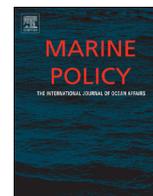




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The changing role of NGOs in Mexican small-scale fisheries: From environmental conservation to multi-scale governance



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ABSTRACT

Multi-scale governance has been widely recommended for effective marine resource management. This approach suggests collective decision-making, the devolution of some rights and responsibilities to various entities, co-production of knowledge, coupling governance and ecological scales, among other elements. Here, the elements of multi-scale governance of Mexican small-scale fisheries (SSF) and the contribution of non-governmental organizations (NGOs) to this approach are described. Three management processes were selected for the analysis: (1) the development of the Fisheries Management Plan (FMP) for the swimming crab fishery; (2) the establishment of fishing refugia in the Punta San Cosme to Punta Coyote Corridor; and (3) the implementation of catch shares in the Gulf corvina fishery. The results suggest that NGOs are contributing to most of the key attributes for multi-scale fisheries governance. Given the NGOs' agenda shift in the Gulf of California region, from advocacy for environmental conservation to participation in sustainable management, there has been a wider promotion and acceptance of NGOs within governance related processes in fisheries management. In order to clarify alignments with other stakeholder agendas, as well as to continue building trust, NGOs need to make their governance agenda explicit. This work provides insights on how NGOs can contribute to multi-scale governance and a framework for the evaluation of management processes and the contribution of different stakeholders to multi-scale governance, which can be applied to any management process.

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1. Introduction

Small-scale fisheries (SSF) are significant at the global scale, with an estimated 22 of the 50 million fishers worldwide working in this sector [1], and catching 50% of the total fish production [2]. They are critically important sources of income, food, and development opportunities in coastal regions, especially in developing countries [3]. In addition, SSF represent ways of living, traditions and cultures [2]. Due to the proliferation of coastal communities, the difficulty and cost to exclude others from exploiting the resource, and the ever-increasing growth in the number of fishers, SSF exhibit the same problems as other common pool resources [4–6]. Furthermore, the sustainable management of SSF to ensure the permanence of fishing culture, fisheries production, and local livelihoods is particularly complex due to the presence of multiple

users, multiple target species, and multiple types of fishing gear [7,8]. Also, SSF tend to be data-poor, lack monitoring and feature reduced compliance, due to their isolation and complexity. These challenges have led to sequential overexploitation of the resources that SSF depend on around the world [3].

Fisheries governance has been defined as a key element of sustainable fisheries management [3,9]. New forms of governance have emerged and have been proposed to improve the management of SSF. These emerging systems of governance include self-organized communities [6,10], co-management [11], polycentric management [12] and multi-scale governance [13]. Particularly with SSF, non-governmental organizations (NGOs) have contributed to new forms of governance by bridging communication between stakeholders, building local capacity for communities to self-organize, as well as participating in and promoting co-management [8,13,14]. Although NGOs have expanded their work into several facets of fisheries governance, their work to date remains poorly documented.

By comparing management processes in three Gulf of California fisheries, multi-scale governance in Mexican SSF and the role that

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NGOs have played in fortifying this approach are analyzed. This work focuses on multi-scale governance, which has been described as an essential element for effective fisheries management because it fortifies collaboration between users and managers, strengthens linkages across vertical and horizontal levels, and provides the framework for institutions to match ecological and social scales [13,15].

2. Background information

2.1. Overview of Mexican SSF

Mexico is one of the 17 world's top diversity-rich countries [16] with 11,122 km of coastline and an area of 231,813 km² of territorial waters [17], with 41% (47,344,698 people) of its population living in 150 coastal municipalities [18]. SSF provide direct employment to 350,000 fishers, which capture 40% of the total national catch [19], fluctuating around 1.2 million metric tons per year over the last 20 years, representing 1% of the world's fisheries production [2]. Around 65% of this catch is for domestic consumption [19] and a large percentage is non-reported or illegal [20]. Since the 1920s access to Mexican fisheries has been controlled through a permit and concessions system [21]. In the 1990s seasonal closures and official bylaws (Normas Oficiales Mexicanas, NOMs), which include specific regulations for each fishery, began to be broadly implemented. Despite these rules, as in other countries, most Mexican SSF are considered *de facto* open access fisheries [22].

2.2. Elements of multi-scale governance in Mexican SSF

Fisheries in Mexico are federally managed [22]; however, centralized management agencies do have attributes that are conducive to implementing multi-scale governance. The National Commission for Fisheries and Aquaculture (CONAPESCA) is the centralized agency in charge of administration, regulation, and enforcement of fisheries, and is currently part of the Ministry of Agriculture, Livestock, Rural Development and Fisheries (SAGARPA). Although its offices are centralized in one of the most important industrial fishing ports (Mazatlan, Sinaloa), CONAPESCA has 32 state offices with several local branches [22]. The National Fisheries Research Institute (INAPESCA), which is the scientific and technical arm of SAGARPA, also has centralized headquarters with 14 regional offices. There are legal mechanisms to devolve responsibility to states and to promote stakeholder participation in decision-making processes [23,26]. These mechanisms include formal institutional arrangements such as the (1) National and State Councils for Fisheries and Aquaculture – conformed by multiple stakeholders to provide advice and recommendations to INAPESCA and CONAPESCA on fisheries management plans, subsidies and research programs, permit and concession issuing and distribution [24]; (2) National Council Subgroup for Responsible Fishing – convened by different Ministries and representatives of industrial fisheries and SSF to revise and approve new regulations [25,27]; (3) National and State Committees of fishery stakeholders (fishers, buyers, distributors) focused on bolstering the value chain see [23,24]. In addition, most NOMs and seasonal closures developed by CONAPESCA are processes, which involve the participation of diverse stakeholders and to some degree are matched with the ecological scale of the fishery.

Mexican fishers have diverse, elaborated and scaled organizations that are also conducive to multi-scale governance. At the local level, fishing cooperatives are very common in Mexico; some of them are successful and well documented examples of self-organized SSF that manage their resources well [11,21,28]. Cooperatives are joined at the regional level into federations or unions

(the latter includes other stakeholders such as the individual permit holders). Finally, there are national confederations that integrate federations and represent small-scale fishing cooperatives. The largest confederation currently includes 32 federations representing 2,685 cooperatives and around 180,000 fishers and has gained political power and a place in the National Council of Fisheries and Aquaculture and the National Council Subgroup for Responsible Fishing. Finally, organized small-scale fishers (at local, regional and national levels) in Mexico have proved to be successful in implementing novel management instruments such as fishing refugia¹ (e.g., Baja California Sur) and quotas systems (e.g. abalone), as well as in fulfilling international standards for sustainable fishing established by the Marine Stewardship Council (MSC) (e.g., lobster fishery in the Baja California Peninsula and Mesoamerican Reef) and the Monterrey Bay Aquarium Seafood Watch program (e.g., Yellowtail Jack fishery in Baja California).

2.3. Role of NGOs in Mexico

NGOs have played a key role in the transition to new forms of fisheries governance in Mexico, especially in the Gulf of California. Given the critical importance of the Gulf of California for biodiversity, NGOs have had a powerful presence since the mid 1980s see [29]. Up until the 1990s, NGOs' work was mostly focused on environmental issues [22] such as endangered species (e.g., vaquita marina, sea turtles), habitat protection, and natural protected areas (e.g., Cabo Pulmo, Loreto, Upper Gulf of California) see [29]. However, over the last couple of decades, NGOs have shifted their objectives and now are playing a key role in working with users for the sustainable management of fisheries and ecosystems. Currently, NGOs' work include key efforts to promoting increased scientific information and the use of traditional knowledge [21,30,31], supporting the development of management plans [32], building local capacities, promoting information sharing across different levels, and fortifying fishers' organization and participatory processes [29,33]. Although NGOs started working in specific communities, their role has slowly gained importance for fisheries agencies and fishers' organizations, especially since their contribution to the MSC certification of the lobster fishery in Baja California in early 2000s (Cisneros-Mata *pers. comm.*).

3. Methods

To evaluate SSF management processes and the role of NGOs in multi-scale governance, a list of key attributes for effective multi-scale fisheries governance was compiled from a literature review [13,15,34–37]. Then, for each one of these attributes, a qualitative scoring system to evaluate management processes was developed (Table 1). Three existing SSF management processes in which NGOs have been participating were selected: (1) the development of the Fisheries Management Plan (FMP) for the swimming crab fishery; (2) the establishment of fishing refugia in the Punta San Cosme to Punta Coyote Corridor; and (3) the implementation of catch shares in the Gulf corvina fishery (described in this section). The three management processes were evaluated against the key multi-scale governance attributes and scored. In addition, the activities implemented by NGOs to contribute to each attribute of multi-scale governance were listed. To validate and ensure fairness in the evaluation of case studies and NGOs' role, impartial external reviewers – who are familiar with the management processes and

¹ Areas closed to fishing to protect target species reproduction, growth, recruitment or habitat [24].

Table 1
Attributes and grading system for multi-scale governance.

Attribute	Description	Scoring scale
Institutional scale (multi-layer)	Representation and participation of local, regional, national, and in some cases, international institutions [13,15].	Ordinal (all, some, none). Depending on the institutions represented in the process.
Cooperative management	Incorporation to management (planning, implementation, evaluation and adaptation) of the knowledge, skills, resources and perspectives of a diverse and inclusive representation of participants, and which is characterized by deliberation and accountability [36,54].	Ordinal (high, medium, low, none). “High” indicates that management includes diverse actors’ knowledge and perspectives, and the process includes deliberation and accountability. “None” indicates that management implements measures unilaterally and there is little management accountability.
Collective action	Ability of a group to have full autonomy to craft and enforce their own rules [6].	Ordinal (high, medium, low, none). “High” indicates that interest groups have full autonomy at the collective-choice level to craft and enforce some of their own rules. “None” indicates that there is no autonomy to craft and enforce rules.
Polycentric management	Devolution of decision-making power to decentralized units. Institutions have multiple centers or authorities, are nested, quasi-autonomous decision-making units operating at multiple scales, balancing between centralized and decentralized control [55 in 36,56].	Binary (yes/no). “Yes” indicates that institutions have multiple centers or authorities, are nested, quasi-autonomous decision-making units operating at multiple scales, balancing between centralized and decentralized control. “No” indicates that institutions are highly centralized.
Match with ecological scales	Match governance to ecological scales. Given the broad spatial range of many fisheries, this attribute is often a significant challenge [13].	Ordinal (high, medium, low, none). “High” indicates that existing institutions or management tools match the ecological scales, or have institutional arrangements that allow for this match. “None” indicates that existing institutions or management tools or systems do not match ecological scales and this creates a problem for SSF management.
Information sharing	Sharing information both vertically (higher and lower levels), as well as horizontally [13] (between regions, communities, or institutions that are at the same level).	Ordinal (high, medium, low, none). “High” indicates that managers actively share information and explain decisions, actions and inactions to stakeholders. Furthermore, the process to define what information is needed, how and who should generate it and how it should be shared is clear to all stakeholders. “None” indicates that managers did not provide, or were under no obligation to provide, information and explain decisions and actions or inactions to stakeholders. In addition, procedures to generate and share information are not clear or defined.
Co-production of knowledge	Plurality of knowledge, sources and types, which if considered in conjunction can improve systems-oriented understanding of a problem [35].	Binary (yes/no). “Yes” indicates that the plurality of knowledge improved or resulted in a system-oriented understanding of the fishery. “No” indicates no plurality.
Social learning	Collective process of learning-by-doing [13], which may result into new knowledge and skills [59].	Ordinal scale (high, medium, low, none). “High” indicates collaborative development of knowledge and skills through learning-by-doing. “None” indicates no collaborative development and sharing of knowledge through learning-by-doing.
Institutional interplay	Multi-level linkages [13]. A linkage was defined as “a formal rule, strategy or regularized action that establishes interdependencies between two distinct actors regarding different tasks” [60 in 34].	Ordinal (high, medium, low, none). “High” indicates that the process had formal rules, strategies or regularized arrangements that established interdependencies between the distinct actors regarding different tasks. “None” indicates these interdependencies were non-existent.

NGOs’ work in the region – reviewed the scoring and provided further feedback on the analysis.

3.1. Case study description

3.1.1. Elaboration of the swimming crab fisheries management plan

Swimming crabs are the target of one of the most important and complex SSFs in Mexico [32,38]. The states of Sonora and Sinaloa produce up to 50% of the total national swimming crab landings [38], providing employment to approximately 20,000 small-scale fishers [39]. In these states, 28 communities (including three indigenous groups: the Comcaác, Yaquis, and Mayos) strongly depend on the swimming crab fishery because its fishing season lasts for several months. This is contrasted by other important species such as shrimp, which fishing season only lasts for up to three weeks. Brown (*Callinectes bellicosus*) and blue (*C. arcuatus*) swimming crabs are the two species concentrated in the catch. *C. bellicosus* represents 57% of the catch in Sinaloa and 95% in Sonora [39].

Swimming crab fishing requires permits. In the Mexican Pacific, the fishery is also regulated by a seasonal closure published every year [40] and the bylaw (NOM-039-PESC-2003)

that establishes regulations for responsible fishing (e.g., size limits, number and specifications for types of fishing gear) [41]. In addition, INAPESCA, through the National Fisheries Chart, has provided key recommendations to improve the long-term sustainability of this fishery, such as the establishment of no-take zones in estuaries to protect female aggregations, the implementation of rights-based management (quotas), and the improvement of gear selectivity [42].

While the fishery has rules for responsible fishing, rules were not fully complied by users and non-sustainable practices (e.g., extraction and commercialization of juveniles and gravid females, use of unauthorized gear) had been recorded. As a consequence, users, INAPESCA, and NGOs expressed a growing need for aligning efforts to achieve the sustainability of the fishery. In 2010 the federal government had already listed the swimming crab fishery as one of the 20 most important fisheries in Mexico to focus management efforts on. In addition, the development of FMPs, which are meant to suggest actions for sustainable fishing based on biological, environmental, socio-economic, and cultural aspects of the fishery [24], became a priority for INAPESCA. Thus, the fishery got political attention and the development of a FMP for swimming crab became the most feasible strategy for integrating

efforts of users and managers towards the sustainability of the fishery.

In July 2011, INAPESCA – in close collaboration with an NGO – started a participatory process to develop the FMP for the states of Sinaloa and Sonora, where catch is concentrated. The process required meetings with all stakeholders from both states to revise the current status of the fishery, visits to 28 communities (including indigenous groups) to collect local knowledge and involve fishers in the process, strategic planning in three zones (Center-North of Sonora, South of Sonora-North of Sinaloa, Center and South of Sinaloa), meetings to present final results to stakeholders, and the development of a website where all the information was uploaded to keep stakeholders informed, see [43]. The goal of the participants was to develop and legally publish the FMP before the Mexican presidential elections of July 2012 because many negotiations at the very high levels already existed. Furthermore, with elections, the heads of the cabinet usually change, thus small arrangements get deluded and have to be re-negotiated to become priorities.

The FMP was not published until July 2014. However, a broader community shared the key management goals and objectives for the fishery since 2012. In addition, that same year INAPESCA integrated a research program that explicitly addresses the research priorities stated in the FMP. Together, INAPESCA and the NGO have started to implement the strategies established within the FMP including research (e.g., possible configurations of no-take zones, prevalence of heavy metals in swimming crab meat and sediment, evaluation of the relative performance of various types of fishing gear, biomass estimations) and capacity building (e.g., rules for responsible fishing). Among other outcomes, the FMP process resulted in the mobilization of fishers to work together to take on other initiatives for sustainable fishing (e.g., seasonal closure) and in the creation of a working community of researchers. Management strategies recommended within the FMP have been included in the spatial management programs elaborated by CONAPESCA. Although there are tangible impacts of the process, there are also intangible results, the most important of which is stakeholders' trust in the process. This is the first marine FMP developed for a SSF with a participatory approach, in which multiple stakeholder input was taken into account since the beginning of the process. This strategy was seen as a success for INAPESCA in terms of a possible methodology for successful co-management. Furthermore, INAPESCA has now expanded the scope of the FMP with a participatory approach so as to include all states on the Pacific coast where swimming crab is caught.

3.1.2. Establishment of fishing refugia in the Punta San Cosme-Punta Coyote Corridor

The Punta San Cosme to Punta Coyote Corridor (“the Corridor”) spans more than 150 km of the remote eastern coastline of the state of Baja California Sur and includes several diverse and highly productive marine and coastal habitats [44]. The eleven coastal and island communities in this region – home to about 500 residents and a total of 168 fishers – use these fishing grounds [44]. Although this is a multi-species fishery in which up to 46 species are landed (including clams, sharks, snappers, groupers, yellowtail jack and tilefish), the most important is red snapper (*Lutjanus peru*) [44]. Due to the relative isolation of all the communities, fishing is the main source of income [44,45]. Although the residents of the Corridor principally fish this region, during different seasons fishers from farther north (Loreto municipality) and south (La Paz municipality) also fish this region. Besides permits, there are no other specific fishery regulations in this area. All the communities are in one state, which has a state level fisheries ministry, as well as the delegations of federal

entities. The Corridor lies between two previously established marine protected areas: the Loreto Bay National Park (established in 1996) to the north and the Espiritu Santo Archipelago National Park (established in 2007) to the south (see Fig. 1), regulated by a national environmental law [46] and managed by the National Commission of Natural Protected Areas (CONANP).

Due to the isolation and difficult access to fishing communities, nearly no-fisheries management was observed in this region. However, many of the local fishers wanted to develop rules for sustainable fishing given the decline in catch and abundance of several species (e.g., sea bass, snappers). Because of the lack of basic information on the fisheries, either a FMP or a bylaw, would have been a long process to achieve. The first approximation to management had to be a clear strategy developed with users' participation and local knowledge. Thus, the fishing refugia management instrument became particularly feasible for this area. In addition to that, in 2008 researchers, the federal authorities, and NGOs gathered to talk about how to implement fishing refugia for sustainable fisheries management in Mexico, the first time this process was to be undertaken under the new revision of the Fisheries Law [24]. As a result of this meeting, CONAPESCA made a commitment to use this tool with the primary input of fishers and INAPESCA. Small communities of little complexity were then the most suitable places to test the management tool.

NGOs had been working with all the communities of the Corridor to generate the required information to understand the fishery management needs of the region since 2007. In 2010 an official from CONAPESCA visited the region and invited the fishers to present a proposal for fishing refugia in the Corridor and committed to supporting a process to regulate unlicensed fishers, as less than 50% of the fishers had permits. After nine months, resident fishers with the help of the NGO presented the proposal to the authorities for a network of fishing refugia. Concurrently, over the period of a year, the process of issuing permits to unlicensed fishers was completed. For this particular case, CONAPESCA did not have to increase the number of permits recommended by INAPESCA; it only had to reallocate existing permits, which were not operated.

The criteria used to decide where to place the fishing refugia to best benefit the fish populations were: (1) areas had to be fishing grounds, (2) areas had to include key habitats and ecological processes (e.g., reproduction aggregation sites), (3) areas had to be feasible to enforce, and (4) the community had to agree and commit to comply. Once the areas were selected, a monitoring program was designed and implemented.

In 2012, the community proposal was signed into law, establishing the first fishing refugia network in Mexico [45]. As a result of this process, 11 distinct zones were established as no-take for a period of five years and 97% of resident fishers had permits. In addition, this process empowered users to participate in fisheries management and motivated the development of procedures for establishing fishing refugia in federal waters, see [47].

Currently, resident fishers are working on the management plan for the now-established fishing refugia network that includes enforcement, monitoring, and evaluation protocols, as well as the establishment of a Regional Committee to formalize the participation of fishers and governmental agencies in the implementation of this management instrument.

3.1.3. Implementation of catch shares for the Gulf corvina fishery

The Gulf corvina or Gulf weakfish (*Cynoscion othonopterus*) is an endemic croaker that aggregates to spawn in the northernmost reaches of the Upper Gulf of California and Colorado River Delta Biosphere Reserve [48,49]. It is one of the most important fishery resources shared between four distinct fishing communities that

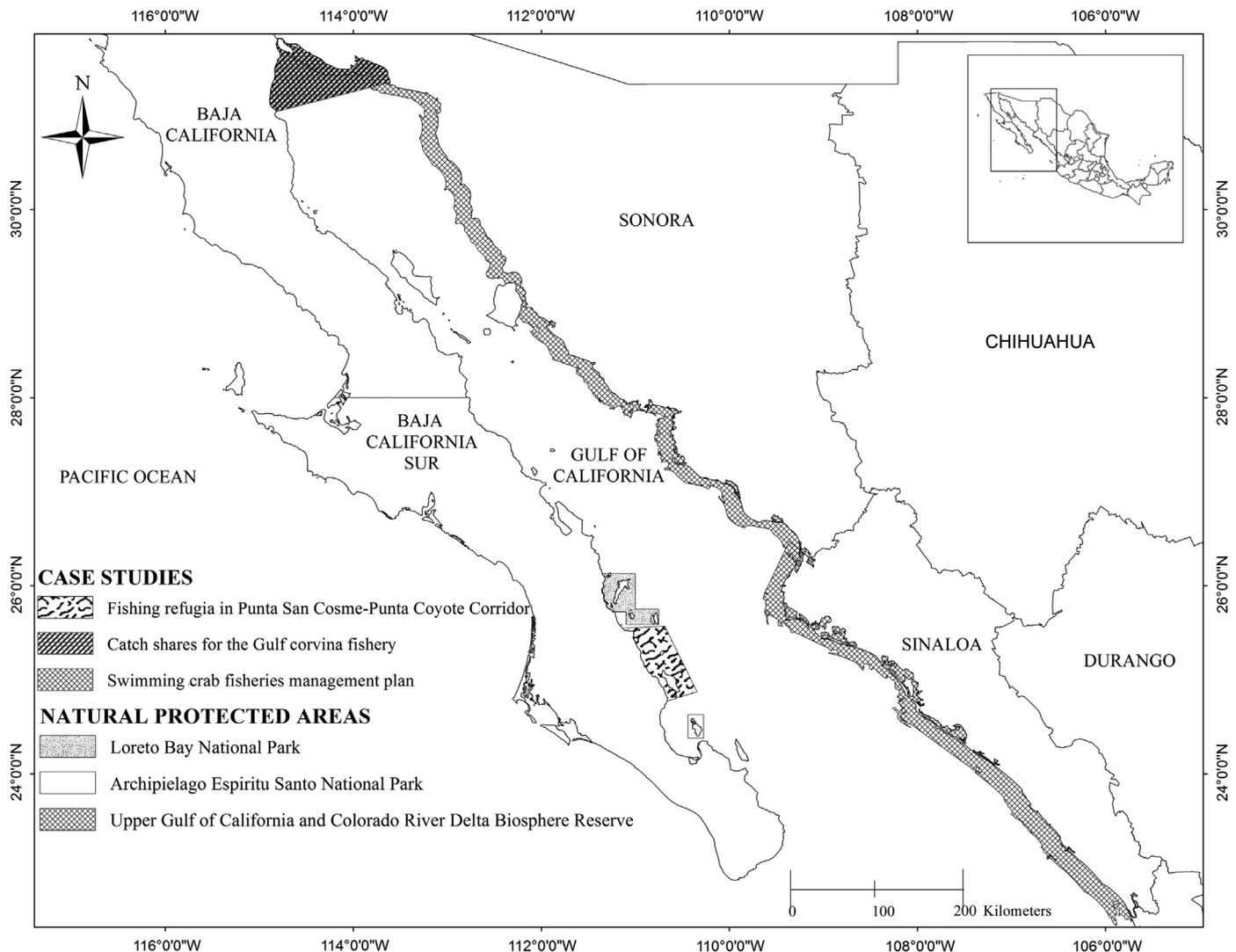


Fig. 1. Mexican small-scale fisheries (SSF) management processes in which NGOs have actively participated. This map only shows the Natural Protected Areas cited in this work.

span two states: Sonora and Baja California. El Golfo de Santa Clara is the most important corvina fishing community, landing 80% of the total volume and having the largest fleet (408 corvina skiffs, 84 cooperatives grouped into seven federations). The Cocopah is an indigenous group that historically fished in the Colorado River, but began to fish Gulf corvina in the Delta as a means of survival once other freshwater and estuarine fishing grounds were no longer available due to the decreased flow from the Colorado River [50,51]. For the three main Cocopah fishing cooperatives, as well as the four cooperatives of the Bajo Rio community, who fish alongside the Cocopah, the Gulf corvina is the main source of income. Although San Felipe is the largest fishing community of the four, it is farthest from the aggregation site, and hence fewer fishers depend on the aggregation as a main source of income, as they have access to a large diversity of other species [29,52].

Several federal agencies (which also have state-level representation) are involved in the management of the region including CONAPESCA, INAPESCA, and CONANP. Since the Upper Gulf Reserve is part of two states, fishery management also includes the state governments with their respective fisheries delegations. Permits and a seasonal closure regulate the access to the fishery. In addition, the Gulf corvina bylaw (NOM-063-PESC-2005) establishes size limits, gillnet mesh size, and landing sites. It also mentions the importance of establishing yearly seasonal closures,

no-take zones, and annual catch limits see [53]. Fishing effort on the aggregation season has been very high, and had often resulted in supply gluts, high levels of discard, and price collapses creating both biological risk and adverse social and economic outcomes.

This analysis focuses on the process of establishing rights-based management in the Gulf corvina fishery. In 2011 INAPESCA established a total allowable catch (TAC) for the 2012 season, which represented less than half of historical landings and was announced without public consultation, initially causing a significant backlash. In the months between the official publication of the TAC and the start of the season, NGOs with several years of a strong presence in the region worked with other stakeholders to turn this potentially large conflict into an opportunity to build stronger foundations for management of this fishery, including the implementation of catch shares. NGOs led the establishment of the Corvina Regional Subcommittee, where all interested parties discuss policy issues. Also, NGOs supported a series of discussions and negotiations between state and federal governments and within fishing communities.

While the bylaw (NOM-063-PESC-2005) was the legal basis for the publication of the TAC in 2012, its allocation was done through signed local agreements. The TAC was shared between fishers from El Golfo de Santa Clara (80%) and the Cocopah-Bajo Rio cooperatives (20%). The first year, San Felipe received no allocation

because there was not enough information to determine its historical Gulf corvina landings. The town of El Golfo de Santa Clara, which had the most frequent meetings, consolidated a set of community agreements to manage the allocated catch in order to avoid supply gluts and price collapses. These agreements established per-skiff, per-tide allocation rules, and relied on buyer commitments to achieve more stable prices, and the overall TAC to reduce biological risk. Although other factors beyond the community agreement are likely involved, from 2011 to 2012 average prices for corvina rose by 67% in El Golfo Santa Clara, while average market prices for corvina at the Nueva Viga market (the most important seafood market in Mexico City) rose by 18%.

The 2013 and 2014 seasons have showed progress. Until 2012, the Gulf corvina was harvested under a finfish permit. With the improvement of the biological information, as well as the increasing importance of the fishery, CONAPESCA began issuing Gulf corvina permits to those cooperatives and individuals that hold finfish permits and had historical corvina landings. Better information also allowed San Felipe to finally receive a share of the TAC. At present, the fishery is managed with individual vessel quotas (IVQs), with most of these vessels or skiffs grouped in cooperatives. Allocation of the TAC is now a formal process that depends on the number of Gulf corvina permits granted to each community. Management challenges still remain in the fishery; however, stakeholders continue to show commitment to the process.

4. Results

There is general agreement in the literature that the following attributes are keys to success in multi-scale governance of SSF: (1) institutional scale, (2) cooperative management, (3) collective action, (4) polycentric management, (5) horizontal and vertical information sharing, (6) co-production of knowledge, (7) social learning, (8) match with ecological scale, and (9) institutional interplay. Definitions and score system are presented in Table 1. The presence of each key attribute across the case studies and NGOs' contribution to each key attribute are described below and

summarized in Tables 2 and 3. Each attribute of multi-scale governance played an important role in the case studies.

4.1. Institutional scale (multi-layer)

Multi-scale governance requires the representation and participation of stakeholders at local, regional, national, and in some cases, international levels [13,15]. The swimming crab FMP process was the only case study where all of the stakeholders at all relevant scales were represented.

In all three cases, NGOs promoted the inclusion of all stakeholders from different levels in the processes and financed travel costs for participants. In the case of the swimming crab fishery, the NGO helped design new structures that could support the participation of stakeholders at different scales, such as a management committee that integrates stakeholders from Sinaloa and Sonora, and the subcommittees for each region. Yet, none of these structures are still operating. In the Corridor, the NGO helped create local cooperatives and support their inclusion in the process and in the regional cooperative federation, which is nested in the largest national confederation of fishing cooperatives. In the case of the Gulf corvina fishery, NGOs led the establishment of a Corvina Regional Management Subcommittee, which has legal standing under the corvina bylaw (NOM-063-PESC-2005), but had not been implemented until 2011. One of the most important achievements was the empowerment and inclusion of indigenous groups that had been previously excluded from decision-making processes.

4.2. Cooperative management

Cooperative management is defined as the process by which management (planning, implementation, evaluation and adaptation) incorporates the knowledge, skills, resources and perspectives of a diverse and inclusive representation of participants, and which is characterized by deliberation and accountability [36,54]. In all three case studies, the inclusion of diverse perspectives and information in management was present. The corvina case

Table 2
Evaluation of management processes using attributes of multi-scale governance.

Attributes of multi-scale governance	Development of the fisheries management plan (FMP) for swimming crab	Establishment of fishing refugia in the Corridor	Implementation of catch shares for Gulf corvina
Institutional scale (multi-layer)	All	Some	Some
Cooperative management	Medium	Medium	High
Collective action	Medium	Medium	Medium
Polycentric management	No	No	No
Match with ecological scales	Medium	Medium	High
Horizontal and vertical information sharing	Medium	Medium	High
Co-production of knowledge	Yes	Yes	Yes
Social learning	High	High	High
Institutional interplay	Medium	Low	Medium

Table 3
Main activities of NGOs that support SSF multi-scale governance.

Meetings and forums	Information	Agreements and rules	Stakeholders
Planning	Identifying needs	Crafting	Ensuring representation
Supporting logistics	Collecting and coproducing	Following up	Linking and bridging gaps
Facilitating	Protocol designing		Empowering
Mediating	Analyzing		Building local capacity
Funding	Communicating		
	Creating data sharing rules		
	Funding		

obtained a high score as scientific information from different sources was included during the process of establishing rights-based management and the government supported stakeholders' agreements and adaptive management. Both the swimming crab FMP process and the Corridor process were scored as medium. Both processes incorporated diverse perspectives and knowledge. However, the swimming crab process was considered to have weak process accountability as the final version of the FMP could not be shared with all stakeholders until it was officially published and the status of its publication was unknown. The Corridor process had unclear rules on who should participate or on how to deliberate in the process of establishing the zones. Although there was deliberation and consensus building within one scale (local fishers), this dialog was lacking a more crosscutting participatory process.

In all cases, NGOs played a prominent role in promoting, facilitating, mediating, and funding multi-level meetings to provide forums for dialog and negotiation, and for stakeholders to bring their perspectives and information to management processes. In all cases, NGOs brought technical expertise to discussions and promoted transparency. For the case of the Gulf corvina catch shares, NGOs also increased plurality of knowledge and perspectives by including buyers in national markets, as well as the indigenous groups. In the case of the swimming crab FMP, given the large number of users participating in the fishery, the NGOs ensured that key representatives from different sectors and knowledge holders were present. In the case of the Corridor, as communities are isolated, the NGO bridged the gap between the communities and the government, and helped integrate the variety of stakeholders' knowledge and perspectives into the fishing refugia proposal.

4.3. Collective action

Collective action refers to the ability of a group to have full autonomy to craft and enforce their own rules [6]. In all of the case studies, it was observed that collective action across multiple levels had occurred. The attribute was scored as “medium” in all case studies for a variety of reasons. In the swimming crab fishery, there was autonomy in the rule making; however, stakeholders felt under no legal obligation to comply because the FMP had not been published and there was not collective enforcement. In the corvina fishery, only one of the four communities has effective collective action. In the case of the Corridor, local communities have autonomy for creating rules and reaching agreements; however, they did not feel their rules were valid until the government recognized them.

To promote collective action, NGOs have been active in creating and promoting multi-stakeholder structures and fora for dialog, rule crafting, and enforcement. NGOs have also been critical in providing follow up to agreements derived from multi-stakeholder meetings. In the corvina and the Corridor cases, NGOs organized capacity building workshops to increase the dialog and negotiation skills of the participants. In the case of the swimming crab fishery, NGOs together with the government started the implementation of the FMP (e.g., capacity building and research) two years before it was officially published.

4.4. Polycentric management

It is necessary for institutions to have nested, quasi-autonomous decision-making units or authorities operating at multiple scales in order to achieve polycentricism [36,55,56]. None of the case study processes appear to be truly polycentric. In the swimming crab FMP process, although a State Council of Fisheries and Aquaculture has to approve the objectives of FMPs and can influence

implementation, the final decision-making on the elaboration and publication process is in the hands of one centralized research institute – INAPESCA. This was similar for the corvina and the Corridor processes – the final management decisions were in the hands of the centralized fisheries management agency – CONAPESCA.

Although NGOs involved in the Gulf corvina and swimming crab case studies have supported the operation of existing structures and the emergence of new ones, no formal polycentric management has been achieved. NGOs have not been found to be active or effective in promoting this attribute of multi-scale governance.

4.5. Match with ecological scales

Given the broad spatial range of many fisheries, matching governance to ecological scales is often a significant challenge [13]. This attribute was scored as high for the corvina case, mainly because management is inclusive of the reproductive aggregation for the whole species, which is endemic to the Northern Gulf of California [48]. In addition, from this process there are emerging institutions that match the ecological scale (at least during the reproductive/fishery period): the seasonal closure, the corvina bylaw and the institutional arrangements defined by the Regional Subcommittee. From these case studies, the swimming crab has the largest ecological range. The attribute was scored as medium in this case. Although the process started with the states of Sonora and Sinaloa – where the majority of the catch and populations are concentrated – and stakeholders have suggested management structures to match this ecological scale; these structures are not yet operating. In the Corridor, this attribute was scored as medium because the multi-species finfish fishery does not yet have management structures that match the ecological scale; however, management goals defined for the region do match the ecological scale (spawning, aggregation, nursery and critical habitat).

NGOs have helped design new management structures that closely match ecological scales in all case studies. In the case of the corvina catch shares process; NGOs also facilitated the conformation and operation of the new structure (the Regional Subcommittee). In the case of the Corridor, the NGO helped define the idea of the “ecological corridor” and created a cohesive narrative of a region. For the case of swimming crab and Gulf corvina, NGOs expanded their scale of work (from local to regional) in order to match governance with ecological scales.

4.6. Horizontal and vertical information sharing

Given the complexity of multi-scale management and coordination between different scales, it is essential that information is adequately shared both vertically as well as horizontally [13]. In the corvina case, this attribute was scored as high because the government shared information used in decision-making. In addition, regional forums, outreach efforts and online resources provided ample means for scientific, market, and catch information sharing. The swimming crab FMP and the Corridor were scored as medium. Although the FMP process was an example of open information sharing between participants, the final version of the FMP could not be shared with all stakeholders until it was officially published. In the Corridor case, because fishing refugia had not been established before, there were not well-defined procedures and it was not clear to participants what kind of information was needed to design and implement the fishing refugia and what the process should be to collect and share information.

NGOs played a significant role in creating and maintaining the processes and mechanisms to share information (including forums, councils, meetings, and online platforms) and in general

acted as liaisons between and across levels. NGOs also helped define what information was needed, generate data, finance data collection, build local capacity to ensure information was produced, and translate scientific information into layman's terms so it could be shared with the community. In the case of the swimming crab, the NGO participated and financially supported the socialization of the FMP to bring back to the fishing communities the information that was gathered and generated.

4.7. Co-production of knowledge

Co-production of knowledge is of special importance in complex, variable systems [35,57] where uncertainty is high and no single stakeholder has, or can provide, all the necessary information to improve management [57,58]. The plurality of knowledge sources at different scales is essential to gain best understanding of the ecological and socio-economic systems [35]. In all case studies co-production of knowledge was central. Diverse stakeholders were able to have a better understanding of the system by bringing together their knowledge (traditional and scientific) and information, which also helped develop and adapt the management instruments to the local/regional contexts.

The role of NGOs was evident in this attribute. In all cases, NGOs financed information generation, promoted information sharing within and among stakeholders, and ensured the participation of knowledge holders in the processes in order to have the plurality of knowledge required for a better understanding and management of the system. NGOs also brought to meetings and forums their technical and scientific expertise in the fisheries field and in the region.

4.8. Social learning

Social learning implies the collective process of learning-by-doing [13], which may result in new knowledge and skills [59]. This was ranked as “high” in all case studies and it was considered a direct effect of the multi-stakeholder processes and the collaboration between NGOs with governmental institutions. In each process diverse stakeholders were involved in generating proposals – using empirical knowledge (biological, social, and economic) to adapt, design, and implement fishery management instruments. Although significant development of knowledge and skills was observed, clear procedures and the involvement of governmental agencies are needed, as their absence in some instances can truncate the feedback loops upon which complete social learning depends in the long term.

NGOs promoted inclusive participation, deliberation and transparency, key elements in the social learning process. In the case of the Corridor, the NGO together with the local community defined management proposals and methods for data collection, resulting in new skills. In the case of the corvina catch shares, NGOs promoted and facilitated after-season analysis with most stakeholders, developed strategies and a system for catch monitoring, and built local capacities on scientific data gathering and dialog tools with community and fisher leaders to enrich multi-stakeholder discussions. Finally, in the case of the swimming crab FMP, the NGO contributed to creating the capacity to do strategic planning with a participatory approach in order to develop management objectives, indicators, research priorities, and tools to better manage the fishery.

4.9. Institutional interplay

Institutional interplay refers to multi-level linkages [13], with a linkage defined as “a formal rule, strategy, or regularized action

that establishes interdependencies among two distinct actors around different tasks” [34,60].

There was variability among case studies in terms of multi-level linkages. The swimming crab and corvina processes were scored as medium. In both, there were formal financial, information, and institutional linkages, as well as coordination between different government agencies. However, in the case of the swimming crab fishery, although the linkages were formalized in the FMP, stakeholders did not feel under official obligation to follow the commitments because the FMP had not been published. In the case of the Gulf corvina, institutional linkages are successful only in one of the four local communities participating in the process: El Golfo de Santa Clara. The Corridor process was scored as low. Although the federal government was coordinated with fishers and the NGO, there was little coordination with other levels of the government, both state and local.

In all cases, NGOs' work focused on providing formal and informal communication channels for all stakeholders. This was essential in the case of the Corridor, where there were no existing multi-level linkages before the process began. In all cases, NGOs also promoted the establishment of rules and strategies mainly for information and data sharing. In addition, NGOs provided partial logistic and financial support where linkages needed to be strengthened, created or formalized.

Overall, NGOs are supporting the attributes of multi-scale governance in the various case studies. Table 3 summarizes the different activities the NGOs completed, which became evident as the main sources of support this governance approach.

5. Discussion

This work provides, and tests, a framework and scoring system to evaluate multi-scale governance attributes and the role of different stakeholders in relation to SSF management processes. Through the case study analysis, the multiple scales of Mexican SSF management and the existing elements of multi-scale governance can be understood. Our analysis shows that NGOs in the Gulf of California region have significantly influenced the following key attributes of multi-scale governance: institutional scale representation, cooperative management, collective action, match with ecological scales, horizontal and vertical information sharing, co-production of knowledge, social learning and institutional interplay. However, NGOs' participation has yet to be effective in promoting polycentric management, which may be an opportunity to explore.

In the Mexican context, at all levels (national, regional, local), stakeholders (governments, academics, NGOs and sponsors of NGOs' work) have recognized fisheries governance as a key element for sustainable fisheries management. As government resources are limited, there are ample governance needs which are not being fulfilled by government actions alone, but which can be effectively promoted by NGOs. Hence, NGOs have found an important niche for their work, and have developed explicit objectives for the promotion of good governance at multiple scales.

The Gulf of California region has experienced a shift in NGOs' agenda in the past decades, from one dominated by direct advocacy for environmental conservation to one which values linked ecological and socio-economic objectives. With this shift we have seen the growth of governance-related NGOs' interventions, which are consistent with NGOs' mandates on conservation and sustainable development at local and regional levels, as well as on public participation on issues of public interest [61].

NGOs are helping management processes to become more transparent and participatory. There have also been significant NGOs' efforts in building local institutions and local capacity within fishing

communities to co-generate data (biological, social and economic) and knowledge, as well as to participate in co-management processes. It is important to mention that in the three case studies collaboration and development of trust between NGOs and users has required a process, which began before the development of the management instruments cited in this work. Due to the strong and long lasting presence of NGOs in fishing communities and their contributions to management processes, Mexican governmental agencies in charge of fisheries management and research are strengthening their collaboration with NGOs, which was unusual before. Shared goals, projects, and funding, as well as formal channels of communication are becoming more common in these collaborations. In addition, NGOs are now present at all scales (local, regional, national, and international) and as in other places, Mexican NGOs are working as bridging organizations and their collaboration with governments has been key to achieve co-management [58].

The evolution of NGOs' work has implied a change on the discourse (oriented to responsible fisheries), professionalization in the fisheries field – NGOs are hiring staff with this expertise, wider collaborations with other stakeholders to better understand social-ecological systems, adjustments in the scope of work (from local to regional) to align governance and ecological scales, and creativity to match conservation and fisheries objectives.

Four main challenges related to NGOs' participation in multi-scale governance were detected: 1) NGOs are playing multiple roles and performing multiple tasks, potentially causing confusion on what their role is; 2) NGOs are clearly focusing on building trust and relationships with stakeholders, often at the cost of achieving the results compromised in their agenda; 3) because NGOs have international sources of funding, distrust from some stakeholders (particularly governmental agencies) is observed on what agenda and interests are being fulfilled, and 4) although the participation of fishing stakeholders in decision-making processes has been formalized through the Fisheries Law, this has not been the case for NGOs. In the three case studies, the flexibility or lack of established procedures for participating in and for developing the management instruments (catch shares, fisheries management plans, and fishing refugia) gave room for NGOs to take part in such processes and take leadership in some tasks such as following up on agreements and organizing and facilitating meetings. However, doors for NGOs' participation in fisheries management processes are not always open. Given these challenges, most processes could benefit from developing clear procedures (for design, implementation, evaluation, and participation in management instruments) and by officially including NGOs in the multiple-stakeholder structures promoted by the Fisheries Law. On the other hand, NGOs will need to make their agendas and funding sources more transparent to users and managers in order to clarify alignments with other stakeholder agendas, as well as to continue building trust.

6. Conclusions

This work provides a framework to evaluate management processes and the contribution of stakeholders to multi-scale governance. As shown in the three case studies, multi-scale governance is essential to sustainable fisheries management, especially in SSFs. Although this work does not focus on the contribution of other stakeholders or the efficiency of NGOs' activities, it provides valuable insights on how NGOs can contribute to this form of governance. NGOs can add value to management processes by working as bridging organizations to foster collaboration across scales; generate, analyze, and communicate information; help craft and follow up on collective agreements and rules; and promote inclusive participation and transparency. In order to build trust and provide clarity on what

their role is and what objectives are being pursued, NGOs need to make their agendas transparent to other stakeholders. Shared visions, clear procedures, and clear roles are essential for collaborative multi-scale governance and will help optimize resources and maximize impact on fisheries management.

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References

- [1] Teh LCL, Sumaila UR. Contribution of marine fisheries to worldwide employment. *Fish and Fisheries* 2013;14:77–88.
- [2] FAO. The state of world fisheries and aquaculture. Rome, Italy, 2012. 230p.
- [3] FAO. International guidelines for securing sustainable small-scale fisheries. Zero draft; 2012. 38p.
- [4] McCay BM, Acheson JM. The question of the commons. The culture and ecology of communal resources. Tucson, USA: The University of Arizona press; 1987.
- [5] Feeny D, Berkes F, McCay B, Acheson J. The tragedy of the commons: twenty-two years later. *Hum Ecol* 1990;18(1):1–19.
- [6] Ostrom E. A general framework for analyzing sustainability of social-ecological systems. *Science* 2009;325:419–22.
- [7] Salas S, Chuenpagdee R, Seijo JC, Charles A. Challenges in the assessment and management of small-scale fisheries in Latin America and the Caribbean. *Fish Res* 2007;87(2007):5–16.
- [8] Seijo JC, Cuevas A, Villanueva R, Duarte J, Villanueva J, Novelo G, et al. Estudio social de la pesca en México: Diagnóstico sobre la problemática social de los pescadores, su entorno y su visión sobre las posibles soluciones a los problemas que afectan la pesca en México. FAO, Universidad Marista; 2009.
- [9] Costello C, Ovando D, Hilborn R, Gaines SD, Deschenes O, Lester SE. Status and solutions for the world unassessed fisheries. *Science* 2012;338(6106):517–20.
- [10] FAO. Case studies in fisheries self-governance. . Rome, Italy: FAO Fisheries Technical Paper; 2008; 465.
- [11] Sen S, Nielsen JR. Fisheries co-management: a comparative analysis. *Mar Policy* 1996;20:405–18.
- [12] Lebel L, Anderies JM, Campbell B, Folke C, Hatfield-Dodds S, Hughes. TP, et al. Governance and the capacity to manage resilience in regional social-ecological systems. *Ecol Soc* 2006;11(1):19.
- [13] Berkes F. Linkages and multi-level systems for matching governance and ecology: lessons from roving bandits. *Bull Mar Sci* 2010;86:235–50.
- [14] FAO. World inventory of fisheries. The role of NGOs in the governance of fisheries. Issues Fact Sheets. Texte by Peter Manning. In: FAO Fisheries and Aquaculture Department [online]. Rome. Updated 27 May 2005. [Cited 26 June 2013]; 2005–2013 (<http://www.fao.org/fishery/topic/13310/en>).
- [15] Berkes F. From community-based resource management to complex systems. *Ecol Soc* 2006;11(1):45.
- [16] Mittermeier RA, Gil PR, Mittermeier CG. Megadiversity: Earth's biologically wealthiest nations. Cemex: Conservation International; 1997.
- [17] CONEVAL. Población total, indicadores, índice y grado de rezago social según localidad, versión 2010. Base de datos; 2010.
- [18] CIMARES. Política Nacional de Mares y Costas de México; 2010. 65p.
- [19] Botello RM, Villaseñor R, Mezo S. Programa de ordenamiento pesquero ribereño. Comisión Nacional de Acuicultura y Pesca (CONAPESCA). México: Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación; 2010; 80p.
- [20] Cisneros-Montemayor A, Cisneros-Mata MA, Harper S, Pauly D. Extent and implications of IUU catch in Mexico's marine fisheries. *Mar Policy* 2013;39(2013):283–8.
- [21] Basurto X, Cinti A, Bourillón L, Rojo M, Torre J, Weaver AH. The emergence of access controls in small-scale fishing commons: a comparative analysis of individual licenses and common property-rights in two Mexican communities. *Hum Ecol* 2012;40:597–609.
- [22] OCDE. Agricultural and fisheries policies in Mexico, recent achievements, continuing the reform agenda: Paris; 2006.
- [23] DOF. Ley de Desarrollo Rural Sustentable; 2011. 67p.
- [24] DOF. Ley General de Pesca y Acuicultura Sustentables; 2007. 51p.
- [25] DOF. Ley Federal de Metrología y Normalización; 2006. 47p.
- [26] Espinoza-Tenorio A, Espejel I, Wolff M, Zepeda-Domínguez JA. Contextual factors influencing sustainable fisheries in Mexico. *Mar Policy* 2011;35:343–50.
- [27] CONAPESCA. Comité Consultivo Nacional de Normalización Agroalimentaria de la Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación. Subcomité de Pesca Responsable. Acta de instalación; 2012. 2p.
- [28] Sanchez Bajo C, Roelants B. Capital and the debt trap. Learning from cooperatives in the global crisis. NY, USA: Palgrave Macmillan; 2011; 274p.

- [29] Herman H, El papel de las organizaciones de la sociedad civil en el manejo costero en México, In: Rivera-Arriaga, Villalobos-Zapata, Azuz-Adeath and Rosado-May, editors, El manejo costero en México, 2004, p. 115–132.
- [30] Moreno-Báez M, Cudney-Bueno R, Orr BJ, Shaw WW, Pfister T, Torre J, et al. Integrating the spatial and temporal dimensions of fishing activities for management in the Northern Gulf of California, México. *Ocean Coast Manag* 2012;55:111–27.
- [31] Cinti A, Shaw W, Torre J. Insights from the users to improve fisheries performance: Fishers' knowledge and attitudes on fisheries policies in Bahía de Kino, Gulf of California, Mexico. *Mar Policy* 2010;34:1322–34.
- [32] Cisneros-Mata MA, Espinosa-Romero MJ, Ramírez-Félix EA, González-Gallardo VI, Gómez-Rojo C, Torre-Cosío J. Proceso de elaboración y resultados preliminares del Plan de Manejo para las Pesquerías de Jaiba en Sinaloa y Sonora. Informe de Investigación. INAPESCA. DGIPN; 32p.
- [33] Basurto X, Bourillon L, Torre J. The role of a Non-Governmental Organization (NGO) in an emerging co-management regime: the Mexican Seri Indians' case study. In: Proceedings of the 8th Biennial conference of the International Association for Study of Common Property (IASCP); 2000. 26p. (http://cobi.org.mx/wp-content/uploads/2012/08/2000-c-cobi_role_of_ngo_may_jun.pdf).
- [34] Basurto X. Linking multi-level governance to local common-pool resource theory using fuzzy-set qualitative comparative analysis: Insights from twenty years of biodiversity conservation in Costa Rica. *Glob Environ Change* 2013;23(3):573–87.
- [35] Armitage D, Berkes F, Dale A, Kocho-Schellenberg E, Patton E. Co-management and the co-production of knowledge: Learning to adapt in Canada's Arctic. *Glob Environ Change* 2011;21(3):995–1004.
- [36] Berkes F. Implementing ecosystem-based management: evolution or revolution? *Fish Fish* 2011;13:465–76.
- [37] Armitage D, Berkes F, Doubleday N, editors. Adaptive co-management: collaboration, learning, and multi-level governance. Vancouver, BC: University of British Columbia Press; 2007.
- [38] CONAPESCA. Anuario Estadístico de Pesca y Acuicultura; 2011. 311p.
- [39] DOF. ACUERDO por el que se da a conocer el Plan de Manejo Pesquero de Jaiba (*Callinectes spp.*) de Sinaloa y Sonora; 2014. 39p.
- [40] DOF. ACUERDO por el que se modifica el aviso por el que se da a conocer el establecimiento de épocas y zonas de veda para la pesca de diferentes especies de la fauna acuática en aguas de jurisdicción federal de los Estados Unidos Mexicanos publicado el 16 de marzo de 1994 para modificar el periodo de veda de jaiba frente al litoral de los Estados de Sonora y Sinaloa; 2014. 2p.
- [41] DOF. NORMA Oficial Mexicana NOM-039-PESC-2003, Pesca responsable de jaiba en aguas de jurisdicción federal del litoral del Océano Pacífico. Especificaciones para su aprovechamiento; 2007. 9p.
- [42] DOF. Acuerdo mediante el cual se da a conocer la actualización de la Carta Nacional Pesquera; 2012. 236p.
- [43] (<http://plandemanejojaiba.blogspot.mx>).
- [44] Basurto X, Bennett A, Weaver AH, Rodríguez-Van Dyck S, Aceves-Bueno JS. Cooperative and non-cooperative strategies for small-scale fisheries' self-governance in the globalization era: Implications for conservation. *Ecol Soc* 2013;18(4):38.
- [45] DOF. Acuerdo por el que se establece una red de zonas de refugio en aguas marinas de jurisdicción federal frente a la costa oriental del Estado de Baja California Sur, en el Corredor marino de San Cosme a Punta Coyote; 2012. 14p.
- [46] DOF. Ley General del Equilibrio Ecológico y la Protección al Ambiente; 2014. 126p.
- [47] DOF. Norma Oficial Mexicana NOM-049-SAG/PESC-2014, Que determina el procedimiento para establecer zonas de refugio para los recursos pesqueros en aguas de jurisdicción federal de los Estados Unidos Mexicanos; 2014. 11p.
- [48] Erisman B, Aburto-Oropeza O, Gonzalez-Abraham C, Mascareñas-Orsorio I, Moreno-Báez M, Hastings PA. Spatio-temporal dynamics of a fish spawning aggregation and its fishery in the Gulf of California. *Sci Rep* 2012;2:284 <http://dx.doi.org/10.1038/srep00284>.
- [49] FAO. Rights-based management in latin American fisheries. In: Orensanz JM, Seijo JC, editors. FAO fisheries technical paper, 582; 2013. p. 142.
- [50] Alvarez WA. People and the river. *J Southwest* 1997;39:331–51.
- [51] Muehlmann S. How do real Indians fish? Neoliberal multiculturalism and contested indigenities in the Colorado Delta. *Am Anthropol* 2009;111:468–79.
- [52] Erisman, Paredes, Plomozo-Lugo, Cota-Nieto, Hastings, Aburto-Oropeza, Spatial structure of commercial marine fisheries in Northwest Mexico, *ICES J Mar Sci* 2011;68: 564–571. <http://dx.doi.org/10.1093/icesjms/fsq179>.
- [53] DOF. NORMA Oficial Mexicana NOM-063-PESC-2005, Pesca responsable de curvina golfina (*Cynoscion othonopterus*) en aguas de jurisdicción federal del Alto Golfo de California y Delta del Río Colorado. Especificaciones para su aprovechamiento; 2007. 7p.
- [54] Lejano RP, Ingram H. Collaborative networks and new ways of knowing. *Environ Sci Policy* 2009;12:653–62.
- [55] Folke C, Hahn T, Olsson P, Norberg J. Adaptive governance of social-ecological systems. *Ann Rev Environ Resour* 2005;30:441–73.
- [56] McGinnis M, Ostrom E. Reflections on Vincent Ostrom, public administration, and polycentricity. *Pub Adm Rev* 2011;72(1):15–25 (The American Society for Public Administration).
- [57] Robinson L, Berkes F. Multi-level participation for building adaptive capacity: formal agency-community interactions in northern Kenya. *Glob Environ Change* 2011;21(4):1185–94.
- [58] Berkes F. Evolution of co-management: role of knowledge generation, bridging organizations and social learning. *J Environ Manag* 2009;90:1692–702.
- [59] Muro M, Jeffrey P. A critical review of the theory and application of social learning in participatory natural resource management processes. *J Environ Plan Manag* 2008;51(3):325–44.
- [60] Heikkilä T, Schlager E, Davis M. The role of cross-scale institutional linkages in common pool resource management: assessing interstate river compacts. *Policy Stud J* 2011;39:121–5.
- [61] INDESOL. Ley Federal de Fomento a las Actividades Realizadas por Organizaciones de la Sociedad Civil. Instituto Nacional de Desarrollo Social; 2012. 66p.