



Local Institutional Responses to Global Market Pressures: The Sea Cucumber Trade in Yucatán, Mexico



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SUMMARY

The expansion of global seafood trade creates opportunities as well as risks for small-scale fisheries (SSFs) livelihoods. Markets provide economic opportunity, but without effective governance, high demand can drive resource degradation. In the context of small-scale sea cucumber fisheries in Yucatán, Mexico, this study documents local governance responses to new markets and identifies factors driving those responses. We conducted a comparative case study of two SSF communities, collecting participant observation and interview data during 16 months of fieldwork. Our study found that local rules-in-use did not match government regulations and that the emergence of local rules was shaped by relations of production in each study site. Specifically, patron–client relationships promoted an open access regime that expanded local fishing fleets while fishing cooperatives attempted to restrict access to local fishing grounds through collective action and multi-level linkages with government. We propose that the different material incentives arising from the way that patron–client relationships and cooperatives organize labor, capital, and profits help explain these divergent governance responses. We hypothesize that this finding is generalizable beyond the study context, especially given that patron–client relationships and cooperatives are common throughout the world's SSFs. This finding builds on previous research that indicates local institutions can mediate the effects of market pressures, showing that the emergence of local rules depends on how resource users are organized not just in relation to resource governance but vis-à-vis the markets themselves. Therefore, effective policies for SSFs facing market pressures require a greater emphasis on regulating local-level trade and governing the commercial aspects of fishing livelihoods. These lessons are relevant to the estimated 540 million individuals whose livelihoods SSFs support who may increasingly engage in the global seafood trade.

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1. Introduction

Seafood is one of the most traded food commodities in the world and the volume of seafood exports has continued to expand in recent years (FAO, 2014b, 2014c). The intensification of global seafood trade has generated both optimism and concern for the well-being of small-scale and developing country fisheries. Revenue from high-value seafood exports may contribute to food security in developing countries and enhance small-scale fishing livelihoods (FAO, 2014c, Asche, Bellemare, Roheim, Smith, & Tveteras, 2015). However, the evidence is inconclusive regarding whether trade benefits actually reach producers (Béné, Lawton, & Allison, 2010; Smith *et al.*, 2010). Furthermore, market pressures often correlate with degradation of fisheries resources, threatening small-scale fishing livelihoods (Berkes *et al.*, 2006; Brewer, Cinner, Fisher, Green, & Wilson, 2012; Cinner, Graham, Huchery, & Macneil, 2013; Cinner & McClanahan, 2006).

Small-scale fisheries (SSFs) constitute 90% of the world's fishers and contribute nearly half of the global fish catch (FAO, 2014b). Governed appropriately, they can play an important role in promoting poverty alleviation and food security around the world (Béné, Macfadyen, & Allison, 2007; FAO, 2015). Many SSFs are located in developing countries where they increasingly contribute to seafood exports (Lem, 2003; Purcell & Pomeroy, 2015). Therefore, understanding the factors that contribute to sustainable and unsustainable resource governance under market pressures stands to benefit the hundreds of millions of livelihoods that SSFs support (FAO, 2014b).

Local self-governance institutions play a particularly important role in SSFs, but faced with market pressures, local governance can be fraught. Many SSFs operate in countries with limited government capacity for fisheries management and enforcement, increasing the burden on resource users themselves to safeguard resources through local institutions (Berkes, 2001). But it is unclear

whether or not local institutions are robust to market pressures (Cinner & Aswani, 2007). In some SSFs, the presence of market pressures correlates with the erosion of local tenure regimes (Cinner, 2005; Cinner, Sutton, & Bond, 2007) while in others, market connections seem to strengthen local governance (Hviding, 1996; Ruddle, 1993).

We aim to contribute to a better understanding of why some local governance regimes gain strength while others falter in response to market pressures. To this end, our study investigates how the two most common relations of production in SSFs (fishing within associations or as individuals for a capitalist) influence different local institutional responses to market pressures. We research these questions in the context of sea cucumber fisheries, a globally traded seafood destined for Asian markets and sourced primarily by small-scale fishers in the global South (Purcell *et al.*, 2013).

Through a detailed analysis of sea cucumber governance in two small-scale fishing communities, our study demonstrates the influence different relations of production have over the governance of highly-valued resources. We find that well-organized fishing cooperatives can more easily find incentives to develop rules-in-use to control access and use. Yet their effectiveness is limited by the intra-community dynamics between fishing cooperatives and patron–client relationships, which ultimately shaped how each community governed their local fishing grounds in our study. The implications for designing effective management of SSFs under market pressures are twofold. First, formal regulations that are coherent with local incentives and capabilities for enacting and enforcing rules are more likely to be effective. This requires paying attention to the existing relations of production in place at the local level. Second, settings where national policies favor relations of production that discourage fishers from organizing into associations and encourage them to individually contract with a patron or capitalist will find it challenging to withstand global market pressures on the supply of local resources, to the detriment of the well-being of their coastal inhabitants.

(a) Sea cucumber fisheries under market pressures

Sea cucumber has been traded for over 1,000 years (Friedman, Eriksson, Tardy, & Pakoa, 2011). However, since the middle of the 20th century global catch has increased more than 13-fold from about 2,300 mt to 30,500 mt and stocks are being discovered and exploited at an increasingly rapid rate (Anderson, Flemming, Watson, & Lotze, 2011). Hong Kong, the largest importer of sea cucumber, reported nearly 6,000 mt of imports in 2011 at a price of 64 USD per kilogram (Figure 1). As sea cucumber fishing has undergone a geographical expansion outward from primary markets in Asia, many stocks have been subsequently depleted (Figure 2).

More recently, as sea cucumber demand has remained strong and modern trade networks have become increasingly efficient, this pattern of geographical expansion has given way to a situation in which almost any stock is within reach of Asian markets. Although production has peaked and subsequently declined in Hong Kong's main sea cucumber sourcing countries, overall imports have remained high, in part accomplished by sourcing sea cucumber from 48 new countries during 1996–2011 (Eriksson & Clarke, 2015; Eriksson *et al.*, 2015). As a result of trade, the status of sea cucumber stocks around the world is dire, with 14% of the world's sea cucumber fisheries fully exploited, 20% depleted and 38% overexploited (Purcell *et al.*, 2013).

The stakes are high for solving the management crises pervading sea cucumber fisheries. Overfishing is likely to bring structural changes to ecosystems including vulnerable coral reef systems (Friedman *et al.*, 2011). If sustainably managed, sea cucumber fish-

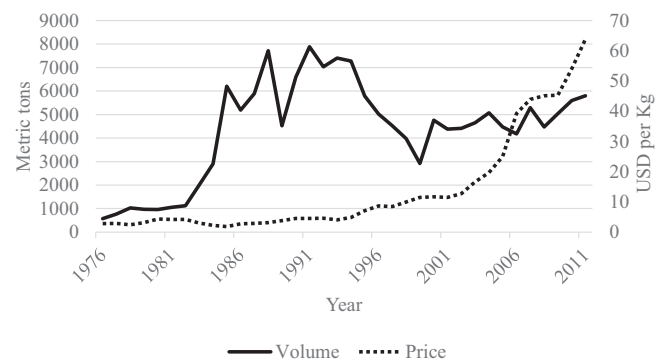


Figure 1. Hong Kong sea cucumber imports: Volume and price. Data retrieved from FAO (2014a).

eries can confer substantial livelihood benefits on an estimated three million fishers worldwide (Purcell *et al.*, 2013). Many communities have already become dependent on the high income the fisheries can generate (Anderson *et al.*, 2011; Dissanayake, Athukorala, & Amarasingi, 2010; Joseph, 2005; Toral-Granda, Lovatelli, & Vasconcellos, 2008).

Governments have employed a range of management tools in efforts to avoid degradation of sea cucumber populations. Common regulations include minimum size limits, individual or seasonal quotas, gear restrictions, closed seasons, and controls on the number or size of fishing vessels (Purcell *et al.*, 2013; Toral-Granda *et al.*, 2008). Management measures that are highly conservative in terms of fishing effort, levels of extraction, and duration of fishing seasons have been effective when coupled with continual re-evaluation of stock status (Léopold *et al.*, 2013). Adaptive precautionary fishery closures that are responsive to changes in fishing effort and abundance have maintained healthy stocks (Eriksson, De La Torre-castro, & Olsson, 2012) and marine reserves have seen some success in sustaining sea cucumber populations (Cariglia *et al.*, 2013).

However, most examples of sustainable sea cucumber management are from countries in the North where enforcement capacity and the complexity of regulations is high (Akamine, 2005; Clark, Pritchett, & Hebert, 2009; Purcell, Lovatelli, Vasconcellos, & Ye, 2010; Purcell *et al.*, 2013). These management models do not transpose easily to sea cucumber fisheries in the South. Indeed, some management measures that are effective in the North such as rotational zoning systems may actually put sea cucumber populations at further risk of collapse in low-income countries that have limited capacity for enforcement and knowledge of target species' biology (Purcell, Eriksson, & Byrne, 2016; Purcell, Uthicke, Byrne, & Eriksson, 2015).

The vast majority of the world's sea cucumber fisheries are located in tropical countries in the South where management is troubled. More than one third of sea cucumber fisheries lack any management measures at all (Anderson *et al.*, 2011; Toral-Granda *et al.*, 2008). Catch and abundance data as well as basic biological information about commercially targeted species are frequently missing, undermining management efforts (Anderson *et al.*, 2011; Friedman *et al.*, 2011). Even where substantial governance institutions have been developed, for example the adaptive co-management regime in the Galapagos Marine Reserve, conflict and illegal fishing are pervasive (Defeo *et al.*, 2014; Hearn, 2008). Enforcement is limited in many countries, with more than a quarter of fisheries operating illegally even after the establishment of moratoria (Purcell *et al.*, 2013). Hong Kong has reported 1.3 times greater annual import volumes than all global exports combined, underscoring the magnitude of illegal and unreported catches (Anderson *et al.*, 2011).

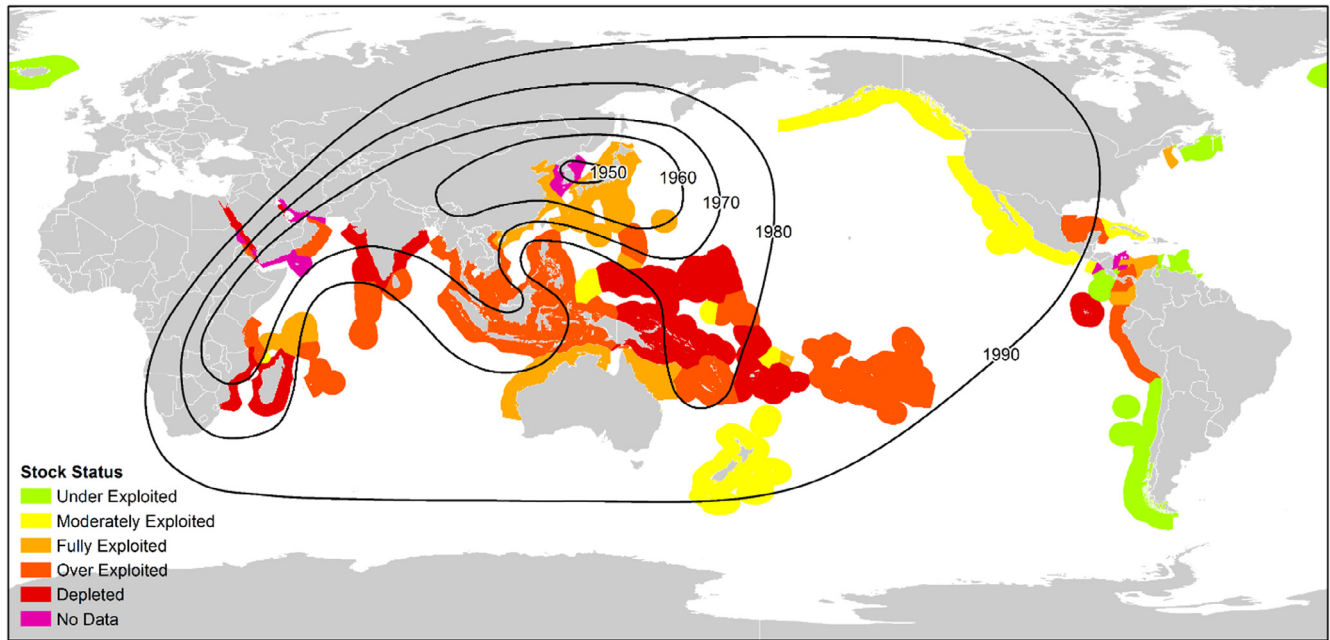


Figure 2. Global expansion of the sea cucumber trade: Stock status and year of fishery establishment. Sea cucumber stock status is reported by Purcell et al. (2013). Years of establishment of sea cucumber fisheries is reported in Anderson et al. (2011). The country and EEZ map elements are based on GIS datasets available in the public domain, accessible through FAO GeoNetwork and marineregions.org.

Driven by high demand and global trade networks, sea cucumber fisheries epitomize the challenges and opportunities of sustainable governance of species with high market value. The apparent limitations of top-down management in sea cucumber fisheries around the world suggests the need to better understand and enhance bottom-up governance responses. This involves investigating how resource users respond to the incentives generated by market pressures and the strategies available to them. We studied these local-scale governance processes in a newly established sea cucumber fishery in the Yucatan Peninsula, Mexico.

(b) Yucatan Peninsula sea cucumber fisheries

Small-scale fishing communities in Mexico's Yucatan Peninsula have recently begun harvesting sea cucumber for commercialization into export markets. In 2006 and in 2010 through 2012, the National Fisheries Commission (CONAPESCA) permitted harvests of the species *Isostichopus badionotus* and *Holothuria floridana* under fishery development permits to evaluate the commercial and ecological viability of the fishery. The 2010–12 development permits allowed for between 215 and 303 fishing vessels to harvest between 1280 and 1773.6 mt of sea cucumber (SAGARPA, 2015b). The presence of previously un-fished stocks allowed the Yucatan Peninsula's production to rapidly overtake the country's older Pacific sea cucumber fisheries (Figure 3).

In 2012, both species were incorporated into the National Fisheries Chart (INAPESCA, 2012), which contains information on the abundance of each species, the fishing fleet, and regulations. The National Fisheries Institute (INAPESCA) determined that there were commercially viable populations of *I. badionotus* but not *H. floridana* and the first commercial fishing permits were issued for four short seasons in April–May and November–December, 2013 and February–March and April, 2014 (SAGARPA, 2013a, 2013b, 2013c, 2013d, 2014a, 2014b). Each season authorized between 140 and 569 fishing vessels to harvest a total of between 350 and 1171 mt of fresh sea cucumber (SAGARPA, 2015b). Government regulations for the fishery included limited entry permits

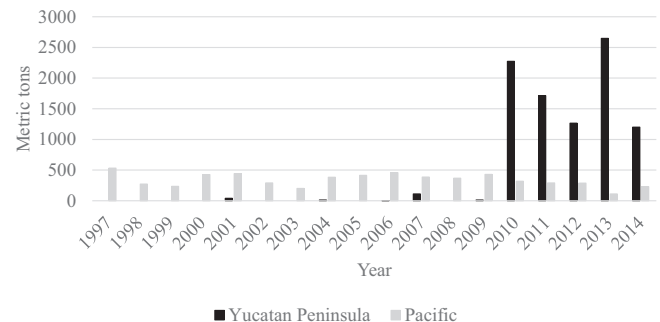


Figure 3. Sea cucumber production in Mexico: Yucatan Peninsula (states of Campeche, Yucatán, and Quintana Roo) and Pacific (Baja California and Baja California Sur) regions. Production data obtained from yearly fisheries and aquaculture reports (Anuarios Estadísticos de Acuicultura y Pesca) 2007–14.

organized by fishing zones as well as closed seasons and fishing quotas (INAPESCA, 2012).

Eight-meter fiberglass fishing vessels with three to four crew members target sea cucumber in nearshore waters. A helmsman steers the boat slowly while one or two divers utilize hookah diving equipment to swim along the seafloor collecting sea cucumbers by hand into a bag. When a diver has filled a bag, he attaches it to a rope and the helmsman lifts the full bag to the surface and lowers an empty bag. A crew member then quickly guts the sea cucumbers and stores them on ice to prevent spoiling. Vessels typically spend four to six hours harvesting sea cucumber depending on weather conditions, productivity, and the physical condition of the divers.

Sea cucumber is commonly referred to in the region as “oro negro” or “black gold” because of its high value. A survey conducted in the region in 2012 reported prices for fresh sea cucumber between \$28 and \$50 Mexican Pesos (MP) per kilogram of fresh sea cucumber (between ~\$2.00 and \$3.70 USD) and between \$270 and \$370 MP (~\$20 and \$26 USD) per kilogram of dried sea cucumber (SAGARPA, 2015b). At this price, earnings are substantial due to the large volumes each vessel can harvest. According to daily landing

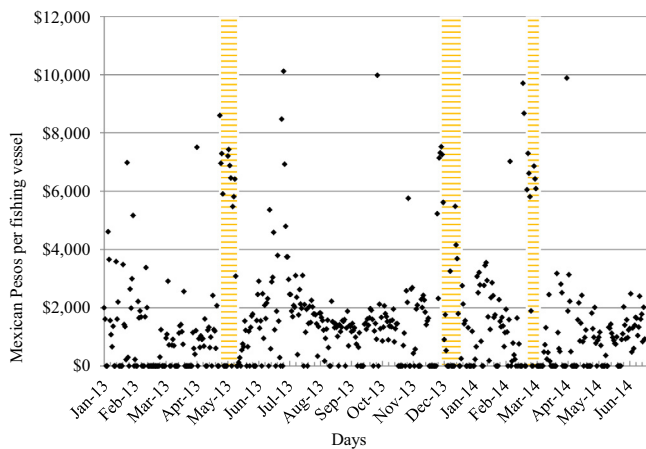


Figure 4. Average daily earnings per vessel in a fishing cooperative in Río Lagartos, January, 2013–June, 2014. Shaded bars indicate sea cucumber seasons.

and payment records obtained from one fishing cooperative in Yucatán, mean daily earnings per boat averaged \$6037.85 MP (~\$459 USD) and reached \$9698.8 MP (~\$737 USD) during sea cucumber fishing seasons. These earnings were higher than almost all other fishing days with the exception of the initial days of lobster fishing season in July (Figure 4).

In addition to fishing crews, the fishery provides employment to a number of other positions including individuals processing sea cucumber, loading and unloading product and supervising processing activities. In some fishing communities, females work in sea cucumber processing. When sea cucumber harvests are bountiful fishing crews often gift sea cucumbers to women and children waiting onshore. The fishery is otherwise predominated by males.

The high-value fishery has affected small-scale fishing communities along the coast of the Yucatan Peninsula. Territorial conflicts among resource users and between fishers and government authorities have been frequent (Canché, 2014a; Canché & Chi, 2014; Euán & Chi, 2014). During one season, the front-page headline of the Yucatán Newspaper read, “War of the sea cucumber fishers: Fishers detained, boats burned, and roadways blocked.” Reports of illegal fishing are common (Por Esto!, 2014a, 2014c; Ucán, 2014c) as well as accusations of corruption in local, state, and federal government (Canché, 2014a; Por Esto!, 2014b, 2014d). Many fishers have died participating in the valuable but risky diving fishery (Chi, 2014; Chi & Euán, 2013; Mandicuti, 2013; Ucán, 2014a, 2014b).

However, these grim reports obscure variation in how local resource users have responded to the high-demand market for sea cucumber. In some communities, fishers have enacted rules in an attempt to control the local fishing fleet and guard local resource stocks from migrant fishers. In other communities, local governance has evolved into open access regimes that expose local stocks to high fishing pressure.

This variation permits us to investigate the factors that shape resource users’ divergent responses to market pressures. We study processes of institutional emergence in two Yucatán fishing communities to develop hypotheses regarding the factors that shape local institutional responses. This is an in-depth study of processes of institutional emergence. As such, it does not evaluate institutional performance. In other words, we do not assess the relationships between local institutions and social, economic, or ecological outcomes. Rather, we seek to explain why particular kinds of institutions emerge under specific conditions, which is a fundamental step toward understanding sustainable environmental governance. The timing of this research provided an opportunity to document processes of institutional emergence as they occurred.

The remainder of this paper is structured as follows. The following section lays out the research approach. Next, the results section first summarizes the government regulations for the fishery and the local rules-in-use in each study site, comparing and contrasting the governance arrangements. Then, to identify factors shaping divergent institutional responses, we provide a detailed description of the emergence of a particularly salient category of governance institutions, boundary rules, which determine access to fishing grounds. The discussion then presents our hypotheses regarding the factors shaping local institutional responses to market pressures, proposes mechanisms to explain the hypotheses, and discusses their generalizability beyond our study context. We conclude by discussing the implications of our findings for developing more sustainable governance of small-scale sea cucumber fisheries around the world.

2. Research approach

This paper builds on common-pool resource (CPR) theory by developing a better understanding of the role that local resource users play in governing common-pool resources (CPRs) linked to global trade. The literature on CPR governance emphasizes the power of institutions to produce a diversity of resource use patterns. Ostrom (2005) broadly defines institutions as “the prescriptions that humans use to organize all forms of repetitive and structured interactions including those within families, neighborhoods, markets, firms... and governments at all scales,” (Ostrom, 2005, p. 3). The literature differentiates between written rules, also called rules-in-form (e.g., governmental regulations) and rules-in-use that structure practices on the ground. Rules-in-use do not necessarily resemble written rules. In sea cucumber fisheries around the world, high rates of illegal fishing signify an incoherence between government regulations and rules-in-use.

One major finding of CPR scholarship has been that resource users have the capacity to devise institutional arrangements for self-governance of CPRs in the absence of, in spite of, or in addition to top-down state management. However robust self-governance institutions are unlikely to emerge unless some combinations of enabling conditions are met (Ostrom, 1990). Where trade is concerned, low or gradual integration with external markets are considered important enabling conditions for robust CPR self-governance (Agrawal, 2001). This finding leads us to ask whether rapid and high integration with external markets precludes resource users from engaging in sustainable commons governance. In addressing this question, we consider key contributions from fisheries economics and critical political economy, two perspectives that have dealt more directly with markets than CPR theory has.

For fisheries economists, sustainability is entirely compatible with market-integration. The threat to sustainability results not from high market demand but from the absence of property rights, which leads to rent dissipation and overexploitation (Gordon, 1954; Wilen, Cancino, & Uchida, 2012). Reconciling governance with the market system through the creation of property rights such as individual transferable quotas (ITQs), individuals quotas (IQs) or even territorial user rights fisheries (TURFs) can eliminate incentives to ‘race to fish’, increase efficiency of the fishery, and even create incentives for resource users to invest in fisheries science and management (Birkenbach, Kaczan, & Smith, 2017; Branch, 2009; Costello, Gaines, & Lynham, 2008; Griffith, 2008; Gutiérrez, Hilborn, & Defeo, 2011). The challenge with this approach, however, is that ITQs and IQs fail when formal governance capacity for monitoring and enforcement is weak. Even for TURFs, which are arguably less institutionally complex and enforcement-intensive, an effective system of rules-in-use and

monitoring and enforcement is a prerequisite for success (Cancino, Uchida, & Wilen, 2007; Rahimi, Gaines, Gelcich, Deacon, & Ovando, 2016). So for the many sea cucumber fisheries operating in the South, rights-based approaches are unlikely to solve existing governance limitations.

Critical political economy and political ecology are wearier of the effects of market integration on livelihoods and sustainability. This literature emphasizes that relations of production defining who controls access to resources, capital, and profits shape patterns of resource use and governance (Peluso & Watts, 2001; Robbins, 2011). Capitalist relations of production frequently have negative effects on resource use, as processes of commodification, accumulation, and the concentration of control over capital and resources within the hands of elites push natural resource use beyond a sustainable limit (Blaikie, 1985; Blaikie & Brookfield, 1987; Campling, Havice, & Howard, 2012; Longo, Clausen, & Clark, 2015). Less pessimistically, recent political ecology also explores how relations of production, power and control in capitalist markets can be re-fashioned in different ways to produce a variety of outcomes (Roelvink, Martin, & Gibson-Graham, 2015).

To flesh out CPR theory's broad conceptualization of market pressures we carefully consider the above insights on how markets affect resource governance. Throughout our analysis, we attend to how local actors seek to establish and enforce property rights and boundaries. We also investigate ways that different relations of production mediate responses to markets.

In SSFs, relations of production at the local level take a variety of forms. Broadly speaking, the two primary relations of production found in commercial SSFs around the world are patron–client relationships and fishing cooperatives (co-ops herein) (Basurto, Bennett, Weaver, Rodriguez-Van Dyck, & Aceves-Bueno, 2013). These two forms represent distinct strategies for organizing fishing capital, labor, commercialization, and profits.

In commercial co-ops, member fishers generally exercise collective control over fisheries property rights (e.g., permits or concessions), capital, and profits from commercialization. Co-ops are defined as an autonomous association of persons united voluntarily to meet their common economic, social, and cultural needs and aspirations through a jointly-owned and democratically-controlled enterprise (FAO, 1971; ICA, 2010). Fishing co-ops are common in SSFs around the world and fulfill a variety of governance functions (Baticados, 2004; Deacon, 2012; FAO, 2012; Jentoft & Sandersen, 1996; Juárez-Torres, Flores-Escobar, & Martínez, 2007; Marín, Gelcich, Castilla, & Berkes, 2012; Ovando *et al.*, 2013; Pollnac, 1988; Unal, Yercan, Guclusoy, & Goncuoglu, 2009). Members often engage in collective action to generate collective benefits such as the joint provision of fishing capital or low-interest loans for boats, motors, fishing gear, reception centers, processing facilities or vehicles for transporting catch. These goods are often provided through membership fees and the co-op's revenue (Bennett, 2017). In most commercial co-ops, each member sells his or her catch to the co-op, then the catch is commercialized jointly to reap benefits from higher-volume sales. Co-ops' profits are typically redistributed among the membership either in the form of aforementioned collective goods or as cash payments.

In contrast, under patron–client relationships, an individual entrepreneur also known as a patron owns fishing capital, such as fisheries property rights, boats, and fishing gear. The patron contracts labor to harvest fish and earns profit from commercializing the harvests. Patron–client relationships are “common economic arrangements . . . that link powerful individuals with numerous subordinates. In exchange for favours, including loans, protection, or intermediation, patrons receive labor, goods, political support or other benefits,” (Johnson, 2010, p. 265). Patrons provide access to fishing livelihoods to individuals who do not belong to a co-op and who cannot obtain fishing capital on an individual basis.

For CPR theory, a focus on relations of production helps specify connections between broadly conceived market pressures and particular institutional arrangements operating in sites of resource use. This approach allows us to open up the concept of market pressures to study how demand generated at the global scale refracts through different local forms of organization to create variegated incentives for resource governance responses at finer scales. We therefore designed our study to compare the emergence of local governance in sites with different local relations of production.

(a) Research design and methods

We conducted a comparative case study with the goals of theory building, hypothesis generation, and conceptual refinement on the topic of local institutions facing market pressures. Detailed case studies, as in other social science fields, have underpinned the development of CPR theory and knowledge on CPR governance (e.g., Berkes, 1986; McKean, 1986; Ostrom, 1990). This study follows in the tradition of other case studies of collective action related to natural resources in that it employs long-term and intensive fieldwork to “discern informal and undocumented arrangements for regulating natural resource use,” and utilizes a combination of interviews, participant observation, and document work, (Poteete, Janssen, & Ostrom, 2010, p. 34).

Our aim was to compare the emergence of resource governance institutions at two sites with different local relations of production. Preliminary fieldwork carried out over two months in June and July 2012 informed the selection of the study sites. Structured interviews with patrons, co-ops, and other community leaders from nine small-scale fishing communities in Yucatán generated data on whether co-ops or patron–client relationships predominated in each community. Based on these data we selected Celestún in western Yucatán and Río Lagartos in eastern Yucatán for a comparative case study (Figure 5).

During subsequent fieldwork (2013–14) we conducted a census to more precisely enumerate the patrons and co-ops operating in Celestún and Río Lagartos. In Celestún, where the number of patrons was substantial, the census was conducted by creating a map of reception centers in the marina and then enumerating each center. The census enumerated all reception centers, which ranged from large cement buildings to huts constructed from tarp and wooden poles. In Río Lagartos, a list of patrons was compiled through conversations with local leaders and other community members rather than through mapping physical reception centers because the number of patrons was small and reception centers were intermixed among other buildings along the boardwalk.

Conducting an independent census was valuable because official statistics do not accurately represent local realities. For example, many patrons do not possess permits and therefore are not included in official statistics. Furthermore, many patrons are formally registered as co-ops in order to receive preferential access to fishing permits and superior tax regulations although in practice they do not function as co-ops. This phenomenon is locally referred to as forming “cooperativas fantasmas,” or “ghost cooperatives.” The census was able to distinguish co-ops according to their organizational and functional structure rather than formal status.

In Celestún, 81 patrons employed a total of 2013 fishers and three active co-ops employed a total of 31 members. In Río Lagartos, nine patrons employed 301 fishers and two co-ops employed a total of 303 members (Figure 6). Unlike those in Celestún, the co-ops in Río Lagartos belong to a federation with co-ops from nearby towns as well as a national confederation of fishing co-ops, which provide political representation at the state and federal levels.

Similarities between Celestún and Río Lagartos make for an appropriate case comparison. Both communities are located in

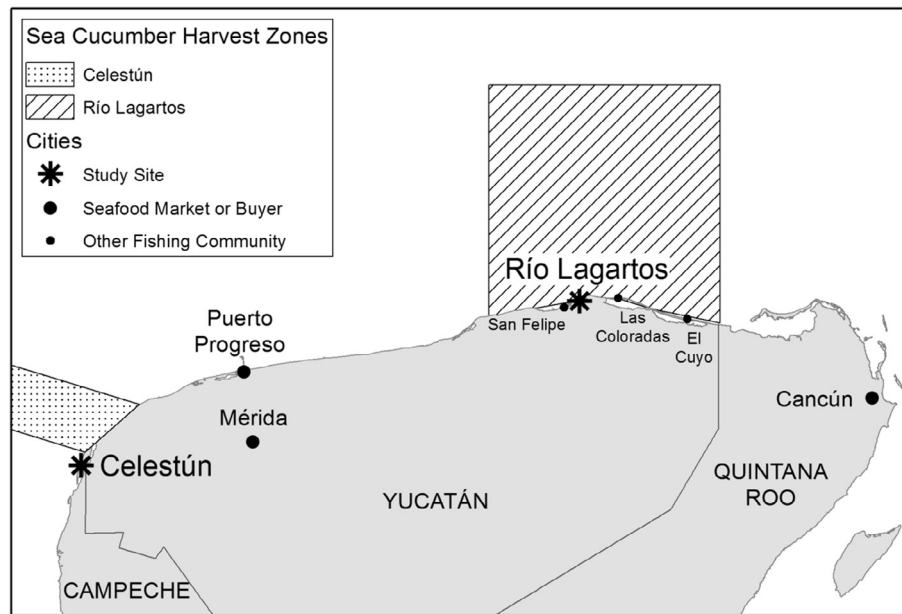


Figure 5. Map of study sites.

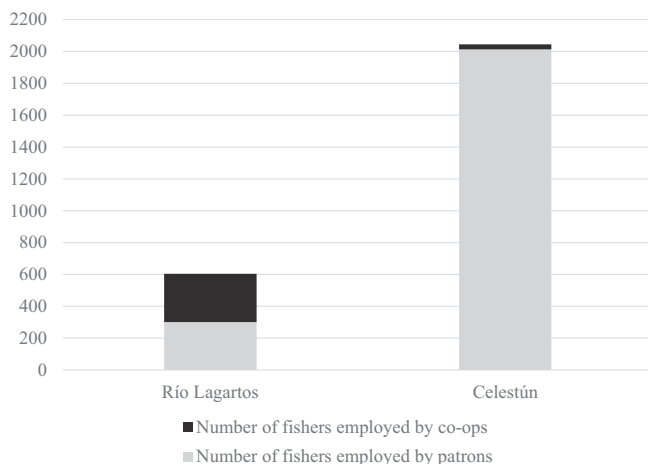


Figure 6. Distribution of the fishing fleet among two different relations of production (patron–client relationships and co-ops) in Celestún and Río Lagartos.

the state of Yucatán, Mexico and therefore subject to the same state and federal fishing regulations. In the municipalities¹ of Celestún and Río Lagartos, 55% and 50% of the population, respectively, is dedicated primarily to fishing (SAGARPA, 2015b). In both communities, multi-species SSFs target primarily finfish, octopus, spiny lobster, and more recently sea cucumber. Both are connected by paved road to nearby market centers. Celestún and Río Lagartos are 105 and 215 km, respectively, from major seafood buyers in the state capital of Mérida and 400 and 300 km, respectively, from major seafood buyers in Cancún. Since the 1980s, population growth in Celestún has outpaced that of Río Lagartos and the population in the Municipality of Celestún is currently about double that of Río Lagartos (INEGI, 2016). While population size may affect local resource governance, these demographic patterns likely co-vary with the presence of different relations of production and designing a comparative study that controlled for population was impossible in this region. We address this issue further in the discussion.

¹ Municipalities also include nearby smaller towns.

Eleven months of fieldwork followed the preliminary fieldwork, documenting the emergence of local rules-in-use governing the sea cucumber fishery in both sites. Fieldwork coincided with the second and third commercial sea cucumber seasons in Río Lagartos (November–December 2013 and February–March 2014) and the second commercial season in Celestún (April 2014), allowing observation of the emergence of local rules-in-use through participant observation. Participant observation activities included observation at co-ops' and patrons' fishing reception centers, working on fishing vessels during sea cucumber seasons, accompanying co-op leaders to commercialize product, and accompanying co-op members in monitoring and enforcement. In addition, participation in daily social life and residing with fishers' families allowed numerous informal conversations and the observation of unanticipated events. To complement observation, we conducted interviews with resource users and other community members about local governance as well as government regulations.

Our analysis was organized using the rule typology described in Ostrom (2005), which delineates and defines categories of rules relevant to any governance context. Two rule types were particularly salient for our case, boundary rules and choice rules. Boundary rules define eligibility and conditions to enter a given position (Ostrom, 2005), for instance who can access and harvest sea cucumbers. Choice rules define required, permitted or forbidden actions to an individual in a particular position (Ostrom, 2005). For a fisher, choice rules may define the types of permitted gears or how much, when, and where to harvest. In addition to these two rule types, we also observed strategies for monitoring and enforcing boundary and choice rules. Together, these rules constitute the operational rules governing sea cucumber fisheries in our study area.

3. Results

We present the results by first comparing and contrasting the rules-in-use in Celestún and Río Lagartos as well as the government regulations for sea cucumber. We organized our summary of the institutions according to rule type (Table 1). For each rule (for example gear restriction or fishing season) we describe the formal government regulation (the written rule) and the local institu-

Table 1
Written rules and rules-in-use in the Yucatán sea cucumber fishery

	Written rules	Rules-in-use	
	Federal	Río Lagartos	Celestún
<i>Choice rules</i>			
Fishing seasons	Fishers may only harvest sea cucumber during the legal seasons	Fishers may only harvest sea cucumber during the legal seasons	None
Fishing gear	None	Fishers may not bring gear other than that used for harvesting sea cucumber aboard vessels	None
Harvest quota	Fishers may not harvest more than the vessel's permitted quota	None	None
Commercialization	A seller may not sell sea cucumber without an official invoice	A seller may not sell sea cucumber without an official invoice	A seller may not sell sea cucumber without an official invoice
<i>Boundary rules</i>			
Fishing permits	A patron or co-op must possess a permit for each fishing vessel	A patron or co-op must possess a permit in order for his/her/its employees/members to fish sea cucumber	None
Number of fishing vessels	A patron or co-op may not utilize any vessels other than those authorized in his/her/its sea cucumber fishing permit for harvesting sea cucumber	The number of vessels a patron or co-op may utilize for harvesting sea cucumber is related to the number of permits he/she/it possesses.	None

tion (rule-in-use) at each study site, highlighting similarities and differences. Few of the rules-in-use in either study site matched government regulations. Furthermore, the complexity and content of rules-in-use varied between the two study sites, Río Lagartos having more complex and stringent rules governing resource access and use than Celestún (Table 1).

Next, we investigated how access (boundary rules) is governed in each study site by describing the distinct strategies that patrons and co-ops used and how power struggles between patrons and co-ops shaped the emergence of boundary rules-in-use. At both sites, co-ops attempted to limit access to local fishing grounds while patrons generally tried to open access and expand fishing fleets. In Río Lagartos, large co-ops were able to assert limited access boundary rules over patrons. The rules they enacted were similar to, but distinct from, the government regulations defining access. In contrast, the smaller co-ops in Celestún were outnumbered and overpowered by patrons who pursued an open access fishing regime.

(a) Fishing seasons

The written rules² concerning fishing seasons are defined by the federal Secretariat of Agriculture, Livestock, Fisheries, and Aquaculture (SAGARPA) with input from the National Fisheries Institute (INAPESCA). They establish the legal periods for harvesting the sea cucumber species *I. badionotus* and typically permit seven to 14 days of fishing per season. Outside of these short seasons, a fishery closure is in effect. Fishing seasons are not guaranteed on a specific date each year. Rather, the opening of a season depends on the results of underwater transect surveys conducted by INAPESCA assessing whether sea cucumber stocks in a given fishing zone meet density, abundance, and size requirements (INAPESCA, 2012).

In Río Lagartos the rule-in-use defining fishing seasons was the same as the written rule. That is, there was widespread agreement among resource users that sea cucumber harvests outside of the legal fishing season were forbidden. Furthermore, reports of local resource users fishing out of season were rare.

In contrast, in Celestún there was no mutually agreed-upon rule restricting harvests to within the legally established seasons. According to conversations with local fishers, two or three large patron–client groups with between 100 and 200 vessels regularly harvested sea cucumber throughout the year, a practice that was well-known throughout the community. At the same time, many

local co-op members and some patrons abstained from fishing out of season. A few patrons cited moral and religious reasons for abstaining. Others voiced environmental concerns. Co-op leaders stated that they did not fish out of season for fear that the government would cancel the co-op's permits for sea cucumber and other species. Despite compliance by co-ops and some patrons, the large portion of the fleet harvesting out of season signifies there was no rule-in-use defining fishing seasons at the community level. Rather, resource users pursued their own strategies largely unconstrained by other community members.

(b) Fishing gear

Unlike some fisheries in Yucatán, for example octopus and some finfish, the written rules for sea cucumber do not explicitly prohibit or require particular fishing gear. Throughout Yucatán, fishers utilize hookah diving equipment and specialized bags for collecting sea cucumber. In the absence of more efficient technologies or technologies that may mitigate harm to stocks, there is no need for a specific institution defining which gears are allowed.

However in Río Lagartos, local rules-in-use for fishing gear existed. Co-ops promoted a rule that prohibited fishers from bringing spear guns or gaffs onboard fishing vessels during the sea cucumber season. The intent of this rule-in-use was to prevent the harvest of other valuable resources such as lobster, finfish, and octopus by divers targeting sea cucumber. A meeting between co-op leaders and patrons in Río Lagartos established a shared understanding of this rule. However, there was no organized monitoring mechanism for this rule, so enforcement occurred only when co-op members happened to observe a vessel using forbidden gear or landing non-target species during the sea cucumber season.

No such rule-in-use was present in Celestún. Indeed, many fishers routinely brought a variety of gear types onboard vessels during the sea cucumber season. This practice was especially common as a way to supplement catch when sea cucumber became scarce.

(c) Harvest quotas

Written rules emphasized fishing quotas to manage sea cucumber. In 2012, the National Fisheries Chart recommended a seasonal quota of less than ten percent of estimated biomass in each fishing zone (SAGARPA, 2012). The issuance of quotas is contingent upon quantitative reference points in the fishery. Specifically, quotas are not issued if the total biomass for a fishing zone is found to

² With the term written rules, we refer to government regulations as opposed to local rules-in-use devised and enacted by resource users themselves.

be below 3,000 mt or if the sea cucumber density is below 10 mt/km². SAGARPA indicated the total allowable quota per fishing zone in the announcement of each fishing season (SAGARPA, 2013a, 2013b, 2013c, 2013d, 2014a, 2014b). In addition, there was a daily limit per fishing vessel of 250 kg of fresh sea cucumber (INAPESCA, 2012). The number of vessels permitted each season therefore reflects the total seasonal quota for each fishing zone.

Despite the emphasis on quotas in the written rules, there were no rules-in-use for harvest quotas in Celestún or Río Lagartos. Fishing authorities did not enforce harvest quotas and local resource users did not develop quota-based rules. Instead, fishing crews harvested as much as possible during fishing trips at both study sites.

(d) Commercialization

Despite not being enforced in fishing communities, harvest quotas were relevant to the written rules regulating the commercialization of sea cucumber. Legal transportation and sale of sea cucumber requires the possession of official invoices, which are documents provided to permit holders (e.g., co-ops or patrons) according to the quotas authorized in their permits. This written rule restricts permit holders from selling volumes greater than their harvest quotas. While, as mentioned above, CONAPESCA did not enforce the volume of sea cucumber harvested, they did monitor volumes transported out of fishing communities. At roadside checkpoints, CONAPESCA inspected vehicles and weighed sea cucumber to verify that invoices matched the amount of sea cucumber being transported. Due to relatively effective enforcement by government authorities, the local rules-in-use for commercialization matched this written rule.

Although resource users shared an understanding of this commercialization rule, many devised noncompliance strategies. The coupling of relatively effective enforcement of quotas during commercialization with the lack of enforcement during resource harvesting generated a surplus of sea cucumber beyond the amount that could legally be transported out of Río Lagartos and Celestún for commercialization. Some permit holders re-used invoices that were not inspected upon initial use. Others froze and stored sea cucumber with the intention of selling it under future quotas during subsequent seasons. Among fishers there were also rumors that bribes paid to authorities allowed transportation and commercialization of undocumented sea cucumber. In addition, this circumstance gave rise to an informal market for invoices. Permit holders often sold their invoices to prospecting buyers prior to each season.

(e) Boundary rules

The written rules defining who may access and harvest sea cucumber are organized through limited entry permits. Individuals, firms, and other groups such as societies and co-ops are eligible to apply for permits for their fishing vessels (DOF, 2007). Each permit corresponds with the license plate numbers of specific fishing vessels. Permits may specify additional information such as vessel quotas or fishing grounds. According to written rules, each fishing vessel harvesting sea cucumber must have a fishing permit for the target species. Furthermore, resource users are supposed to reside in the communities adjacent to fishing grounds where harvests take place (INAPESCA, 2012). Government enforcement of these written boundary rules for the sea cucumber fishery was limited, permitting the emergence of different local rules-in-use determining access to local fishing grounds for harvesting sea cucumber.

In Río Lagartos, boundary rules-in-use were similar to but distinct from the government permitting system. While co-ops obtained fishing permits for the majority of their vessels, seven

out of nine local patrons obtained just a few permits each. Knowing that patrons would utilize more of their vessels than the few which were officially permitted to harvest sea cucumber, co-ops met with patrons to establish a rule limiting the number of vessels. Specifically, permit holders with one permit would be allowed to use 10 fishing vessels to harvest sea cucumber while permit holders with two or more permits would be allowed to use five fishing vessels per permit. In addition to limits on the number of fishing vessels, local rules-in-use in Río Lagartos prohibited non-local individuals from harvesting sea cucumber in local fishing grounds, unless they were working directly for local permit holders.

In Celestún, there was no local rule-in-use restricting the number of vessels that could access and harvest resources. During the census of fishing reception centers, 23 patrons reported possessing one or more sea cucumber permits. However 62 identified the buyer to whom they sold sea cucumber, indicating that many un-permitted resource users participated in harvests. Furthermore, there was no local rule-in-use prohibiting non-local individuals from harvesting sea cucumber.

The above summary of local rules-in-use highlights differences between the study sites. Río Lagartos, where more than half of the fishing fleet was organized into two large fishing co-ops had a more restrictive local institutional regime than Celestún where the vast majority of fishers worked for patrons. To explore the potential relationship between these relations of production (patrons and co-ops) and the communities' divergent institutional responses to sea cucumber markets, we documented patrons' and co-ops' strategies in the fishery and the events surrounding the emergence of boundary rules. We focused on boundary rules because they were the most salient and contentious within the study sites. Furthermore, of the rules-in-use operating in these communities, boundary rules are particularly important because they influence the size of the fishing fleet and thus harvesting pressure on the resource.

(i) The emergence of boundary rules-in-use in Celestún

In Celestún, patrons and co-ops exhibited different boundary strategies in response to sea cucumber markets, ranging from recruiting non-local labor to placing restrictions on who is allowed to harvest sea cucumber. Patrons' and co-ops' divergent strategies resulted in conflicts that ultimately shaped understandings of boundary rules shared by the local fishing community at-large.

Many patrons in Celestún expanded their fleets prior to the season to maximize profits. They displayed signs with their phone numbers in reception centers that read, "hiring divers." Temporary increases in non-local labor were evidenced by a housing scarcity. In the marina, patrons allowed their reception centers to serve as overflow housing for migrant fishers. One community member complained that the price of food staples rose as result of the influx of non-local labor.

The willingness of patrons to hire divers with questionable experience further evidenced the excess labor demand they generated during the sea cucumber season. One Celestún patron explained:

They tell me that they know how to dive, 'yeah, I am a sea cucumber diver,' so that I will hire them. One guy told me he was a diver, but when he came back from fishing, the other guys told me he got scared. He didn't want to dive that far from shore, (patron, Celestún marina, April 2014).

Many patrons in Celestún expanded their fishing fleets beyond what their permits allowed or participated in the fishery despite not possessing permits at all. During an interview in 2012, a community liaison for the Celestún City Hall described how the fishing fleet had already changed as a result of the new market pressures for sea cucumber:

There was control here. There was a fleet of about 50 local divers, approximately. There were other people who went out diving, but only about 50 who were dedicated primarily to diving. There were not many people because diving was not very profitable. The diver goes out and grabs whatever there is to be able to take out enough for his household. Of course, when sea cucumber appeared, more divers shot out. Now we have – only locals – 500 or 600 divers, I believe even more. Including divers from the migrant fishers, we have a fleet of almost 1000 divers. Now they are essentially using up the marine species at a very rapid rate (City Hall liaison, Celestún, June 2012).

As patrons recruited non-local labor to expand their fleets, co-ops in Celestún attempted to prevent patrons without permits from harvesting sea cucumber. During the second sea cucumber season in Celestún, co-ops used their boats to create a blockade of the marina to prevent un-permitted boats from accessing the fishing grounds. However, the blockade failed because the co-ops' boats were vastly outnumbered by patrons'. A co-op president recalled, "the illegal fishers turned against us, they made a blockade to say 'if we don't all go out fishing, no one goes,'" (co-op president, Celestún, April 2014).

A group of women from Celestún, many of whom were wives of co-op members, undertook monitoring efforts to search for temporary camps where patrons were processing sea cucumber either without a permit or outside of the legal season. When the women located a processing camp, they contacted authorities from CONAPESCA to enforce government regulations. In response, patrons began to offer the women bribes in exchange for notification when monitoring activities were planned. This technique eventually led to the disintegration of the group, whose efforts were no longer effective because the women were unsure who among them was accepting bribes.

In sum, although co-ops in Celestún attempted to restrict the expansion of the local fishing fleet harvesting sea cucumber, they were unsuccessful. The small size of co-ops ultimately limited their ability to control the patrons who sought to expand their fleets. Furthermore, the high remuneration of illegal harvests created financial incentives that enabled patrons to undermine additional, third-party monitoring activities. With government regulations unenforced and the influx of outside fishers uncontrolled, the local boundary rule-in-use constituted an open access fishing regime.

(ii) *The emergence of boundary rules in Río Lagartos*

Patrons and co-ops in Río Lagartos exhibited strategies similar to their counterparts in Celestún. Patrons' recruitment of non-local labor to augment their fishing fleets was conspicuous in Río Lagartos and co-ops attempted to block the entry of non-local vessels and fishers. However, the dynamics between patrons and co-ops were markedly different in Río Lagartos.

Prior to sea cucumber fishing seasons, fishers arrived from other communities and states by boat, public buses, and even buses chartered by local patrons. Local food vendors stocked extra supplies anticipating migrant laborers and some community members established temporary food stands to serve incoming labor.

Co-ops implemented a number of strategies to restrict the expansion of the local fishing fleet. For example, the federation of fishing co-ops including co-ops from Río Lagartos and nearby towns enacted a by-law prior to the sea cucumber season in February 2014. A sign posted at co-op reception centers notified members of the new rule, which prohibited the hire of any non-members to work on vessels as additional divers or helmsmen. When asked why the new rule was enacted, the co-op president explained that it was "for the problems with sea cucumber. . . you saw how many people come down from other places when it's sea cucumber season. . . It's to avoid all these people coming, so that

when it is sea cucumber season and there are not enough divers in town, it is to avoid members from looking for people from outside," (co-op president, Río Lagartos, February 2014).

Co-ops also attempted to limit the number of vessels per permit that patrons' used to harvest sea cucumber. As explained in the rules summary above, patrons' fishing capacity was greater than the number of vessels permitted to harvest sea cucumber. Yet patrons tended to work their entire fleet during sea cucumber season due to the government's limited enforcement capacity. Knowing that it would be too difficult to limit patrons' fleets in accordance with the written rules, co-op leaders held a meeting with patrons and established an agreement that patrons with one permit could use 10 vessels to harvest sea cucumber and those with two or more permits could use five vessels per permit. Although patrons initially agreed to this rule, infractions were frequent.

In contrast to Celestún, Río Lagartos co-ops leveraged their large membership for more robust enforcement of boundary rules-in-use. For example, a co-op president recounted that prior to the opening day of the first sea cucumber season in Río Lagartos, two buses and multiple vans brought more than 200 migrant fishers that a single patron had contracted to harvest sea cucumber. Co-op members quickly united against the patron, enlisting local leaders to force the workers out of town.

On the day prior to the third season (February–March, 2014), non-local fishers claiming to have been contracted by local patrons and patrons from the nearby town of El Cuyo began to arrive to Río Lagartos by boat. That evening, more than 50 co-op members created a boat blockade of the narrow channel that provided passage from the Gulf of Mexico to the waters adjacent to town. The blockade ensured that migrant fishing crews who had already arrived to town could not leave to access fishing grounds. Furthermore, they forced any additional crews arriving to dispose of ice they had onboard, without which harvesting sea cucumber would be futile. The following day as local actors and migrant fishers gathered on the boardwalk, authorities from CONAPESCA arrived and expelled the non-local and unpermitted fishing crews from Río Lagartos.

Although co-ops in Río Lagartos had been fairly successful in limiting local patrons' fishing fleets, non-local poachers without ties to local patrons were more difficult to observe and expel because they operated entirely offshore. Poaching vessels utilized powerful motors to travel from elsewhere along the coast. When co-op members observed poachers offshore, they recorded their location and alerted the co-op. Small groups of co-op vessels apprehended the poachers. Initially, co-ops were successful at limiting offshore poaching through locally organized monitoring and enforcement.

However, as poaching intensified, Río Lagartos co-ops directed substantial resources to lobbying for the assistance of government authorities in monitoring and enforcement. Representatives from the co-ops and from the regional federation of co-ops traveled to the offices of SAGARPA and CONAPESCA in the State capital of Mérida on multiple occasions. Co-op leaders as well as patrons and the town mayor also traveled to Mexico City to meet with the president of the fisheries committee in the Mexican Senate to ask for assistance combating poaching.

Despite these lobbying efforts, local fishers observed an increase in poaching, and local monitoring and enforcement by co-ops became increasingly dangerous. Poachers were often armed and in one instance opened gunfire at co-op members. In June, 2014, 14 co-op vessels set out from Río Lagartos to intercept poachers that members had sighted. When the co-op members arrived to the reported location, the poachers had arranged a formation of more than 40 vessels including one larger vessel with a powerful motor. The co-op vessels were unable to flee quickly enough. Armed poachers forced co-op members onboard their vessel, set fire to one co-op vessel, and kidnapped the members.

Subsequently, co-ops as well as fishers working for patrons in Río Lagartos and nearby towns created a blockade of the highway leading to Río Lagartos, cutting off access to a large salt mine and halting shipments. They hung signs over co-op trucks denouncing fisheries personnel for failure to enforce government regulations. The road blockade concluded when the kidnapped co-op members were returned and government authorities agreed to talks with co-op leaders, the town mayor and even local patrons at the Secretary of Public Security in the state capital.

The local actors obtained some assistance from the government in monitoring and enforcement as a result of the talks. A CB90 military interceptor boat, the model typically used to combat drug trafficking, was stationed offshore from Río Lagartos to combat poaching. Authorities assembled a mixed security force, including police, co-op leaders, and fishing authorities. The government dedicated a vessel specifically to monitoring for sea cucumber poachers as well as a small plane for aerial observation of fishing grounds. Fisheries authorities also replaced the co-op vessels that had been burned by poachers.

Government efforts to monitor and enforce sea cucumber regulations were temporarily effective. At the conclusion of fieldwork in July, 2014, no more poachers had been sighted near Río Lagartos, suggesting that the attempts to dispel outside poachers had been successful. However, in a follow-up interview in October, 2014, a co-op leader explained that the government's enforcement efforts had subsided and Río Lagartos co-ops had discontinued local efforts to combat outside poachers.

(f) Initial indicators of fishery outcomes

The primary aim of this study was to document local institutional responses to market pressures and identify factors shaping those responses. An important next step is to evaluate the relationship between specific institutions observed and outcomes in the health of the fishery. While the effects of local institutions were not explicitly measured in this study and indeed the implications of local institutions were still evolving at the time of this research, there are initial indications of fishery impacts worth reporting.

By 2014, there was evidence of declining catches in southeastern Yucatán including Celestún. During 2014 fieldwork in Celestún, sea cucumber harvests were taking place farther from shore than they had during previous seasons, according to local fishers. A co-op member described previous years in which there were densities of sea cucumber so close to shore that divers could free-dive without hookah diving equipment. During that period, some fishing crews would make two fishing trips per day, each with harvests of 400–500 kg of sea cucumber. During the 2014 season in Celestún, fishing crews frequently landed under 50 kg per day, although those fishing in deep-water locations were more productive. A patron in Celestún explained that he was only participating in the April 2014 season in an attempt to recover an investment made during the previous season which he had failed to recover due to low production.

In the same year, the fishery in western Yucatán including Río Lagartos was more productive, with fishers landing between 150 and 300 kg. These landings were nonetheless lower than the 400–500 kg landings fishers described for 2013. In February 2014, landings of 300 kg of sea cucumber, including large individuals measuring between 30 and 35 cm were reported in Dzilam de Bravo, west of Río Lagartos (Canché, 2014b). In May 2015, the government deemed sea cucumber stocks in the fishing zone inclusive of Río Lagartos healthy enough to allow a short harvest period (SAGARPA, 2015a) and in 2016, SAGARPA authorized ten days of sea cucumber harvests for the entire Yucatán coast including both Río Lagartos and Celestún (SAGARPA, 2016).

Published in 2015 (after this study concluded), the Fishery Management Plan for Sea Cucumber species *I. badionotus* and *H. florida* in the Yucatán Peninsula lays out a vision of sustainable, organized, economically beneficial and equitable sea cucumber fisheries by the year 2022 through actions such as biological monitoring, equitable distribution of fishing rights, combating illegal fishing, and fomenting a culture of responsible resource use among fishers (SAGARPA, 2015). With such significant variation in local rules-in-use, the fate of Yucatán sea cucumber fisheries is uncertain. Nonetheless, a discussion of this study's findings regarding local governance processes can inform governance of sea cucumber and other SSFs facing market pressures.

4. Discussion

The goal of this study was to document local-level institutional responses to market pressures and identify the factors influencing those responses. The results demonstrate that despite extensive written institutions, widespread rule-breaking by resource users and limited government capacity for enforcement meant that many of the written rules were not effectively operating on the ground in the study sites. The local rules-in-use enacted by resource users themselves therefore played an important role in shaping actual patterns of resource use. The observations presented above show that relations of production (patron–client relationships and co-ops) influenced the emergence of rules-in-use in each study site. Patrons and co-ops pursued different strategies in response to market pressures and in each study site, the predominance of patrons or co-ops influenced whether local rules reflected patrons' or co-ops' interests. Additionally, when widespread poaching by non-local vessels undermined emergent rules-in-use, multi-level linkages with government temporarily reinforced local institutions.

The claim that relations of production shaped local rules-in-use is supported by a correlative finding as well as direct observation. In Celestún, where 98% of the fishing fleet worked for patrons, few rules-in-use were observed and the fishery was open access. In Río Lagartos, where more than half of fishers worked for two large co-ops, local rules-in-use restricted expansion of the fishing fleet. Observations showed that patrons in both study sites tended to hire outside labor during sea cucumber seasons, promoting open access boundary rules. Co-ops in both study sites implemented strategies to block non-local labor and limit the number of unpermitted vessels. Deliberative processes, for example meetings between patrons and co-ops in Río Lagartos, as well as conflictive processes, such as boat blockades in both sites, reconciled these divergent strategies to shape community-level rules-in-use. We hypothesize that the relationship between relations of production and institutional responses to market pressures is generalizable to other SSFs. We propose two mechanisms to support this hypothesis.

First, the distinctive ways that patron–client relationships and co-ops organize control over capital and the distribution of profits generate different material incentives for resource governance. Patrons receive all of the profits from commercializing the catch of each fishing vessel in their fleet. In contrast, co-ops distribute profits among the entire membership. Thus, the profits each co-op member could obtain from adding a vessel to the co-op's fleet is marginal compared to the profits a patron gains from each vessel he adds. Furthermore, the successful provision of fishing capital by co-ops relies on collective action by all members, which may be undermined if the co-ops' fleet and membership expand substantially. Indeed, many co-ops have internal rules restricting membership, constituting additional institutional barriers to increasing the co-op's fleet. These differences in material costs and benefits of

fleet expansion help to explain why co-ops and patrons pursue distinct strategies.

A second potential mechanism emphasizes the costs of governing resources under market pressures. The cost of monitoring rules increases as the number of resource users grows (Agrawal & Goyal, 2001). If the number of individuals targeting a resource increases as a result of high market demand, monitoring and enforcement costs are likely to rise. Because co-ops distribute operational costs among members, they typically have a pre-existing organizational mechanism through which members can collectively contribute to costs of monitoring and enforcement. As co-op members land catch at the cooperative, a deduction contributes to administrative operations, including monitoring and enforcement. The Río Lagartos co-ops used this financial pooling mechanism to pay governance costs such as fuel for monitoring excursions and travel to lobby for government aid in monitoring and enforcement.

Even though rules-in-use were effective in controlling the local fishing fleet in Río Lagartos, non-local poachers necessitated multi-level linkages with state and federal government. International markets for seafood often bring “roving bandits” who, because of their mobility, lack incentives to follow rules designed to protect local resource stocks (Berkes *et al.*, 2006). In sea cucumber fisheries, roving bandits also operate at sub-national scales as fishers abandon locally depleted stocks in search of new fishing grounds (Eriksson *et al.*, 2012). When external poachers threaten resources, a lack of multi-level linkages can undermine local self-governance (Cudney-Bueno & Basurto, 2009), especially when there is a potential for violence. In Río Lagartos, after the establishment of local rules-in-use that placed limits on the expansion of the local fishing fleet, patrons as well as co-ops invested in creating multi-level linkages by lobbying government to assist in combatting poaching by roving bandits. This suggests that the emergence of local rules reshaped patrons’ incentives. Namely, by limiting patrons’ freedom to expand their own fishing fleets, local rules generated incentives for them to cooperate with co-ops to limit poaching by non-local fishing vessels as well.

In SSFs, relations of production also interact with broader issues of migration, adding complexity to the analysis. To the extent that small group size and shared understandings facilitate successful local self-governance (Ostrom, 1990), immigration into fishing communities potentially undermines the emergence of rules that safeguard resources. Patrons can drive immigration as they recruit nonlocal labor (Fraga Berdugo, Salas, & Mexicano-Cíntora, 2008) while co-ops comprised of long-standing community members may resist newcomers (Quezada Domínguez, 1995).

In our study, the fishing population in Celestún was nearly twice that of Río Lagartos. The expansion of Celestún’s population coincided with the decline of an important agricultural industry in the late 1980s and early 1990s, when the state government actively encouraged unemployed agriculturalists to migrate to the coast and become fishers (Baños Ramírez, 2010; Fraga Berdugo, 1993). This shift coincided with a period of neoliberalization in Mexico’s fisheries policies, which reduced support to co-ops and facilitated the proliferation of patron–client relationships. Many of the migrants ended up in coastal communities nearest to the agricultural centers they were leaving, including Celestún. However, Río Lagartos was located outside of the region of agricultural decline and was largely shielded from the brunt of migration (Bennett, 2017).

Thus, for our comparative case study it is impossible to fully disentangle the broader influence of migration and population growth on local governance from the proliferation of patron–client relationships and their implications for local institutional responses to market pressures. However, the observation that patrons behaved similarly in both study sites supports our hypothesis. A likely account is that relations of production are shaped by

broader geographies while also functioning as proximate factors shaping institutional responses.

Some research suggests that assigning property rights to co-ops in the form of quotas or TURFs can increase fishery efficiency and sustainability (Cancino *et al.*, 2007; Deacon, Parker, & Costello, 2008; Deacon, Parker, & Costello, 2013; Griffith, 2008). In Mexico, some well-organized co-ops with secure property rights have been able to create and enforce rules regarding access and use of resources (McCay *et al.*, 2014; Miller, 1989; Méndez-Medina, Schmook, & McCandless, 2015). However, our study highlights that patrons can influence co-ops’ role in governance. Understanding what drives the distribution of a fishing fleet among different relations of production is therefore relevant to enhancing SSFs governance in the context of market pressures.

An emerging body of research investigates the drivers of patron–client relationships and co-ops in commercial SSFs. Research from the Gulf of California, Mexico suggests that fishers choose to work in co-ops when transaction costs of commercialization are high, obtaining legal fishing permits is valued by fishers, and there are prior experiences of successful collective action among fishers (Basurto *et al.*, 2013). Individual-level characteristics such as social skills and perceptions of individuals’ reliability and loyalty may affect choices to work with a patron or a co-op as well (Lindkvist, Basurto, & Schlüter, 2017). Finally, state policies also influence local relations of production. For example, processes of neoliberalization beginning in the 1980s that diminished the role of the state in organizing fisheries development and marketing and encouraged private investment in fisheries has likely undermined the role of co-ops in small-scale fishing communities in Yucatán (Bennett, 2017).

5. Conclusion

Sea cucumber fisheries in Latin America, like many others around the world, have transitioned rapidly from boom to bust. Sea cucumber trade from Latin American countries is relatively recent. Costa Rica, Panama, Colombia, Ecuador, Nicaragua, Peru, Venezuela, Cuba, Chile, and the Pacific coast of Mexico all began producing sea cucumber during late 1980s and 1990s and most have subsequently experienced rapid declines in abundance (Toral-Granda *et al.*, 2008). Many fisheries, for example in Panama, Colombia, Nicaragua, Peru, Venezuela, and Chile, lacked regulations or implemented moratoria after evidence of resource decline. Cuba, Mexico, and Ecuador have each applied some form of limited entry permits, a total allowable catch, and closed seasons (Toral-Granda *et al.*, 2008). Yet the high rate of illegal fishing throughout the region underscores that controlling sea cucumber fisheries requires more than government regulations. Local rules-in-use also play a key role in governance outcomes. The sea cucumber fishery in Yucatán, Mexico is one of the most recent in Latin America, beginning in earnest in the 2010s. While outcomes are still evolving, observing its emergence has provided insight into the kinds of interventions that may support local governance.

This study underscores the idea that high and rapid integration with markets create challenges that can undermine commons governance. However, the analysis also suggests that different relations of production function as intervening factors mediating the way external market demand affects local governance. In particular, the organization of resource users with respect to markets creates a variety of incentives, some of which may actually facilitate sustainable governance. These findings are consistent with other research that has observed that cost sharing and profit redistribution can leverage markets to enhance natural resource governance (Alcorn & Toledo, 1998; Bray, Merino-Pérez, & Barry, 2009). After all, collective action is only likely when actors anticipate benefits

and are capable of incurring the costs. High market value potentially augments long-term benefits from collective action while compensating higher costs. In order to understand whether markets are likely to bolster or undermine local governance, CPR theory should attend not just to the rules designed explicitly to control resource access and use, but also to the evolution and design of institutions that organize market interactions and the different incentives that result.

Our study expands on the idea that regulations should target aspects of trade and commercialization in addition to resource harvesting activities (Asche & Smith, 2010; Barclay, Fabinyi, & Kinch, 2017). The results suggest that the governance of trade need not only occur at the national and international scales but can also be scaled down to the local level, placing limits on the commercialization of sea cucumber within and between individual fishing communities. In both of our study sites, government authorities enforced regulations controlling commercialization more effectively than harvest controls. Inspection of patrons' and co-ops' reception centers and roadside checkpoints represent less costly monitoring actions. Again, relations of production affect the local-level governance of commercial activities, with the activities of many small patrons in Celestún potentially more complex to regulate than the few patrons and two large cooperatives in Río Lagartos.

In sum, in the context of designing effective regulations for managing sea cucumber and other SSFs facing market pressures, formal regulations are unlikely to be effective unless they cohere with prospects for local implementation and enforcement, which depends on the type of relations of production that are in place. In our study, fishing co-ops could find more incentives to develop rules to control access and use than patrons. Policies that encourage fishers to access capital, property rights, and markets by organizing into associations rather than contracting individually with a patron or capitalist can help build a stronger foundation for fishing communities to withstand global market pressures and enhance the well-being of coastal inhabitants.

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