

# The Emergence of Access Controls in Small-Scale Fishing Commons: A Comparative Analysis of Individual Licenses and Common Property-Rights in Two Mexican Communities

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**Abstract** Addressing global fisheries overexploitation requires better understanding of how small-scale fishing communities in developing countries limit access to fishing grounds. We analyze the performance of a system based on individual licenses and a common property-rights regime in their ability to generate incentives for self-governance and conservation of fishery resources. Using a qualitative before-after-control-impact approach, we compare two neighbouring fishing communities in the Gulf of California, Mexico. Both were initially governed by the same permit system, are situated in the same ecosystem, use similar harvesting technology, and have overharvested similar species. One community changed to a common property-right regime, enabling the emergence of access controls and avoiding overexploitation of benthic resources, while the other community, still relies on the permit system. We discuss the roles played by power,

institutions, socio-historic, and biophysical factors to develop access controls.

**Keywords** Small-scale fisheries · Gulf of California · Comparative analysis · Fishing concessions · Marine tenure · Tragedy of the commons · Individual licenses · Mexico

## Introduction

The contribution of small-scale fisheries (SSFs) to global fisheries catch and their role in maintaining human welfare (i.e., human nutrition, food security, poverty alleviation and development) has been systematically underestimated in past global assessments (Jackson *et al.* 2001:205; Worm *et al.* 2009). Increasing evidence suggests that SSFs are marine common-pool resources of global social, economic, and ecological significance (Andrew *et al.* 2007; FAO 2009; Smith *et al.* 2010). When including fisheries-associated livelihoods the number of people sustained by SSFs around the globe is estimated at 200–250 million people (Berkes *et al.* 2001; Delgado *et al.* 2003), the great majority of whom reside in developing countries, producing more than half of the world's harvests (Berkes *et al.* 2001; Pauly 2006).

Addressing the global fisheries overexploitation crisis will require better understanding the conditions that enable fishing communities in developing countries to craft access control mechanisms and prevent overfishing. In this paper we compare case studies of two Mexican fishing communities through an “embedded” institutional analysis approach (McCay 2002). Both fishing communities have similar fishing history, share the same ecosystem and have adjacent fishing grounds, harvest similar species with similar technology, but have achieved contrasting conservation outcomes. Our study shows that while both communities were governed under the same system based on individual licenses (herein permit

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system or permits), neither could effectively control access to their fisheries, eventually leading to overuse. It was only after the establishment of a communal property-rights regime in one of them (also regarded as marine tenure within the text) that access control was more effective and helped avoid overharvesting of its primary benthic resources. However, this change in access control effectiveness took over a decade to emerge after the formal establishment of property rights, and key socio-cultural, historical, ecological, and geographical aspects in which the communal property is embedded influenced such change.

As Acheson states (2006), understanding under what conditions resource users develop rules to sustain their livelihoods is a long standing question of interest to commons scholars (Berkes 1989; Blomquist 1992; Ostrom 2005; Agrawal *et al.* 2008; Persha *et al.* 2011). Our study is located in the communities of Kino Bay (hereafter Kino), and the Seri village of Punta Chueca (hereafter the Seri) (Fig. 1) in the Gulf of California (GC), a very important ocean biologically (Brusca *et al.* 2005) that comprises 40–50 % of Mexico's fisheries (Cisneros-Mata 2010). From a policy perspective, better understanding how permit or marine tenure regimes perform is of great importance since fishing permits are the most commonly used tool to control access to marine resources throughout Mexico (Soberanes Fernández 1994). This can be also of relevance to other developing countries in Latin America that rely on similar –license-based- systems for the management of SSFs (Salas *et al.* 2007), many of which are *de facto* managed under open-access and close to overuse or already overexploited (Salas *et al.* 2011).

Next we introduce the theoretical approach and the sources of information on which this study is based, and progress chronologically to describe the early evolution of fisheries governance and performance, the transition towards access controls in the Seri case study and the present state of fisheries governance and performance. The present-day description focuses on the exploitation of a benthic

resource (pen shells, *Atrina* spp. and *Pinna rugosa*) because it became of significant importance in the region during this period and is almost the only one for which some information on its condition exists. Finally we discuss how issues of power, institutional and sociocultural factors, geography, ecology, and history have shaped each community's ability to control access, engage in self-governance, and promote conservation behaviours. We end up with some brief policy implications.

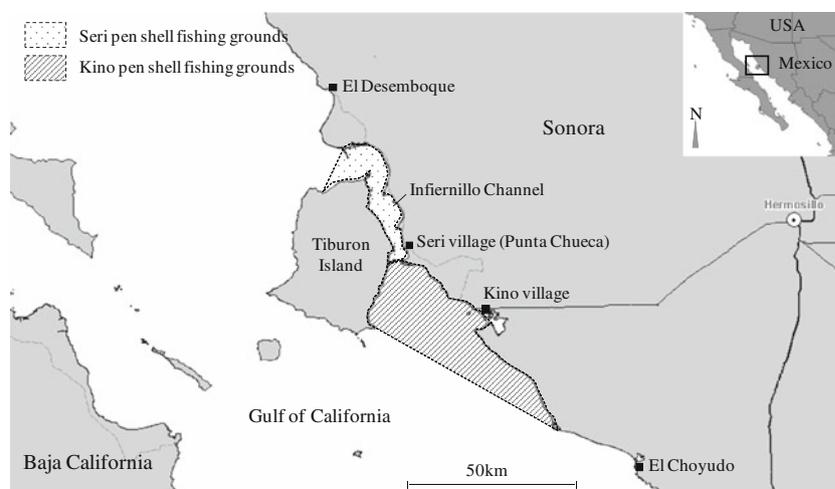
## Theoretical Approach

We follow a cultural and historical approach in human ecology to explore commons-related questions “as ones about competition and collaboration among social entities; the embeddedness of individual and social action; and the historical, political, sociocultural, and ecological specificity of human-environmental interactions and institutions” (McCay 2002:362).

We examine the role that formal property-rights play in the emergence of local institutions to control access to fishing commons. Institutional emergence is conceptualized as a change from open access—the null condition of no rules or property claims (McCay 1996)—to a rule structure or property right regime that assigns roles and responsibilities for what is required, prohibited, or permitted. Under this view, an institutional change from open access to an alternative regime involves some form of collective action to develop, maintain, and enforce agreements by those that can foresee being benefited by the new institutional structure (Acheson 2006).

By “assessing performance” we mean comparing the kinds of incentives that permit and marine tenure policies create for local fishers' ability to develop institutions to control access, and avoid the overexploitation of their fishing commons. We take an “embedded” approach that views

**Fig. 1** Map of the study area



institutions as closely interlinked features of the cultural, cognitive, and ecological realms within which acting and decision-making is embedded (McCay 2002:362). This approach brings to the forefront of the analysis the human dimension of fishing, interweaving the role of “property-rights”, “culture”, “power”, and “history” in understanding policy performance for the emergence of access controls that promote conservation in small-scale fishing settings (Jentoft 2004).

We find this approach useful to avoid interpretations of institutional analyses as about finding/designing “the right” combination of property-right regime, which can become associated with ideologies that privilege the choice of some property-rights regimes over others, and problematizes the assessment of their performance by minimizing attention to the social, cultural and personal costs of implementation and other potential alternatives (Mansfield 2004; McCay 2008; Lowe and Carothers 2008).

In taking an embedded approach to better understanding how small-scale fishers govern their commons, we aim at avoiding this shortcoming and also contribute to the literature on the commons as social-ecological systems (SES) (Ostrom 2009). In our comparative study of two adjacent fishing communities, exploiting the same resources, using the same technology and in the same general ecosystem, one of the communities did not go through a change in property-rights regime. This provides the opportunity to assess with a counterfactual the effects of the change in property-rights in the other community. Being able to hold some ecological and social factors constant to analytically focus on the effect of a small number of variables in a SES system, has been mentioned as an important way forward towards developing a multi-tiered diagnostic framework for the analysis of particular SES systems (Ostrom and Cox 2010, Poteete *et al.* 2010).

### Sources of Information

Both fisheries lend themselves to a quasi-experimental setting (Cook and Campbell 1979). Our comparison is inspired by Mills (1967) notion of “most similar system” and uses a before-after-control-impact (BACI) design commonly used in the biological and environmental sciences, but less so in commons studies. We compared both fisheries’ institutional ability to control access and avoid overexploitation before and after a change in formal property-rights that took place in the Seri community in 1975 (Table 1). Before 1975 the permit system governed fisheries in both communities. In 1975, the Seri were formally granted communal property-rights that superimposed with the permit system. Meanwhile, Kino fishers did not experience any change in property-rights regime and continued governing their fishery through the permit system until present (Table 1).

**Table 1** Schematic representation of our research design

Fishery	Before granting formal property-rights (<1975)	After granting formal property-rights (> 1975)
Kino (“control”)	Permit	Permit
Seri (“impact”)	Permit	Permit + Marine Tenure

To compare governance systems and the state of fishery resources in both communities before and after the introduction of formal property-rights in Seri territory we used primary and secondary—historic (early 1900s–1980s) and recent (1990s–2010)—sources of information. Historic sources of information included publications from several authors who reported historical data from the study region (i.e., Smith 1954; Malkin 1962; Cruz-Acosta 1979; Chenaut 1985; Felger and Moser 1985; Cisneros-Mata *et al.* 1995; Bahre *et al.* 2000; Bowen 2000; Basurto 2006). Recent sources of information were obtained through research efforts carried out by the authors of this study between 1995 and 2010, some of which have been published elsewhere (i.e., Bourillón 2002; Basurto 2005, 2008; Basurto and Coleman 2010; Moreno *et al.* 2005a, b; Cinti *et al.* 2010a, b). These studies utilized social sciences methods, including participant observation, formal interviews with fishers, fish-buyers and authorities, and analysis of official statistics and documents like fishing cooperatives’ bylaws and legislation, among others. We also relied on first hand experience of the co-authors who lived in these communities for extended periods of time (>10 years) either as their place of origin, to conduct academic studies and/or professional work.

### Early Evolution of Fisheries Governance and Performance

Kino and the Seri communities have always shared contiguous fishing areas characterized by sandy shallow bottoms near the shore and rocky habitats in the western side of Tiburon Island (Fig. 1). Their commercial fishing history is closely intertwined even though culturally and ethnically they differ greatly. Most Kino fishers are *mestizo* and recent immigrants to the area (~1920s), while Seri fishers have been native and resident to the region for thousands of years. The Seri have a long history of conflicts with Spanish and *mestizo* Mexicans who tried to remove them and gain control of the natural resources in their historic terrestrial and marine territory (Sheridan 1999). We will later elaborate on how this antagonism served as a strong motivator to control access to Seri fishing grounds.

## Fishing down the Food Web: 1930s to Early 1970s

Between the 1930s and early 1970s, both Kino and Seri fishing communities were governed by the permit system and sequentially overfished their food web as characterized by Pauly *et al.* (1998) for open access regimes. The first fisheries law in Mexico (1925) defined permits as its main management policy for harvesting a number of species including sharks, sea-turtles, other fin-fish species, bivalves, lobster, shrimp, among others (Soberanes Fernández 1994:5–6). Historic descriptions suggest that the functioning of the permit system was—as it is today—heavily influenced by the relationship between permit holders and fishers. It is thought that both communities' fisheries operated roughly in the same manner because the *same* Mexican permit holders (who also acted as fish-buyers) commercialized the catch of both communities' fishers (Smith 1954; Cruz-Acosta 1979; Bowen 2000; Bourillón 2002; Basurto 2006).

As permit holders, fish buyers had a powerful influence on the permanent settlement of fishers, the formation of fishing cooperatives and fishing towns. In the 1930s Kino and Seri fishers established their first fishing cooperatives (Table 2). The “Lázaro Cárdenas” cooperative in Kino (established in 1935) reached up to 100 members until it was dismantled in the 1990s due to mismanagement issues. The Seri cooperative (established in 1938) was organized by the non-Seri fish buyer Chucho Salazar<sup>1</sup>, who obtained its first fishing permits, acted as its manager, and commercialized all its catch.

Fish buyers often competed for Seri labour because they accepted a lower price for their catch or exchanged it for other goods (Smith 1954). The Seri also gained from the relationship because it provided a steady source of income and access to outside commercialization channels. Malkin (1962:33) nicely summarizes Seri fisheries governance at the time:

“[t]he Seris' commercial fishing is pretty much controlled and exploited by the two or three Mexican fish traders from Nogales and Hermosillo. These have their tiendas in El Desemboque, which at set prices sell things to the villagers. They also provide the Indians with the five horse-power motors for fishing trips and pleasure cruises and with the oil and gasoline essential to run these—also at set price. They finally purchase the fish—at a set price—and from the proceeds the Seris purchase goods at the tiendas, completing the cycle...”

In an effort to gain control of the Seri labour pool and monopolize all its catch, Solórzano established the

<sup>1</sup> A pseudonym replaced the real name.

**Table 2** Historical summary of both communities' fisheries (1920s–2000s)

Year	Events
1920–1930s	<ul style="list-style-type: none"> <li>• Law establishing the permit system in Mexico.<sup>a</sup></li> <li>• Both communities involved in fishing totoaba (booming<sup>bc</sup>) and sea turtles.<sup>d</sup></li> <li>• First fishing cooperatives established in Kino (1935) and Seri village (1938).</li> <li>• Ubiquitous presence of non-Seri fishers living in Seri villages.<sup>e</sup></li> </ul>
1940s	<ul style="list-style-type: none"> <li>• Both communities involved in fishing large shark species (booming fishery<sup>f</sup>) and sea turtle fishing (increased effort).<sup>d</sup></li> <li>• End of 1940s: collapse of large sharks fishery<sup>eg</sup>, scarcity of saleable fish in the Gulf of California due to war-time overexploitation and use of dynamite in fishing.<sup>hi</sup></li> </ul>
1950–1960s	<ul style="list-style-type: none"> <li>• Both communities involved in booming of sea turtle fishery<sup>j</sup> and its decline in the 1960s<sup>b</sup>.</li> </ul>
1970s	<ul style="list-style-type: none"> <li>• Both communities involved in diving fisheries<sup>k</sup> including rainbow lipped pearl oysters (<i>Pteria sterna</i>), rock scallops (<i>Spondylus limbatus</i>), lion paw scallops (<i>Nodipecten subnodosus</i>), and pen shells (<i>Atrina</i> spp. and <i>Pinna rugosa</i>).</li> <li>• Sea turtle fishery overfished (early 1970s)<sup>l</sup> and totoaba fishery closed (1974)<sup>m</sup>.</li> <li>• Declaration of Seri exclusive fishing<sup>n</sup> (1975) and land rights (1978)<sup>n</sup>.</li> <li>• Open access fisheries continue inside the Seri marine tenure.</li> </ul>
1980s	<ul style="list-style-type: none"> <li>• The state company PROPEMEX arrives to Seri territory promoting heavy exploitation of fin fish species. Outside fishers actively involved in fishing activities.<sup>k</sup></li> <li>• Diving fishing effort of benthic species diminishes substantially until PROPEMEX leaves the Infiernillo Channel by the end of the decade.<sup>k</sup></li> <li>• Kino fishers start encroaching the Seri marine tenure.<sup>fk</sup></li> <li>• The Seri to start controlling access to their marine tenure (~1984)<sup>fk</sup></li> </ul>
1990s	<ul style="list-style-type: none"> <li>• Both communities involved in pen shell fishing.<sup>n</sup></li> <li>• Swimming crab fishery begins.<sup>n</sup></li> <li>• Seri fishing permits expire and are not renewed (1992).<sup>f</sup></li> <li>• Multi-specific fisheries boom in Kino including triggerfish, rays, jellyfishes, swimming crabs.<sup>o</sup></li> <li>• Kino small shark species fisheries in decline.<sup>p</sup></li> </ul>
2000s	<ul style="list-style-type: none"> <li>• Pen shell fisheries boom in the Infiernillo Channel.<sup>nk</sup></li> <li>• Kino pen shell, swimming crab, and triggerfish fisheries in decline or overexploited.</li> </ul>

<sup>a</sup> Soberanes Fernández (1994), <sup>b</sup> Bahre *et al.* (2000), <sup>c</sup> Cisneros-Mata *et al.* (1995), <sup>d</sup> Felger and Moser (1985:45), <sup>e</sup> Smith (1954), <sup>f</sup> Seri informants (Basurto field notes 2009), <sup>g</sup> Alcalá Moya (1999), <sup>h</sup> Saenz-Arroyo *et al.* (2005b), <sup>i</sup> Saenz-Arroyo *et al.* (2005a), <sup>j</sup> Bowen (2000), <sup>k</sup> Basurto (2006), <sup>l</sup> Seminoff (2010), <sup>m</sup> Lercari and Chávez (2007), <sup>n</sup> Bourillón (2002), <sup>o</sup> Cisneros-Mata (2010), <sup>p</sup> Bizzarro *et al.* (2007)

cooperative in what is today the town of El Desemboque. The cooperative was located more than 50 km north of

Kino, as a way to move the Seri away from other competing fish buyers. The move effectively created the first sedentary village of the Seri community and improved Seri fishers' quality of life. But after Solórzano decided to leave the Seri in 1948 (Smith 1954), the cooperative declined.

The main marine resources harvested by Kino and Seri fishers between 1925 and the mid 1970s included sea turtle (Cheloniidae), shark (Lamnidae, Triakidae, Heterodontidae, Squatinidae, Carcharhinidae, Sphyrnidae), other large specimens of selected species of the Sciaenidae Family (e.g., *Totoaba macdonaldi*) grouper (Serranidae), snapper (Lutjanidae), mackerel (Scombridae), jack (Carangidae) and mullet (Mugilidae), and resources harvested by diving such as scallops (Pectinidae), pearl oysters (Pteriidae), or pen shells (Pinnidae) to a lesser extent. Many of these resources had been sequentially overexploited in the Kino and Seri areas by the 1970s (See Table 2 for details and citations).

### The Transition Towards Access Controls

#### Open Access amid a Change in Formal Property Rights: 1970s- mid 1980s

In the 1970s three executive decrees granted the Seri formal rights to a portion of their historic coastal territory in the form of common land use-rights in the mainland—using the *ejido* system of communal land tenure (Diario Oficial de la Federación 1970)—and Tiburon Island (Diario Oficial de la Federación 1978), and permanent and exclusive withdrawal rights of marine resources, i.e., a marine concession to “the waters surrounding Tiburon Island” (Diario Oficial de la Federación 1975). Granting Seri property rights over a portion of their historic range was part of a federal policy by the National Institute for Indigenous Affairs (INI for its acronym in Spanish) to prevent the smallest native groups in Mexico from disappearing through conflict with other neighbouring and faster growing *mestizo* settlements.

The marine tenure granted to the Seri in 1975 was territorial in nature, that is, not species-specific like the fishing concessions granted to cooperatives or individuals elsewhere in Mexico, and limited to those individuals belonging to “the Seri tribe and the Seri fishing cooperative” (Diario Oficial de la Federación 1975). These changes also forced the Seri to organize a local government following the structure required to govern *ejido* common property, i.e., a “governor” or president, a secretary, and a treasurer.

Despite the formal change in property-rights regime in Seri fishing grounds, all commercialization continued to be controlled by non-Seri permit holders under the same *de facto* open access regime as before, and the sequential overexploitation of primary resources continued: The sea

turtle fishery started to show signs of overuse and by 1974 the totoaba fishery was formally closed. Diving fisheries continued to increase their fishing effort until the State company PROPEMEX arrived to Seri territory, providing gear and infrastructure for targeting fin fish species and fishing pressure on diving species diminishes substantially (Table 2).

#### Emergence of Incentives to Control Access: Mid 1980s—Present

Around the mid 1980s, large fin fish scarcity led Kino and Seri fishers to increasingly target species of lower trophic levels, particularly as new markets emerged for species previously considered as “trash” [e.g., triggerfish (Balistidae), jellyfish (Stomolophidae), sea cucumber (Stichopodidae), etc.,] (Cisneros-Mata 2010). The economic importance of diving fisheries increased in Kino and Seri communities, and scarcity increased Kino fishers' need to travel further and use Tiburon Island as a stopover fishing camp during multi-day trips. The Seri observed such encroachment on their territory with unease, particularly as outsiders made explicit their interest to access valuable benthic resources inside the Infiernillo Channel. Outsiders' demand for access prompted an entrepreneurial Seri leader and governor, to require monetary payment in exchange of permission to access Tiburon Island fishing camps and the Infiernillo Channel. As one informant put it: “it was easy money, it was crazy to pass up on this opportunity!” Between 1984 and 1987 other rules to grant temporary access and withdrawal rights to harvest benthic resources inside Seri territory were created (Table 3). According to cultural custom, the income generated by the access fees stipulated in rules 1 and 2 accrues only to the Seri governor and his family in lieu of taxes and State or Federal funding. However, rule 3 stipulates that all non-Seri pen shell fishers must hire a member of the Seri community as part of the fishing crew which allows other members of the Seri community economic compensation from the presence of outsiders, since under rule 4 the monetary returns from the catch are shared equally among all crew members. The presence of members of the Seri community on outsider boats (usually from Kino) could also help monitor their compliance with other rules-in-use, rule 5, dictating that divers must not harvest pen shells in culturally important areas.

The rules shown in Table 3 are enforced through a variety of means including shaming or through the *Guardia Tradicional* (Seri Traditional Guard), an armed, informal group of community members whose main task is to police the Seri marine and terrestrial territory to prevent poaching, land invasions and ensure collection of access fees (Basurto 2005).

**Table 3** Some of the most important Seri rules to grant access to outside pen shell fishers (modified from Basurto 2005)

#	Seri locally designed rules
1	Must make monetary payment.
2	Must direct payment to Seri Government officials.
3	Must hire a Seri as part of the fishing crew.
4	Must pay the Seri fisher the same share as to non-Seri crew-members.
5	Must not fish in culturally important areas.
6	Must not exceed the current maximum allowable catch per day (not enforced since 2009).

### Present-Day Fisheries Governance and Performance (with Emphasis on Both Communities' Pen Shell Fisheries)

#### The Setting

Currently small-scale fisheries (SSFs) in the Gulf of California harvest about 80 target species and employ about 50,000 fishers with a fleet of about 25,000 out-board boats (8–9 m long) (Cisneros-Mata 2010:119). According to the Instituto Nacional de Estadística y Geografía (INEGI 2005), the population of Kino stands at about 5,000 inhabitants, while the Seri indigenous community numbers about 600 people of whom about half live in *Punta Chueca* village. Kino is the closest (ca. 100 km) coastal town to the rapidly growing city of *Hermosillo*, the capital of Sonora, one of Mexico's largest states and an important outlet for major national and international seafood markets. In contrast, the Seri are still fairly isolated, only accessible by land via a 30 km dirt road from Kino (Fig. 1).

**Table 4** Contemporary bio-physical and sociocultural characteristics of Kino and Seri fisheries

	Kino	Seri
Population size	5,000	~600
Size of pen shell fishery (Approx.)	50 boats	10–20 boats
Species harvested through diving	Pen shells (mainly <i>Atrina tuberculosa</i> ), octopus, groupers and snappers, sea cucumber, and others.	Pen shells (mainly <i>Atrina tuberculosa</i> and <i>Pinna rugosa</i> ), and some sea cucumber.
Historical characteristics	First settlements in 1920s to fish commercially.	Presence since pre-historic times.
Cultural homogeneity	Low: fishers belong to different ethnic groups and many have immigrated from different parts of Mexico	High: fishers belong to the same ethnic group and are native to this small region.
Geographic characteristics of fishing areas	Open bay of variable depth.	Narrow and shallow Channel next to the village.
Fishing areas and their boundaries	Wide fishing areas and diffuse boundaries.	Contracted fishing areas and clear boundaries.

Kino has many more boats than the Seri community. In 2007, roughly 50 of the approximately 200 active boats in SSFs in Kino commercially harvested pen shells (Comunidad y Biodiversidad 2007, unpublished report). In contrast, a 2009–2010 estimate by the Seri community showed between 30 and 60 active boats of which 10–20 targeted pen shells (Basurto unpublished data) (Table 4). Kino divers target at least 11 other species throughout the year (Cinti *et al.* 2010b). Seri divers however, generally dive only for pen shells throughout the year. Both pen shell fisheries employ the same harvesting technology based on a rudimentary underwater “hookah” breathing apparatus connected through a long hose to an air compressor mounted atop the boat.

Geographically, the fishing areas claimed by both groups of fishers contrast in that those of Kino are located inside a large—and less controllable—open bay. Kino fishers claim as their ‘uncontested’ fishing territory the areas between “El Cholludo” fishing camp and the southern entrance of the Infiernillo Channel (depths ranging between 5 and 70 m), and the offshore islands, although fishing permits do not explicitly recognize these areas, leading to ambiguity and contestation. In contrast, fishing areas within the narrow and shallow (5–15 m in depth) Infiernillo Channel are considered the sole property of Seri fishers, making it easier for the Seri to observe the entrance and exit of boats (Fig. 1).

Note that some of the same fish buyers (most of them permit holders) that were active before the emergence of access control by the Seri, continued conducting business with Kino and Seri fishers in the 1990s and 2000s (Basurto 2006).

#### Condition of Kino and Seri Pen Shell Fisheries

Pen shells harvested in both communities' fishing areas are usually declared and recorded in official statistics as if

harvested in the same location since fish buyers (many of whom are also permit holders) have been historically the same. Thus it is impossible to trace the amount harvested by one or other community. Instead, we used (1) proxy data based on information gathered through formal interviews with fishers about historical catches and published historical accounts, (2) information gathered through underwater surveys in Kino and Seri waters to estimate pen shell densities, and (3) unofficial pen shell catch data collected through efforts by the NGO Comunidad y Biodiversidad, the Seri community, the PANGAS Project, and Duke University.

Catch patterns between Kino and Seri differ, according to findings from interviews. Kino fishers state that pen shell catches decreased between 1992 and 1998, while Seri fishers state that catches have remained relatively constant during that period. Fishers from both communities consistently indicate that Seri pen shell fishing grounds are more abundant and “generally doing much better than any other in the region” (Basurto 2005). These reports are supported by an experienced pen shell buyer who conducted business in both communities from the 1970s to 2007, who reported that two thirds of the catch usually came from Seri fishing grounds.

Field findings of underwater surveys and fisher logbooks also support this observation. In 2004 Moreno *et al.* (2005a) found densities of less than five individuals per 300 m<sup>2</sup> in most of the Kino fishing grounds. In 2001 Basurto found an average of 64 individuals per 300 m<sup>2</sup> at five different Seri fishing grounds (Basurto unpublished).

Data from a voluntary logbook program (The PANGAS Project, <http://pangas.arizona.edu>) reported by Cinti *et al.* (2010a) indicate lower average annual catch per unit effort (CPUE) for the 2007 pen shell fishing season in an important fishing ground for Kino’s divers (1.1 kg of adductor muscle/hour diving) compared with fishing grounds inside the Infiernillo Channel (2 kg of adductor muscle/hour diving, where Basurto and Coleman (2010) reported 5.9 Kg of adductor muscle/hour diving for 2009 (average from 12 fishing trips).

Finally, the tendency by Kino fishers to diversify their catches throughout the year despite the elevated price that pen shells command year round, might also constitute a proxy of the scarcity of pen shells in their fishing grounds in recent years. Although pen shells are one of the few resources with year-round national demand at a constantly high market price, Kino fishers tend to diversify their catches throughout the year and conduct their pen shell fishery between December and March (Moreno *et al.* 2005a). As the water warms up in the late spring many Kino pen shell fishers switch to harvest octopus as they find it more profitable than pen shells.

Overall, available evidence suggests that Seri pen shells fishing grounds are in better shape than those of Kino. Next

we provide a description of the institutional arrangements in place in these communities, to help us understand why they have reached contrasting conservation outcomes.

## Comparative Institutional Arrangements

### *General Framework to Govern Fisheries in Mexico*

The 1925 fisheries law determined the duration of fishing seasons, delineation of fishing areas, and fishing gear specifications to be regulated through fishing permits (Soberanes Fernández 1994). Nowadays permits are issued by the National Commission of Fisheries and Aquaculture (CONAPESCA), which is the primary agency in charge of fisheries regulation and enforcement at a national level. It works through state offices of SAGARPA (the Ministry of Agriculture, Livestock, Fisheries, Food and Rural Development) to coordinate administration, management and enforcement at a regional level.

Fishing permits can be granted to any corporate entity (typically a cooperative) or individual, for periods of 1 to 5 years, although some must be renewed annually. The core requirements to access fishing permits include (a) presenting personal documentation, (b) specifying the species, fishing area, landing port, and duration of the right being solicited, (c) specifying and certifying technical information about boat(s), motor(s) and fishing gear(s) as registered in the Secretariat of Communication and Transportation (SCT), (d) certifying the legal possession of boat(s), motor(s) and fishing gear(s), (e) certifying the legal constitution and membership of corporate entities, (f) certifying registration at the Federal Taxpayers’ Registry (Ministry of Economy), and (g) paying the required fees, which in 2008 were about US\$50 (“Ley Federal de Derechos”, Art 191A, inciso IIa), but the actual cost of the permit varies according to the target species and is usually much higher.

There is no specified limit on the number of permits a cooperative or individual may hold. Permit holders must use only the fishing equipment (boat, motor, and fishing gear) registered in their permits, and are only allowed to commercialize the products caught using the fishing equipment registered in their permits. Only permit holders can legally land the catch and report it at CONAPESCA. The landing document, *aviso de arribo*, must accompany the fiscal document to sell the catch in the market. Similarly, only permit holders can provide invoices for the catch, which constitute proof of legal ownership of the harvest. Invoices are necessary to sell, buy, or transport the catch to regional or international markets.

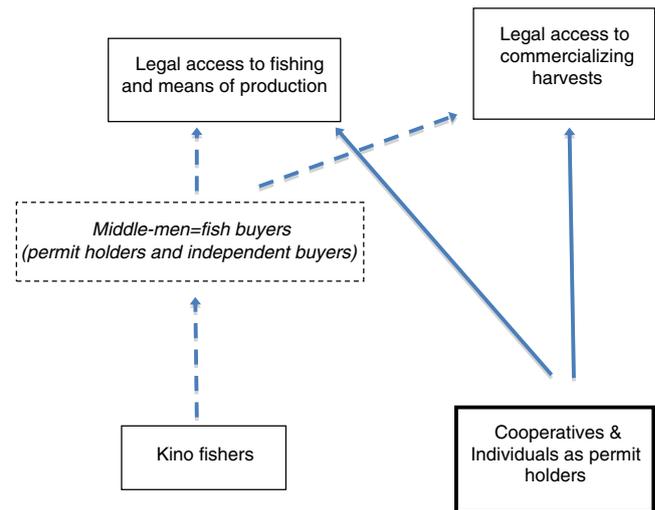
Specific regulations for resource use are defined by Official Mexican Norms published in the Federal Registry. Seasonal closures (temporary or permanent) and gear or size restrictions are the most common regulations affecting

the diving harvest with the one exception of abalone (*Haliotis* spp., Haliotidae) fisheries in Baja California (Cinti *et al.* 2010a). In addition the National Fisheries Institute (INAPESCA), as the scientific arm of CONAPESCA, develops the National Fisheries Chart which summarizes the status, management recommendations, and indicators for all Mexican fishery resources. These recommendations became legally binding under the new October 2007 fisheries law, “Ley General de Pesca y Acuicultura Sustentables”. Unfortunately, for most species targeted by divers in the study area there are no specific Official Mexican Norms or official information about their population status (Cinti *et al.* 2010a).

### Rules-In-Use in the Kino Diving Fisheries

In Kino the permit system tends to exacerbate social inequalities and discourage responsible fishing practices by fishery stakeholders (Cinti *et al.* 2010a). Under federal law, only permit holders are legally registered and legally able to participate in any fishery (Cinti *et al.* 2010a).

Most Kino pen shell divers are *pescadores libres* or independent fishers who do not own a fishing permit and are not members of any cooperatives holding permits (Cinti *et al.* 2010a). Consequently they are in effect the labour force supplying permit holders with catch, and must enter into an informal working relationship with permit holders in order to be able to “legally” harvest and commercialize their catch. However, independent fishers are considered illegal even if they work under the permits of current permit holders. Generally, Kino permit holders are the same individuals who are buyers of the catch, own the necessary equipment and are familiar with the channels to control the commercialization process. They usually do not participate in fishing activities (Fig. 2).<sup>2</sup> However, as legal permit holders they are the only stakeholders with whom the government formally communicates key information concerning the fishery (e.g., regulatory measures, availability of new permits to be allocated), and who have access to government



**Fig. 2** Formal (solid lines) and informal (dotted lines) institutional arrangements for diving fisheries in Kino

benefits available to the fishing sector (e.g., fuel discounts, loans or grants for acquiring new processing technology or building improved facilities, etc.). Permit holders are also the only stakeholders participating in local monitoring and enforcement activities, since they are the only members of the local committee organized for that purpose. Because of their preferential access to resources and information, permit holders are in a privileged position to protect their own interests and to influence authorities’ decisions regarding regulatory measures, fishing rights’ allocation, etc. In contrast, the fishers, who have the fishing expertise and the knowledge about the resources they harvest, are literally marginalized from any formal process concerning their fisheries.

Such inequitable social structure and the informality of fisher’s labour are enabled by elements of the permit system (Cinti *et al.* 2010a, b) since: (a) actual requirements to access fishing permits are often too difficult to fulfil by fulltime fishers (too costly, complicated and bureaucratic); (b) technically there is no explicit limit to the number of permits an individual or cooperative could hold, and no explicit limit to the number of boats each permit holder could register under a permit. This—in the case of individual permit holders—generates the need for hiring people to operate several boats; (c) there is no formal registry of—or social provisions for—the people working under the permits of existing permit holders; (d) there are practically no new permits to be issued, and existing fishing permits—also entailing commercialization rights—are already concentrated in a few hands. In any case, the number of permits and boats to be allocated to a given fishery is subject to the management recommendations of INAPESCA and the final decision of SAGARPA through CONAPESCA.

<sup>2</sup> Further, most of local corporate permit holders exist only on paper (Cinti *et al.* 2010a). Generally, only one person—usually the president of the cooperative—effectively acts as the corporation, so that in practice these cooperatives are not cooperatively managed. Also, the few cooperatives holding fishing permits (for commercial diving products) whose members do participate in fishing usually do not sell their product through their cooperative, but to other permit holders or independent buyers with no fishing permit. This means that even in the few cases where true fishers are holders of fishing permits, they act in practice as independent fishers. Most independent fishers also depend on permit holders to gain access to fishing equipment and supplies (Moreno *et al.* 2005b; Cinti *et al.* 2010a). As a result they are usually in some sort of continuous peonage debt with them and in a weak bargaining position to negotiate the price they receive for their catch.

Ironically, the people who are legally part of the system have few incentives to follow the rules. Since only permit holders are allowed to legally commercialize catch extracted directly from sea, they have high incentives to “launder” fishing products from illegal sources (e.g., from boats not registered in their permits) (Cinti *et al.* 2010a). Often permit holders will buy from anyone willing to sell, and thus ‘legitimize’ the catch. Once the catch is landed it is nearly impossible to trace back to the actual fisher who made it.

Some Kino permit holders are also known to bring outside boats and fishers to fish locally on condition they sell them their catch (Cinti *et al.* 2010a). These acts are a major source of recurrent internal conflict among fishers, competing permit holders, authorities, and other community members. While these permit holders push for increasing the number of boats to increase their profits, local fishers generally reject the addition of boats in order to keep local resources for themselves. Local fishers are willing to accept fishers from outside the community if these fishers work with local boats (an informal arrangement) (Cinti *et al.* 2010a), but are frequently unable to enforce it and prevent access, leading possibly to conflicts.

The resulting *de facto* open-access situation is greatly exacerbated by inefficient official oversight and enforcement despite the presence in town of a local office of the federal agency in charge of fisheries management.

#### Rules-In-Use in the Seri Diving Fishery

Since approximately 1984–1987 the Seri have managed their fisheries based on the *de jure* autonomy provided by the multi-species fishing concession formally granted to them in the mid-1970s in addition to the national permit system. Formally, the Seri fishing cooperative is bound to the same rules and regulations as any other fishing cooperative in Mexico, and thus must have fishing permits enabling it to legally commercialize the catch. In practice however, according to a former president, the Seri fishing cooperative has not updated its fishing permits since 1992. The fishing cooperative has also historically lacked a functional infrastructure (e.g., ice house, vehicles, etc.) and commercialization networks. While a number of fishing cooperatives have emerged within the Seri community in recent times, as in Kino, they do not seem to be cooperatively managed or sell their product through the cooperative. In general, most Seri fishers depend on external fish buyers (i.e., permit holders usually from Kino) to take their products to the national market. Recently some Seri villagers who are no longer active fishers have started operating as middlemen. Unlike the fish buyers from Kino, these Seri middlemen are not permit holders and do not own the fishing means of production or control the commercialization channels. Having access to transportation resources,

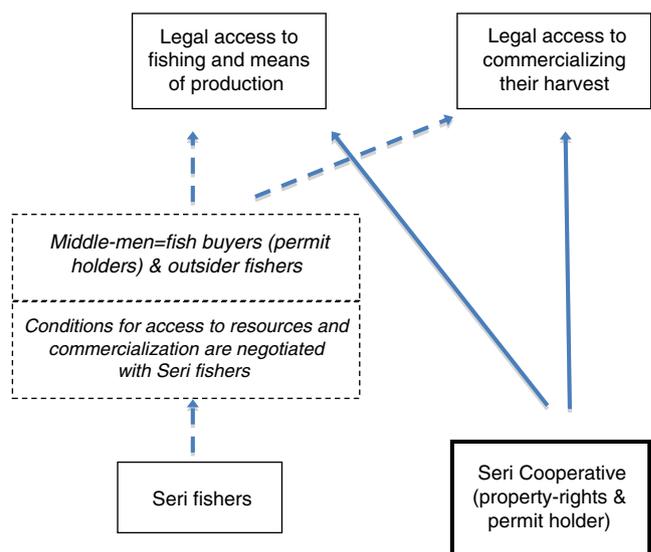
their business is to receive the catch from other Seri fishers and transport it to Kino fish buyers in exchange for a nominal fee (Fig. 3).

Even under these limitations, the Seri have managed to set a relatively effective rule system (even if not free from internal conflict) to grant temporary access to ‘outsiders’ that helps prevent excessive increases in fishing pressure.

#### Discussion: An Embedded Performance Assessment

##### Power, Self-Governance, and Conservation

The permit system in Mexico as implemented in the study area disproportionately empowers permit holders—who generally are not fishers—while disempowering and marginalizing the fishers in such way that neither group has incentives to coordinate and effectively limit outsider access to their fisheries. Permit holders act as middle-men in control of the entire fishing process and behave as roving bandits (Berkes *et al.* 2006). They have low dependency on a specific set of local resources and have the economic power to “hire” fishers to fish where they are told. Permit holders and independent buyers are often the reason why large numbers of outsider boats arrive to fish generating conflict among local fishermen. Permit holders find no incentives to encourage local fishers to limit fishing and these fishers find themselves in a constant race to harvest local—and other communities’—resources farther away, before others do the same. Why should Kino fishers pay the costs involved in self-organizing if they cannot have reasonable expectations that they will be the recipients of the benefits generated by their efforts?



**Fig. 3** Formal (solid lines) and informal (dotted lines) institutional arrangement for the Seri pen shell fishery

While a new class of middle-men seems to be emerging among the Seri, it is unlikely that it will lead to the same power inequalities between fish buyers and fishers as observed in Kino, given that they merely transport the catch and are not in control of fishing permits or the fishing means of production. The marine tenure granted to the Seri appears to have incentivized fishers to—over time—self-organize and design a complex set of informal rules to control access and reduce fishing pressure. Given weak monitoring and enforcement capacity from the government, the Seri common-property regime has comparatively promoted more resource conservation (Table 5).

Although Seri fishers are also required under federal law to operate under the permit system, fisheries authorities do not enforce it, and thus fishers enjoy the autonomy to design their own rules to govern the extraction of resources like pen shells. Such rules-in-use are proving key to gain and keep in control access to marine resources inside the Infiernillo Channel, guide fishers' participation in informal monitoring and enforcement, and—to a lower but increasing rate—gain access to fishing means of production and resource commercialization.

In both communities, fish buyers play an important role in the fishing process, particularly as entrepreneurs willing to absorb most of the inherent risk and uncertainty of highly volatile and competitive seafood markets. Fishers cannot effectively play the role of fish buyers and also be active fishermen in such environments. However, fish buyers, also need to be held accountable for their actions and for the most part, the permit system does a poor job at that.

#### Not by Property-Rights Alone!

The presence of legally established property rights did not automatically result in the emergence of access controls for the Seri. It took them about 10 years from when they were

granted marine tenure to the time when they started exercising access controls to the Infiernillo Channel. During this period they continued fishing down the food web (Table 2), until the increasing encroachment of outsiders in Seri territory reminded them of the long history of domination attempts by Spaniard and Mexican—a strong incentive to overcome the costs of engaging in collective action towards the defence of their territory and resources. If history is a guide, the Seri are not a single cohesive social entity except when they are confronted with a common enemy. For the Seri, controlling access to their fishing grounds is also about defending the biophysical space that provides meaning to *who they are* as a distinctive social group.

The decadal gap also suggests that the emergence of effective access controls and the avoidance of overexploitation in the Seri pen shell fishery could not be solely attributed to the presence of property-rights and socio-historical factors, but also to particularities of pen shell biology and biophysical features of Seri fishing grounds. For instance, the narrowness of the Infiernillo Channel easily allows the Seri to identify the presence of other boats. Also, the occurrence of the most extensive annual eelgrass meadows in the Eastern Pacific (Torre-Cosío *et al.* 2003) make it very cumbersome to harvest pen shells that inhabit those areas, likely having positive effects for the recovery of the fishing stock. Other pen shell-specific biological characteristics (e.g., a continuous reproductive cycle and a rapid growth and sexual maturation, among others), likely help buffer the potential negative effects of sudden increases in fishing effort when monitoring and enforcement is absent or weak inside the Infiernillo Channel (Basurto 2008; Basurto and Coleman 2010).

But what is the role of formal and exclusive property rights in helping prevent the overexploitation of pen shells, amid the relevance of socio-historic and biophysical factors? Without exclusive property rights the Seri would likely have

**Table 5** Summary of resource condition for the Kino and Seri fisheries before and after the emergence of access controls (with emphasis on the pen shell fishery)

Fishery	Before the emergence of access controls	After the emergence of access controls
Kino (“control”)	1. Governance regimen: <ul style="list-style-type: none"> <li>• Permit</li> </ul> 2. Resource conservation: <ul style="list-style-type: none"> <li>• Abundant pen shells</li> <li>• Overexploitation of major fisheries (see Table 2).</li> </ul>	1. Governance regimen: <ul style="list-style-type: none"> <li>• Permit</li> </ul> 2. Resource conservation: <ul style="list-style-type: none"> <li>• Scarce pen shells.</li> <li>• Continued overexploitation of major fisheries.</li> </ul>
Seri (“impact”)	1. Governance regimen: <ul style="list-style-type: none"> <li>• Permit</li> </ul> 2. Resource conservation: <ul style="list-style-type: none"> <li>• Abundant pen shells.</li> <li>• Overexploitation of major fisheries (see Table 2)</li> </ul>	1. Governance regimen: <ul style="list-style-type: none"> <li>• Permit + Marine tenure + Informal Rule System.</li> </ul> 2. Resource conservation: <ul style="list-style-type: none"> <li>• Abundant pen shells.</li> <li>• Potential for other fisheries recovery due to access control to fishing areas.</li> </ul>

had greater difficulty in finding the incentives to design their own rule system and maintain it overtime as has been observed in other settings (Cudney-Bueno and Basurto 2009). Having formal property rights legitimize Seri fishers as rightful owners, diffusing potential disputes that might emerge regarding “who” is a legitimate fisher in the eyes of other local fishers. Fishers from all over the region consistently state that “the Infiernillo Channel belongs to the Seri.” This recognition creates social structure by setting up the basis of who is inside the group and who is not, and therefore facilitates the negotiation of informal access arrangements between “legitimate owners” and “outsiders” for the use of Seri fishing grounds by non-Seri fishers. The Seri’s authority over this territory operates despite the Mexican Constitution’s stipulation that fishing resources in territorial waters belong to all Mexican nationals, a tenet that is commonly used to question small-scale fishers’ territoriality.

### Policy Implications

We caution policy-makers to interpret the current performance of fishing permits as implemented in the study area as strong support towards the enactment of marine tenure systems like the Seri in other settings, unless careful consideration and re-adaptation to local socio-ecological contexts is conducted. The Seri marine tenure did not directly result in the development of access controls until a decade after its enactment. While having formal property rights likely served as an enabling factor for locals’ ability to find enough incentives to develop local institutions our study shows that the performance of property rights regimes needs to be tightly coupled in space and time with their social and ecological context. Performance evaluations will need to be able to incorporate these dimensions in a systematic fashion to be more effective and relevant for policy-making. The performance of the Mexican permit system as implemented in the study region echoes previous findings suggesting that to be effective, these policies are highly dependent on external control by authorities (Hilborn *et al.* 2003). In most small-scale fisheries in developing countries where usually large numbers of boats land their catch in multiple sites, and where institutional capacity for management, monitoring, and enforcement is often poor (Berkes *et al.* 2001), the use of approaches strongly dependent on external enforcement is unlikely to produce favourable outcomes (Christy 2000), nor be conducive to the accumulation of needed social capital for the development of self-reliant rural coastal communities.

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### References

- Acheson, J. M. (2006). Lobster and Groundfish Management in the Gulf of Maine: A Rational Choice Perspective. *Human Organization* 65: 240–252.
- Agrawal, A., Chhatre, A., and Hardin, R. (2008). Changing Governance of the World’s Forests. *Science* 320: 1460–1462.
- Alcalá Moya, G. (1999). *Con el Agua Hasta los Aparejos. Pescadores y Pesquerías en El Soconusco, Chiapas. México: CIESAS, UNICACH, CIAD.*
- Andrew, N. L., Béné, C., Hall, S. J., Allison, E. H., Heck, S., and Ratner, B. D. (2007). Diagnosis and management of small-scale fisheries in developing countries. *Fish and Fisheries* 8: 227–240.
- Bahre, C. J., Bourillón, L., and Torre, J. (2000). The Seri and Commercial Totoaba Fishing (1930–1965). *Journal of the Southwest* 42: 559–575.
- Basurto, X. (2005). How Locally Designed Access and Use Controls Can Prevent the Tragedy of the Commons in a Mexican Small-Scale Fishing Community. *Society and Natural Resources* 18: 643–659.
- Basurto, X. (2006). Commercial Diving and the Callo de Hacha Fishery in Seri Territory. *Journal of the Southwest* 48: 189–209.
- Basurto, X. (2008). Biological and Ecological Mechanisms Supporting Marine Self-Governance: The Seri Callo de Hacha Fishery in Mexico. *Ecology and Society* 13.
- Basurto, X., and Coleman, E. (2010). Institutional and Ecological Interplay for Successful Self-Governance of Community-Based Fisheries. *Ecological Economics* 69: 1094–1103.
- Berkes, F. (ed.) (1989). *Common Property Resources. Ecology and Community-Based Sustainable Development.* Belhaven, London.
- Berkes, F., Hughes, T. P., Steneck, R. S., Wilson, J. A., Bellwood, D. R., Crona, B., Folke, C., Gunderson, L. H., Leslie, H. M., Norberg, J., Nystrom, M., Olsson, P., Osterblom, H., Scheffer, M., and Worm, B. (2006). Globalization, Roving Bandits, and Marine Resources. *Science* 311: 1557–1558.
- Berkes, F., Mahon, R., McConney, P., Pollnac, R., and Pomeroy, R. S. (2001). *Managing Small-scale Fisheries. Alternative Directions and Methods.* International Development Research Centre, Ottawa.
- Bizzarro, J. J., Smith, W. D., Hueter, R. E., Tyminski, J., Márquez-Farías, J. F., Castillo-Géniz, J. L., Cailliet, G. M., and Villavicencio-Garayzar, C. J. (2007). The status of shark and ray fishery resources in the Gulf of California: applied research to improve management and conservation. Moss Landing Marine Laboratories.
- Blomquist, W. (1992). *Dividing the Waters. Governing Groundwater in Southern California.* ICS Press, San Francisco.

- Bourillón, L. (2002). Exclusive Fishing Zone as a Strategy for Managing Fishery Resources by the Seri Indians, Gulf of California. Dissertation, University of Arizona at Tucson, Mexico.
- Bowen, T. (2000). Unknown. Island Seri Indians, Europeans, and San Esteban Island in the Gulf of California. University of New Mexico, Albuquerque.
- Brusca, R. C., Findley, L. T., Hastings, P. A., Hendrickx, M. E., Torre, J., and van der Heiden, A. M. (2005). Macrofaunal Diversity in the Gulf of California. In Cartron, J.-L. E., Ceballos, G., and Felger, R. S. (eds.), *Biodiversity Ecosystems and Conservation in Northern Mexico*. Oxford University, New York, pp. 179–369.
- Chenaut, V. (1985). *Los Pescadores de Baja California (Costa del Pacífico y Mar de Cortés)*. Vol. 2. Los Pescadores de México. México: Centro de Investigaciones y Estudios Superiores en Antropología Social. Museo Nacional de Culturas Populares.
- Christy, F. T. (2000). Common Property Rights An Alternative to ITQs. In Shotton, R. (ed.), *Use of Property Rights in Fisheries Management Proceedings of the Fish Rights 99 Conference*. FAO Fisheries Technical Paper 404/1, Freemantle Western Australia.
- Cinti, A., Shaw, W., Cudney-Bueno, R., and Rojo, M. (2010a). The Unintended Consequences of Formal Fisheries Policies: Social Disparities and Resource Overuse in a Major Fishing Community in the Gulf of California, Mexico. *Marine Policy* 34: 328–339.
- Cinti, A., Shaw, W., and Torre, J. (2010b). Insights from the Users to Improve Fisheries Performance: Fishers' Knowledge and Attitudes on Fisheries Policies in Bahía de Kino, Gulf of California, Mexico. *Marine Policy* 34: 1322–1334.
- Cisneros-Mata, M. A. (2010). The Importance of Fisheries in the Gulf of California and Ecosystem-Based Sustainable Co-Management for Conservation. In Brusca, R. C. (ed.), *The Gulf of California. Biodiversity and Conservation, Arizona-Sonora Desert Museum Studies in Natural History*. The University of Arizona, Tucson, Arizona, pp. 119–134.
- Cisneros-Mata, M. A., Montemayor-Lopez, G., and Roman-Rodriguez, M. J. (1995). Life History and Conservation of Totoaba Macdonaldi. *Conservation Biology* 9: 806–814.
- Cook, T. D., and Campbell, D. T. (1979). *Quasi-experimentation: Design and Analysis Issues for Field Settings*. Houghton Mifflin, Boston.
- Cruz-Acosta, H. (1979). 'Estudios Preliminares de las Pesquerías Indígenas: Seri, Yaqui y Mayo del Estado de Sonora.' 1er Simposio internacional de educación y organización pesqueras, Cancun, Quintana Roo, 1979.
- Cudney-Bueno, R., and Basurto, X. (2009). Lack of Cross-Scale Linkages Reduces Robustness of Community-Based Fisheries Management. *PLoS One* 4: e6253.
- Delgado, C. I., Wada, N., Rosegrant, M. W., Meijer, S., and Ahmed, M. (2003). *Fish to 2020. Supply and Demand in Changing Markets*. International Food Policy Research Institute and WorldFish Center.
- Diario Oficial de la Federación. (1970). 28 de Noviembre de 1970. México, DF., México.
- Diario Oficial de la Federación. (1975). 11 de Febrero de 1975. México, DF., México.
- Diario Oficial de la Federación. (1978). 2 de Agosto de 1978. México, DF., México.
- FAO. (2009). *The State of World Fisheries and Aquaculture 2008*. Food and Agriculture Organization of the United Nations.
- Felger, R. S., and Moser, M. B. (1985). *People of the Desert and Sea. Ethnobotany of the Seri Indians*. University of Arizona, Tucson.
- Hilborn, R., Branch, T. A., Ernst, B., Magnusson, A., Minte-Vera, C. V., Scheuerell, M. D., and Valero, J. L. (2003). State of the World's Fisheries. *Annual Review of Environment and Resources* 28: 359–399.
- INEGI. (2005). "Censo General de Población y Vivienda [online] URL: <http://www.inegi.gob.mx>".
- Jackson, J. B. C., Kirby, M. X., Berger, W. H., Bjorndal, K. A., Botsford, L. W., Bourque, B. J., Bradbury, R. H., Cooke, R., Erlanson, J., Estes, J. A., Hughes, T. P., Kidwell, S., Lange, C. B., Lenihan, H. S., Pandolfi, J. M., Peterson, C. H., Steneck, R. S., Tegner, M. J., and Warner, R. R. (2001). Historical Overfishing and the Recent Collapse of Coastal Ecosystems. *Science* 293: 629–637.
- Jentoft, S. (2004). Institutions in Fisheries: What they Are, What they Do, and How they Change. *Marine Policy* 28: 137–149.
- Lercari, D., and Chávez, E. A. (2007). Possible causes related to historic stock depletion of the totoaba, *Totoaba macdonaldi* (Perciformes: Sciaenidae), endemic to the Gulf of California. *Fisheries Research* 86: 136–142.
- Lowe, M. E., and Carothers, C. (eds.) (2008). *Enclosing the Fisheries: People, Places, and Power*. Vol. 68. American Fisheries Society, Bethesda, Maryland.
- Malkin, B. (1962). Seri ethnology. Occasional Papers of the Idaho State College Museum 7.
- Mansfield, B. (2004). Rules of Privatization: Contradictions in Neoliberal Regulation of North Pacific Fisheries. *Annals of the Association of American Geographers* 94: 565–584.
- McCay, B. J. (1996). Common and Private Concerns. In Hanna, S. S. F., Carl, Maler, and Karl-Goran (eds.), *Rights to Nature: Ecological, Economic, Cultural, and Political Principles of Institutions for the Environment*. Island Press, Washington, DC, pp. 111–156.
- McCay, B. J. (2002). Emergence of Institutions for the Commons: Contexts, Situations, and Events. In Ostrom, E., Dietz, T., Dolšák, N., Stern, P. C., Stonich, S., and Weber, E. U. (eds.), *The Drama of the Commons*. National Academy Press, Washington, D.C., pp. 361–402.
- McCay, B. J. (2008). Introduction: Ethnography and Enclosure of the Marine Commons. In Lowe, M. E., and Carothers, C. (eds.), *Enclosing the Fisheries: People, Places, and Power*, vol. 68. American Fisheries Society, Bethesda, Maryland, pp. 1–18.
- Mills, J. S. (1967). [1843]. *A System of Logic: Ratiocinative and Inductive*. University of Toronto Press, Toronto.
- Moreno, C., Torre, J., Bourillón-Moreno, L., Durazo, M., Weaver, A. H., Barraza, R., and Castro, R. (2005a). Estudio y Evaluación de la Pesquería de Callo de Hacha (*Atrina tuberculosa*) en la región de Bahía de Kino. Sonora y recomendaciones para su manejo, Comunidad y Biodiversidad.
- Moreno, C., Weaver, A., Bourillón, L., Torre, J., Égido, J., and Rojo, M. (2005b). Diagnóstico Ambiental y Socioeconómico de la Región Marina-Costera de Bahía de Kino, Isla Tiburón, Sonora México: Documento de trabajo y discusión para promover un desarrollo sustentable. Comunidad y Biodiversidad, A.C.
- Ostrom, E. (2005). *Understanding Institutional Diversity*. Princeton University, Princeton.
- Ostrom, E. (2009). A General Framework for Analyzing Sustainability of Social-Ecological Systems. *Science* 325: 419–422.
- Ostrom, E., and Cox, M. (2010). Moving Beyond Panaceas: A Multitiered Diagnostic Approach for Social-Ecological Analysis. *Environmental Conservation* 37: 451–463.
- Pauly, D. (2006). Major trends in small-scale marine fisheries, with emphasis on developing countries, and some implications for the social sciences. *Maritime Studies (MAST)* 4: 7–22.
- Pauly, D., Christensen, V., Dalsgaard, J., Froese, R., and Torres, F. (1998). Fishing Down Marine Food Webs. *Science* 279: 860–863.
- Persha, L., Agrawal, A., and Chhatre, A. (2011). Social and Ecological Synergy: Local Rulemaking, Forest Livelihoods, and Biodiversity Conservation. *Science* 331: 1606–1608.
- Poteete, A. R., Janssen, M. A., and Ostrom, E. (2010). Working Together: Collective Action, the Commons, and Multiple Methods in Practice. Princeton University, Princeton.
- Saenz-Arroyo, A., Roberts, C., Torre, J., and Carino-Olvera, M. (2005a). Using fishers' anecdotes, naturalists' observations and grey literature to reassess marine species at risk: the case of the Gulf grouper in the Gulf of California, Mexico. *Fish and Fisheries* 6: 121–133.

- Saenz-Arroyo, A., Roberts, C., Torre, J., Cariño-Olvera, M., and Enríquez-Andrade, R. (2005b). Rapidly shifting environmental baselines among fishers of the Gulf of California. *Proceedings of the Royal Society B: Biological Sciences* 272: 1957.
- Salas, S., Chuenpagdee, R., Charles, A., and Seijo, J. C. (eds.) (2011). *Coastal Fisheries of Latin America and the Caribbean*. Vol. 544. *FAO Fisheries and Aquaculture Technical Paper 544*. FAO, Rome, Italy.
- Salas, S., Chuenpagdee, R., Seijo, J. C., and Charles, A. (2007). Challenges in the assessment and management of small-scale fisheries in Latin America and the Caribbean. *Fisheries Research* 87: 5–16.
- Seminoff, J. (2010). Sea Turtles of the Gulf of California Biology, Culture, and Conservation. In Brusca, R. C. (ed.), *The Gulf of California Biodiversity and conservation*. The University of Arizona, Tucson, Arizona.
- Sheridan, T. E. (1999). *Empire of Sand The Seri Indians and the Struggle for Spanish Sonora*. The University of Arizona Press, Tucson, pp. 1645–1803.
- Smith, M. D., Roheim, C. A., Crowder, L. B., Halpern, B. S., Turnipseed, M., Anderson, J. L., Asche, F., Bourillon, L., Guttormsen, A. G., Khan, A., Liguori, L. A., McNevin, A., O'Connor, M. I., Squires, D., Tyedmers, P., Brownstein, C., Carden, K., Klinger, D. H., Sagarin, R., and Selkoe, K. A. (2010). Sustainability and Global Seafood. *Science* 327: 784–786.
- Smith, W. N. (1954). *The Ethno-History of the Seri Indians 1890 to 1953*. University of Arizona Library Special Collections, Tucson Arizona.
- Soberanes Fernández, J. L. (1994). “Historia Contemporánea de la Legislación Pesquera en México,” in *El Régimen Jurídico de la Pesca en México*, vol. Serie G: Estudios doctrinales, núm. 150. Edited by M. González Oropeza and M. Á. Garita Alonso, pp. 1–26. Mexico: Instituto de Investigaciones Jurídicas.
- Torre-Cosío, J., Bourillón-Moreno, L., Meking-López, A., and Ramírez-García, P. (2003). Distributional Patterns of an Annual Eelgrass, *Zostera marina*, Population in the Gulf of California. *Gulf of Mexico Science* 21: 136.
- Worm, B., Hilborn, R., Baum, J. K., Branch, T. A., Collie, J. S., Costello, C., Fogarty, M. J., Fulton, E. A., Hutchings, J. A., Jennings, S., Jensen, O. P., Lotze, H. K., Mace, P. M., McClanahan, T. R., Minto, C., Palumbi, S. R., Parma, A. M., Ricard, D., Rosenberg, A. A., Watson, R., and Zeller, D. (2009). Rebuilding Global Fisheries. *Science* 325: 578–585.