background and expertise as historical users, their readiness to fulfill the new requirements to obtain concessions and their political influence.

The Pescadores de Vigía Chico cooperative has the concession to an area of 850 km² entirely enclosing the Bahía de la Ascension (760 km²) and a narrow tract of the coast (85–90 km²) northwards of the bay. Two cooperatives possess the federal concession to harvest lobster in Bahía Espíritu Santo (350 km²), the northern area was granted to the Cozumel cooperative and the southern was allocated to the cooperative “Jose M. Azcorra”.

In Mexico, the seabottom is federal property and by law cannot be owned by individual citizens or private companies. This legal restriction has been effective since the early stages of the campos system development though subsequently local fishers grouped in the cooperative *Pescadores de Vigía Chico* found an interpretation to handle this asserting that while the seabottom is federal property, the casitas deployed over the seabottom are property of the fishers who build, maintain and use them (Miller, 1982a,b; Seijo and Fuentes, 1989; Seijo, 1993). Thus, the main purpose of individual campo or marine plot delimitation was to protect the investment on casitas made by the fishers. Internally, the members of the cooperative accepted this view and it provides the basic principle for the respect of individual campos and has become the cornerstone of the campos system until the present (Figure 4).

Federal regulations applying to the exploitation of the spiny lobster not only have been fully observed by the Pescadores de Vigía Chico cooperative, but also have been reinforced through extra penalties internally agreed upon by the cooperative. In some cases, the internal penalties are more severe than those of the federal government (Miller, 1982a,b; Seijo and Fuentes, 1989; Seijo, 1993). This is consistent with the fishing cooperative attitude to the law and has evolved as a remarkable tradition of this cooperative: the high respect for the federal law and internal regulations.

Other cooperative internal policies, such as its closed membership, excepting as members only sons of fishers, and the prohibition of use SCUBA or Hookah diving to harvest spiny lobster represent extra regulations self-imposed by the fishers grouped in cooperatives. These actions also promote the health of the fishery and the resource.

4. DESCRIPTION OF SELF-GOVERNANCE INSTITUTION; HOW IT EMERGED AND HOW IT OPERATES

The fishing cooperatives represent the most important institutions regarding the spiny lobster fishery in Punta Allen, as well as the lobster fishery in Bahía del Espíritu Santo, although the latter is less developed (Sosa-Cordero *et al.*, 1996). The legal framework regulating the structure and function of these cooperatives is composed of four laws.

- i. Federal fishing law, which applies to fishing activities country-wide. It refers to several resources subject to exploitation, imposing requirements and specific regulations on fishing.
- ii. General law for cooperatives: it applies to every cooperative in Mexico.
- iii. “*Actas y bases constitutivas de la Sociedad Cooperativa de Producción Pesquera Pescadores de Vigía Chico S.C.L.*” (Anon., 1995), this is a foundational document whose observance is mandatory for each cooperative. It establishes the purpose and scope of activities of the fishing cooperatives, including the specifics of the membership, administrative organization and operational issues,
- iv. “*Reglamento interno de Trabajo*” the internal rules of each cooperative. An internal document applying to the Pescadores de Vigía Chico cooperative is reviewed in detail, later in this section (Table 3).

In summary, a fisher belonging to one cooperative must be aware first of (i), and then of (iii) and (iv), because they closely regulate his daily activities.

Since its inception, the campos system required the internal acceptance by the fishers grouped in the Pescadores Vigía Chico cooperative, as well as a form of government recognition that implied an *ad hoc* interpretation of federal law regarding ownership

TABLE 3
Internal rules developed by the fishing cooperative *Pescadores de Vigía Chico* in the Punta Allen lobster fishery

Articles	Purpose of each article or issue it deals with
# 1-7	Declaration of purpose of the internal rules (A1), obligation of every fisher to know them (A2), penalties for fishers who do not attend the General Assembly (GA) meetings (A3, A4) ways to justify the absence in GA meetings (A5), media to announcement of meetings (A6) and frequency of meetings (A7).
# 8	Duties and obligations of cooperative directors and commissioners to accomplish their tasks, setting the penalties (fines and lose of administrative positions) for non-compliance
# 9	On duties and obligations of the cooperative accountant to attend the various meetings and its full availability to provide the needed support.
# 10	Defines procedures for the payment of fines, who is in charge of collection of payments, penalties if somebody reacts aggressively.
# 11	Penalties for cooperative members who (a) sell lobster outside to the cooperative and (b), fish lobster during the closed season. In both cases, the fisher will be ejected of the cooperative, losing all their rights and properties: campos, boat, motor and pending payments in the previous season. This property is transferred to the cooperative.
# 12	It is mandatory for fishers to mark properly the borders defining the limits of their campos.
# 13	Set penalties to fishers for using nets, traps, in fishing grounds or campos belonging to other fishers. The fisher invading a campo automatically loses the fishing gear used, which becomes property of the fisher possessing the right over the invaded campo.
# 14	Forbids the deployment of stationary nets (silk or monofilament) in the bay.
# 15	Sets penalties for fishers diving for lobsters in campos of other fishers having artificial habitats, located in either the back-reef or fore-reef: the fisher loses his fishing equipment: boat, motor and artificial habitats.
# 16	Sets fines to fishers throwing fish waste or lobster heads on campos or the beach of the town (specific limits are cited).
# 17	Fisher who hire as partners or helpers somebody who was expelled from the cooperative in the past; the first offence is a fine. The second offence results in loss of the rights to harvest lobster during the current season.
# 18	The cooperative allows only students of fishing technical schools to catch lobsters as helpers of a fisher belonging to the cooperative. They must have the proper identification to show to cooperative officers. In the contrary Article 17 applies.
# 19	Fishers who invite a parent to fish must notify the surveillance commission to get the proper permission.
# 20	Diving for lobsters is forbidden for all fishers who do not possess campos adjacent to the fore-reef, as there are a great number of ovigerous lobsters in this area.
# 21	Fishers in possession of sub-legal size lobsters in his boat or elsewhere will pay a fine, rated at \$10/kg.
# 22	Fishers in possession of lobster tails showing remains of egg-mass are fined.
# 23	Fishers in possession of live egg-bearing lobsters must return them to the sea (or pay a fine).

of the seabottom. A key element relating to the first issue is the agreement of a set of internal working rules (*Reglamento Interno de Trabajo*), a document containing a series of rules with the purpose of maintaining the internal structure, promoting cohesion aiming at solving common conflicts and penalizing undesirable behavior of fishers when interacting with (a) other fishers (internally) and (b), external actors, including the government. Due to their importance as a tool for self-governance of this cooperative, these rules are presented here as a synthesis of their 23 articles (Table 3). Four articles, 12–15 are directed to protect the individual campos from other fishers and this is a sensitive issue for the members of this cooperative. It is not surprising that a rigorous penalty applies to fishers diving for lobster in a campo allocated to another fisher: the miscreant forfeits his equipment – boat, motor and artificial shelters (Article 15, Table 3). Five articles (11, 20–23; Table 3) directly reinforce the federal regulations for lobster harvesting contained in the *NOM-PESEC-006-1993*. In particular, Article 11 imposes a severe internal penalty for fishers violating the closed season (ejection from the cooperative and loss of their property) compared to the federal law. Less severe internal penalties are prescribed for fishers that contravene the minimum size limit of lobster and catch egg-bearing females. Those differences could imply that the closed season is considered the most important management regulation by the fishers; or alternatively, that it reflects previous experiences for which regulation needs more severe penalties in order to minimize violations.

Although this set of rules is accepted internally, it has been used as evidence in court cases as part of the process of the formal justice system. In at least two cases, members ejected from their cooperative claimed jurisdiction was held by the federal authority

and went to trial. After the cooperative lawyers demonstrated that all members of the cooperative had signed and knew the internal rules, the judges delivered sentences supporting the cooperative decision (Manuel Mendoza, pers. comm.). This was one of the first formal acceptances of the internal rules by government authorities outside the cooperative. In general, the federal government has tacitly accepted the internal rules of this cooperative and expressed a high degree of tolerance toward the campos system, which shapes the organization of this cooperative. It can be viewed as a wise response of the federal government in light of the relative success of this cooperative, in terms of productivity and sustainability of the fishery.

5. DISCUSSION

In the face of the need to make a living, local fishers grouped in the Pescadores de Vigía Chico cooperative built with great effort an organizational structure (the cooperative) and a self-governance institution (internal rules) according to their needs and consistent with their interests. During this process they obtained incentives through the lobster catch and the high prices this resource commanded. Their first step consisted in assuring that the campos system was maintained through a single organization that evolved within a smooth organizational climate. In parallel, a second requirement was fulfilled through a tradition of high respect for the law, both federal and internal. Observance of the law was perceived as an advantage by fishers. This desirable individual and collective behaviour was the basis for maintaining the high benefits to all the participants. Since the beginning, the fisheries learnt that it was preferable to solve their conflicts internally, among partners, given the isolation of the fishing village, located far away from the formal authorities.

The efficient gear used – casitas – implied a large investment and, when deployed over a productive fishing ground for lobsters, resulted in relatively high financial returns to the fishers. Both, investment and benefits engendered protection for self-interest. This, in turn reinforced the respect to law. Thus, the circle was closed, circumventing the many forms of ‘social traps’ often arising in fisheries (Seijo, Defeo and Salas, 1998).

The time trajectory followed by available indicators of catch and effort indicates that the Pescadores de Vigía Chico cooperative achieved success regarding the effective reduction of fishing effort. Effort indices showed that the number of fishers, boats, casitas and daily fishing trips reached their maxima during the late half of the 1980s, after which all of these experienced declines (Figures 3 and 5; Table 3). Effort reduction was not by design, indeed it reflected rational behaviour on the part of the fishers. In the practice, it represented the application of hard and difficult responses to economic problems affecting the cooperative due to a combination of low catches after Hurricane Gilbert (September 1988) hit the coast (Sosa-Cordero, 1995) and a poor financial decision concerning a loan to build a processing plant (Briones-Fourzan *et al.*, 2000). Another element of the success of this cooperative is its high productivity (Figure 2, Table 1) and efficiency (Figure 5 A, B). Overall, this cooperative devised original and simple tools such as the campos system and a set of internal rules (Table 3) that have the merit of aligning the self-interest of individual members with their collective interest (Hilborn *et al.*, 2004, 2005).

The geographical isolation is among the factors identified to explain the success of the Punta Allen lobster fishery. Although this partially contributed to the cooperative’s success, the high mobility and job opportunities outside Punta Allen must also be considered. The fishing localities are relatively isolated, but the adjacent areas offer good job opportunities related to the tourism. Thus, fishers who are expelled, and others looking for alternative jobs, have comparable livelihoods opportunities in nearby towns, such as Tulum and Playa del Carmen. Indeed, in Punta Allen there is now growing tourism activity (Briones-Fourzan *et al.*, 2000; Solares-Leal and Alvarez-Gil, 2003). These factors have favored the success and performance of this lobster fishery.

Two factors linked to the success of the Punta Allen must be stressed. One is leadership, the second is the tradition of respect for the law (federal and internal). Leadership and a sense of empowerment are derived from the highly democratic process, open discussion and transparent agreement in the meetings of General Assembly of the cooperative: this provides the maximum authority (Seijo and Fuentes, 1989). In these meetings the principle of one fisher, one vote promotes equity among all the members. When this is combined with the respect for the law as the preferred way to solve conflicts, the means are enabled to achieve the success as observed in the Punta Allen lobster fishery. Both factors are requirements for successful self-governance (Kooiman and Bavinck, 2005). Again, authors arguing that overfishing is a consequence of poor governance systems (Hilborn *et al.*, 2004), could use the case of Punta Allen lobster fishery as a basis for this assertion.

Any attempt to replicate the specifics of the system developed in this fishery in different contexts makes little sense. Instead, it can be argued that some general principles inspired by the Punta Allen lobster fishery are feasible to apply in other fishing communities. For example, a first principle could be the need for the creation of a cohesive group structure, e.g. a cooperative, a syndicate, an union of fishers. A second need is to establish a number of internal rules that facilitate the solution of conflicts among fishers and between fishers and external actors, preferably embracing the formal laws of the government. The third, and hardest principle, is to build a tradition of respect for the law, both internal and federal. Other actors, such as governments must collaborate to this end, through thoughtful interventions, as has been the case here.

Among the challenges that can be named for the system developed in the Punta Allen lobster fishery are the following: (a) it is highly desirable that most of the members of the cooperative possess at least one campo – equity from the perspective of a member could be through having a share on the investment in fishing equipment (casitas, fishing boat, etc); (b) mechanisms to maintain a number of desirable properties such as good compliance with the law (federal and internal), existence of the observance of democratic processes within the cooperative, (c) training opportunities for new leaders; (d) closed membership; (e) improved fishing practices to maintain a reasonably low percentage of sublegal sizes in the catch and (f), a balance between fishing and tourism activities so as to minimize conflicts among the sectors. One interesting issue will be how the experience gained by the fishers in facing challenges during the 1980s and 1990s will be transmitted to the new generations that will face new challenges during this century.

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