Classification and mapping of Territorial-Use Rights Fisheries (TURF) systems in Mexico

India Charlotte Dove

Advisor: Erendira Aceves-Bueno

Committee Member: Anne Beaudreau

University of Washington

School of Marine and Environmental Affairs

June 10, 2022

Introduction

Unsustainable fishing practices have contributed towards the overexploitation of marine resources around the world (Hilborn et al. 2003; Pauly et al. 2005). Additionally, unregulated harvesting of marine species has become a persistent marine conservation problem, with consequences for the livelihoods and economies of coastal communities. In particular, artisanal or small-scale fishers depend on marine resources as a source of income and food which promotes food security in coastal areas (Escamilla-Perez et al., 2021; Canty and Deichmann 2022). However, in Mexico, most small-scale fisheries operate under an open permit system that creates challenges for maintaining sustainable fisheries. Although the Mexican permit system facilitates fleet monitoring efforts, the absence of limits on the number of permits or allowable catch maintains the fishery under open access. These conditions hinder the capacity of the artisanal fishing fleets to achieve sustainable harvests and secure the wellbeing of coastal communities (Basurto et al. 2012). The relaxed regulations, along with the pressure to meet an increasing demand for fish, are currently reflected on the health of many marine resources, leading to overexploitation (Basurto et al. 2012). Therefore, improving the management of artisanal fisheries in the country is a pressing need.

Solutions exist however, to encourage the sustainability of fisheries and advance social equity within fishing communities. For example, incentive-based management regimes, whether species-based or area-based, exist and have the potential to support the economic and ecological sustainability of fisheries (Grafton et al. 2006; Costello et al. 2008; Quynh et al. 2017). One area-based management tool that has globally been used in small-scale or artisanal fishing communities is known as Territorial Use Rights in Fisheries (TURFs); this approach specifically allocates one or more fishermen exclusive access to a fishing territory in order to incentivize

them to steward, not overexploit, marine resources and the environment. Therefore, TURFs can be considered a form of catch shares in which exclusivity in access to a portion of the fisheries catch is assigned spatially. By securing access to the targeted resources, these systems allow the development of long-term harvest goals and reduce the race to fish (McCay 2017). Research about TURFs can be found for Japan (Yamamoto 1995; Uchida and Mitsutaku 2008), Chile (Arias and Stotz 2020), and the Vizcaino peninsula of Baja California and Baja California Sur (McCay et al. 2014; McCay 2017). In Mexico, TURFs exist largely across several regions, including Baja California (along the Ensenada coast), Baja California Sur, but also the Southern Gulf of California (Sinaloa coast), South Pacific (Chiapas coast), Gulf of Mexico (Veracruz coast), and lastly the Yucatan Peninsula.

Mexican TURFs are also referred to as concessions and throughout these regions, concessions can be categorized according to their unique ecological, social, and economic characteristics. The success of concessions and their influence on the social equity within a community can be affected by many factors, including the type and productivity of the ecosystem in which a concession is located, the local governance structure or isolation away from surrounding concessions or major cities, and the value of targeted species. There has been a considerable focus on describing and assessing the concessions along the Pacifico Norte region of Baja California Sur, in particular the FEDECOOP and the Caribbean Lobster fisheries, both of which have attained the Marine Stewardship Council (MSC) certification, however, concessions elsewhere have received less attention (McCay et al. 2014; McCay 2017; Cunningham et al. 2017).

Although Mexican concessions for benthic species are present in the entire country, the reported success stories are reduced to a handful of cases. In this paper, we analyze the

challenges and opportunities to scale up these success stories nationwide. We do so by exploring, for the first time, the Mexican TURF landscape in its entirety, adding to the literature on well-known case studies of TURFs elsewhere. We further analyze the unique characteristics of the system and categorize them into different archetypes and provide the first interactive map and static maps of Mexican TURFs. To facilitate our analysis, we identified five TURF archetypes in Mexico. These archetypes allowed us to understand how the system works and identify challenges and opportunities for the improvement of artisanal fisheries management.

Methods

Data collection

In the fall of 2013, data on the locations of all Mexican concessions with permits for benthic species were requested through the system of Mexican transparency (INFOMEX) by Dr. Erendira Aceves-Bueno and collaborators. In January of 2014, over 200 documents containing concession titles and geographic coordinates of their respective territories were provided by the Mexican government. The records were digitized by Claire Atkins-Davis from Duke University. In 2021, a request for updated documents was made and a new set of documents was received. Our request was received by the INAI (request number 0819700021621) and redirected to CONAPESCA. We received the geographic coordinates for active concession territories or polygons between April 2000 and April 2020 and corroborated our previous map with the new information received. However, the old concession polygons were retained for analysis, since some concessions were in the process of being renewed.

Polygon digitalization and mapping

The documents and coordinates for the Mexican concessions were reviewed and summarized for analysis. Information for each concession included the title of the cooperative or name of the private owner, targeted species, year the concession was granted, duration of the concession, and the state in which the concession is located. The spatial territory of each concession was mapped by a collaborator using Google Earth and ArcPro and polygons were outputted for analysis in R software. Two-hundred and forty concessions were mapped, however, discrepancies in metadata or erroneous spatial information required the exclusion of several polygons from the dataset. Static maps were constructed in ArcGIS and an interactive map was created in R programming software with the Leaflet package. Features of the interactive map that are dynamic include the ability to pan or zoom in or out across Mexico in order to see TURFs and when specifically hovering over a TURF with a mouse, the color of the TURF outline changes and the name of the TURF appears.

Identification of concession archetypes and case studies

Five different archetypes of Mexican concessions were identified by grouping concessions according to their governance structure (concessions owned by a single cooperative, joint cooperatives, or private companies/owners) and resource focus (permitted to harvest a single or multiple species; Figure 1). An additional hypothetical archetype was defined, resulting in a total of six archetypes (Figure 2).

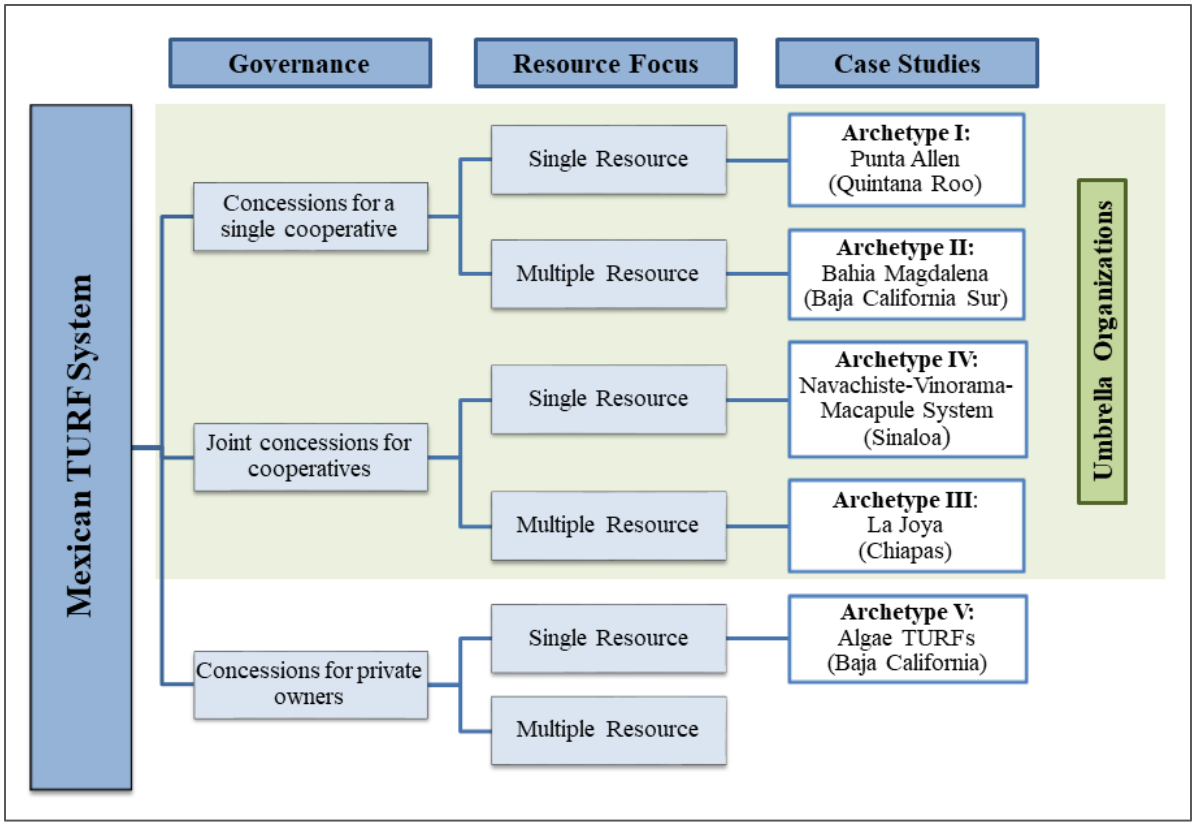

Figure 1: *Categorization of concessions into different archetypes according to their governance structure and resource focus.*

Archetype I comprises a concession that is owned by a single cooperative and is permitted to harvest only a single species or species group, such as abalone, lobster, or shrimp. Archetype II is a concession owned by one cooperative but is allowed to harvest multiple marine species within the exclusive fishing territory. Archetypes III and IV include concessions that target a single species or multiple species respectively but are accessed by more than one cooperative. Lastly, Archetype V consists of a concession owned by a private company or person. There could possibly be a sixth archetype whereby a private person or company owns a concession that is permitted for multiple species, however there was no such case in our current dataset.

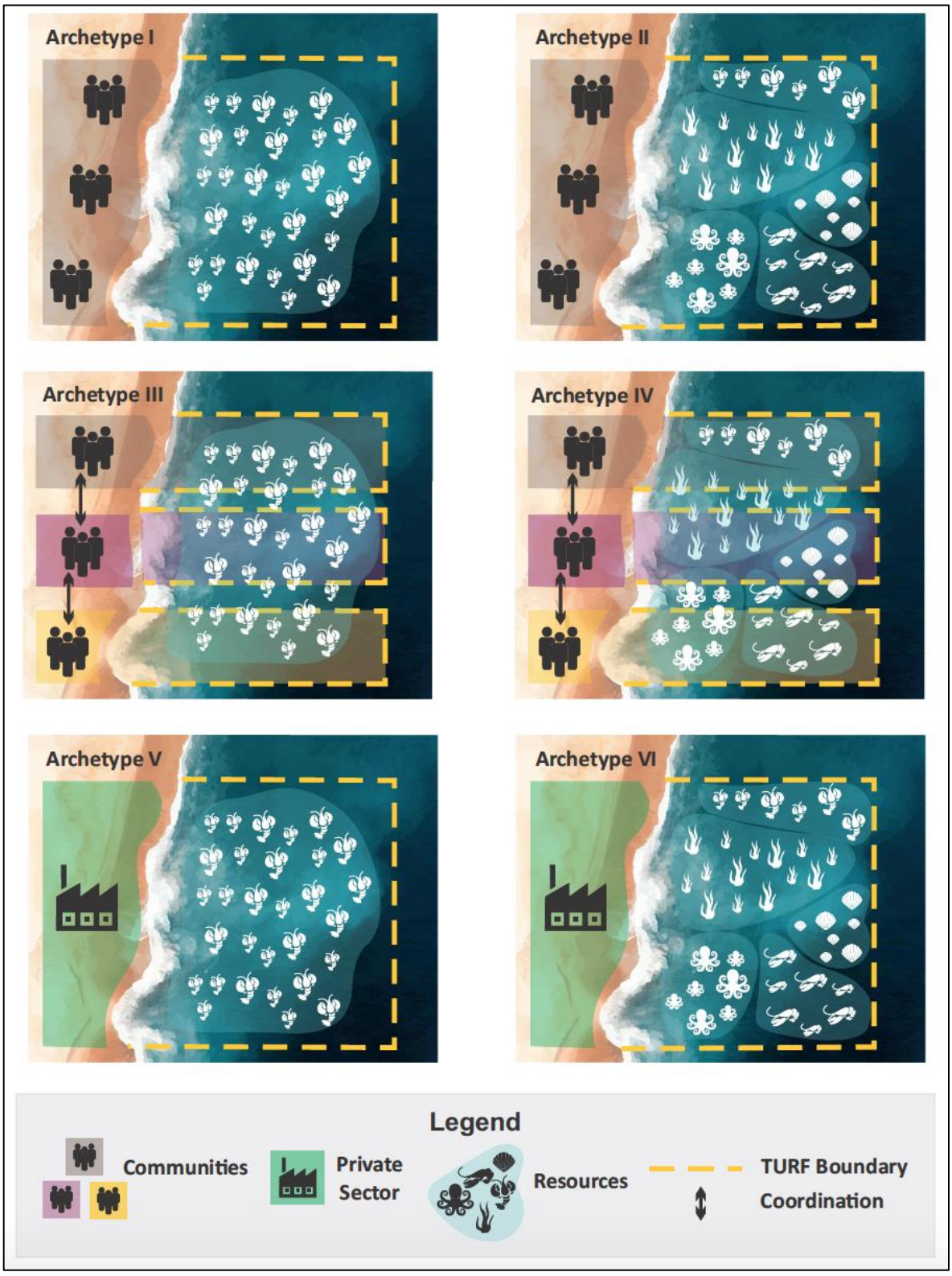

Figure 2: Six archetypes of Mexican Concessions.

Mexican concessions are found across several regions of the country with each region different in its ecological and social conditions pertaining to exclusive fishing territories. Regions where concessions are located include Baja California (along the Ensenada coast), Baja California Sur, the Southern Gulf of California (Sinaloa coast), the South Pacific (Chiapas coast), the Gulf of Mexico (Veracruz coast), and lastly, the Yucatan Peninsula. Five case studies were chosen to exemplify each archetype (excluding Archetype VI), namely Punta Allen in Quintana Roo for Archetype I, Bahia Magdalena in Baja California Sur for Archetype II, the Navachise-Vinorma-Macapule for Archetype III, La Joya for Archetype IV, and Agarmex for Archetype V.

A literature review was performed for all case studies to describe examples that fulfill each archetype of TURFs. In cases that were not well documented in the literature, information gathered from public sources was complemented by interviews with key stakeholders. This was a particular need for the Navachiste-Vinorama-Macapule system in Sinaloa, for which Raul Leal Felix was interviewed. Information drawn from the literature included: a) a general description of the system (e.g., the ecosystem, main fisheries, current regulatory framework), b) description of the governance structure (e.g., how is access determined? how are fishing activities coordinated?), c) current challenges (e.g., state of the resources, observed conflicts, state of the governance system), and d) ecological, social, and legal enabling conditions. Enabling conditions are critical features of a TURF system that contribute towards the functioning of the fishery. Examples of ecological enabling conditions are clearly defined biological units and low vulnerability of the targeted species (Poon and Bonzon 2013). An example of a social enabling condition is if there are clearly defined fishing territories and an example of a legal enabling condition is if there is long term exclusive access (e.g., 20 year permits). A description of other

enabling conditions and whether a case study fulfills such a condition is detailed in Table 1 based upon the catch share design manual by Poon and Bonzon 2013.

For the purposes and scope of this thesis, only the case studies for Archetype I (Punta Allen, Quintana Roo) and Archetype II (Bahia Magdalena, Baja California Sur) are reported.

Results

Interactive and static maps of Mexican concessions

Prior to this work, there has not been a comprehensive map of concessions across Mexico. Therefore, this is the first effort to explore the Mexican concession landscape and system in its entirety. Both static maps and an interactive map (e.g., screenshot shown in Figure 3) were produced of over 200 Mexican concessions. After mapping all the concessions through the Leaflet interactive feature in R, visible patterns emerged about the shape and location of concessions that, in turn, aligned with the type of species permitted to be harvested by cooperative members. For example, concessions that are located along the coast of Ensenada in Baja California, Mexico are relatively small, compared to the larger concessions that target mobile species elsewhere in Mexico (i.e. Baja California Sur), and these concessions encompass open waters (Figure 4). The species targeted in these concessions fall under the genera *Gelidium* (red algae) and *Sargassum* (brown algae). Concessions along the coast of Baja California and the Yucatan

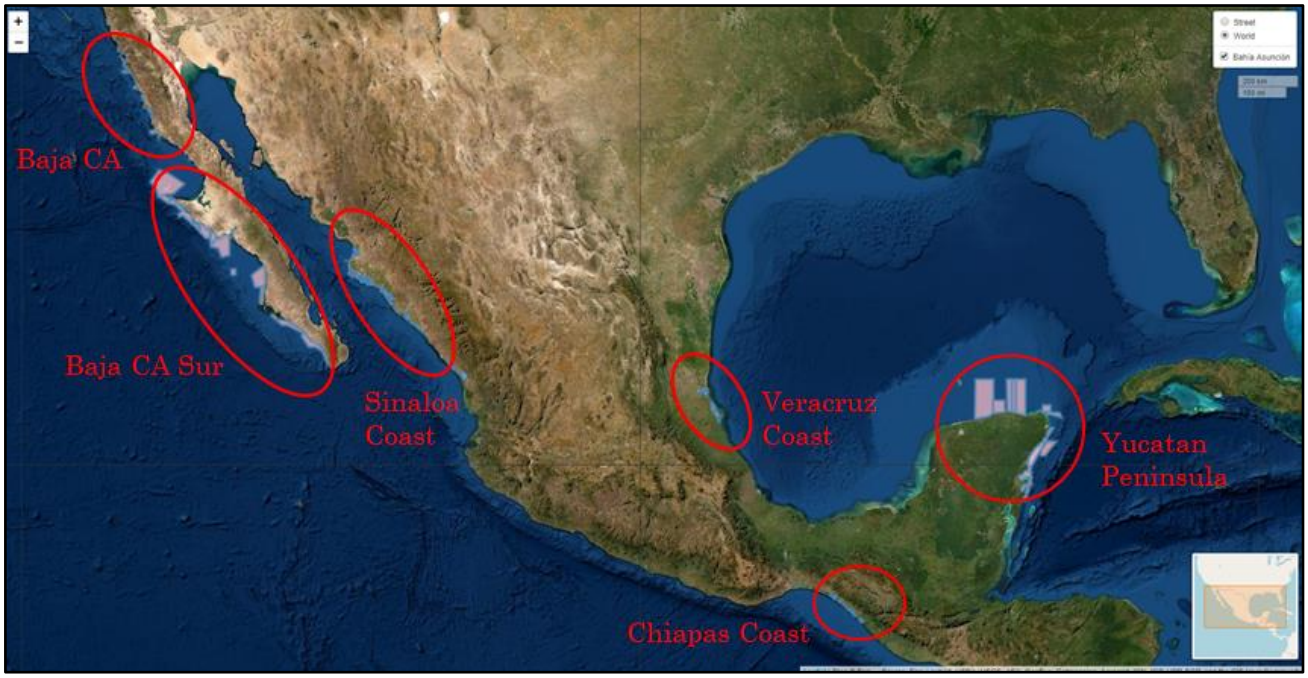

Figure 3: Regions across Mexico where concessions are located.

Peninsula are larger (Figure 5), and located in open waters (Figure 6). The cooperative members for concessions in these regions are permitted to target relatively mobile species such as lobster which have a greater distribution range for the concession to accommodate. In contrast, concessions along the Sinaloa, Chiapas, and Veracruz coasts are small and located in estuaries and lagoons (Figures 7-9); cooperative members of concessions in these regions are mainly permitted to take shrimp. Interestingly, some concessions for shrimp were jointly owned by different cooperatives, which allowed members within each cooperative to potentially harvest within each other's concessions. It is not clear why these agreements take place.

By inspecting the maps, it is apparent that the type of species harvested aligns with the size and location (i.e., open waters or lagoons/estuaries) of the concessions. The interactive map, when published, will be a valuable tool for resource managers in Mexico, as it enables the user to

explore the concession landscape in order to see where exclusive territories are located, what their proximity is to other concessions, and which cooperative owns a particular concession.

Two particular cooperatives and their respective concessions are highlighted herein. The first is the Pescadores de Vigia Chico cooperative, which manages the Punta Allen concession in Bahia de Ascension in Quintana Roo, Mexico; this concession is large, located in open waters, and comprises Archetype I, since it is owned by a single cooperative and targets only one species, the spiny lobster. The second is the Cooperative de Bahia Magdalena, which owns the Bahia Magdalena concession in Baja California Sur, Mexico. This concession is also large, exposed to open waters, and exemplifies Archetype II, because it is also owned by a single cooperative, however, cooperative members are permitted to take multiple species, such as lobster, abalone, sardines, and mackerel.

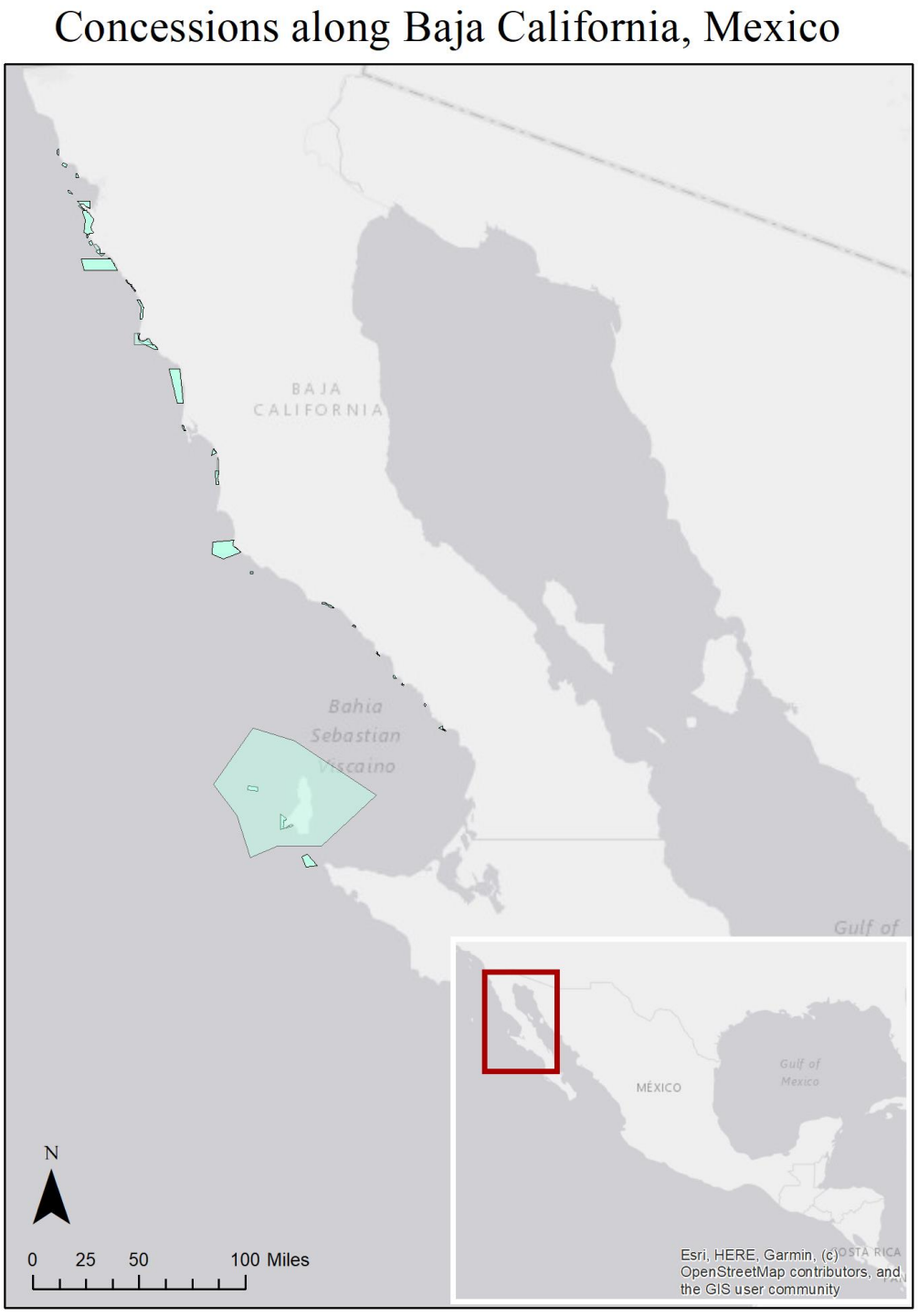

Figure 4: Concessions along the coast of Baja California, Mexico. All concessions are identified by green polygons.

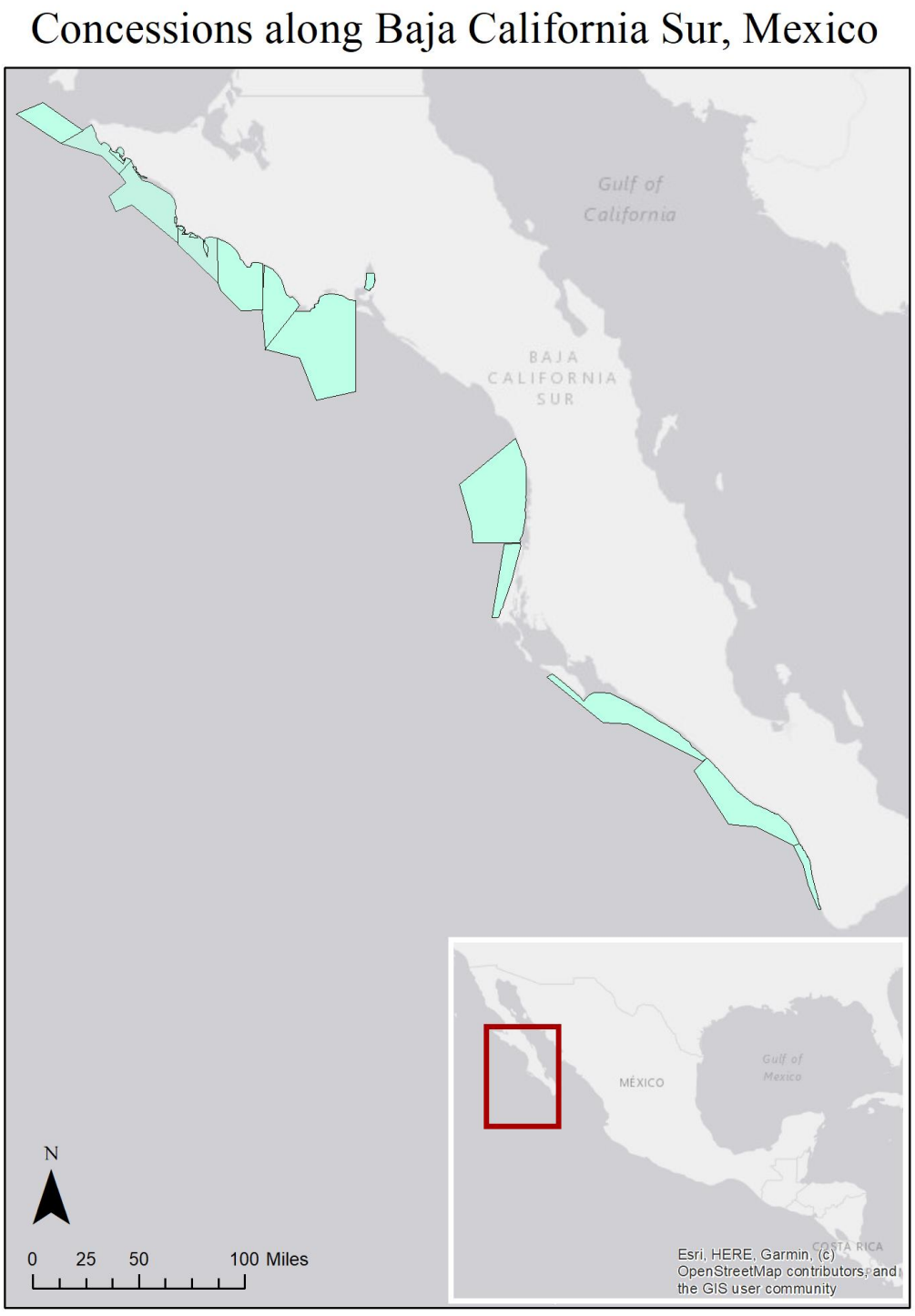

Figure 5: Concessions along the coast of Baja California Sur, Mexico. All concessions are identified by green polygons.

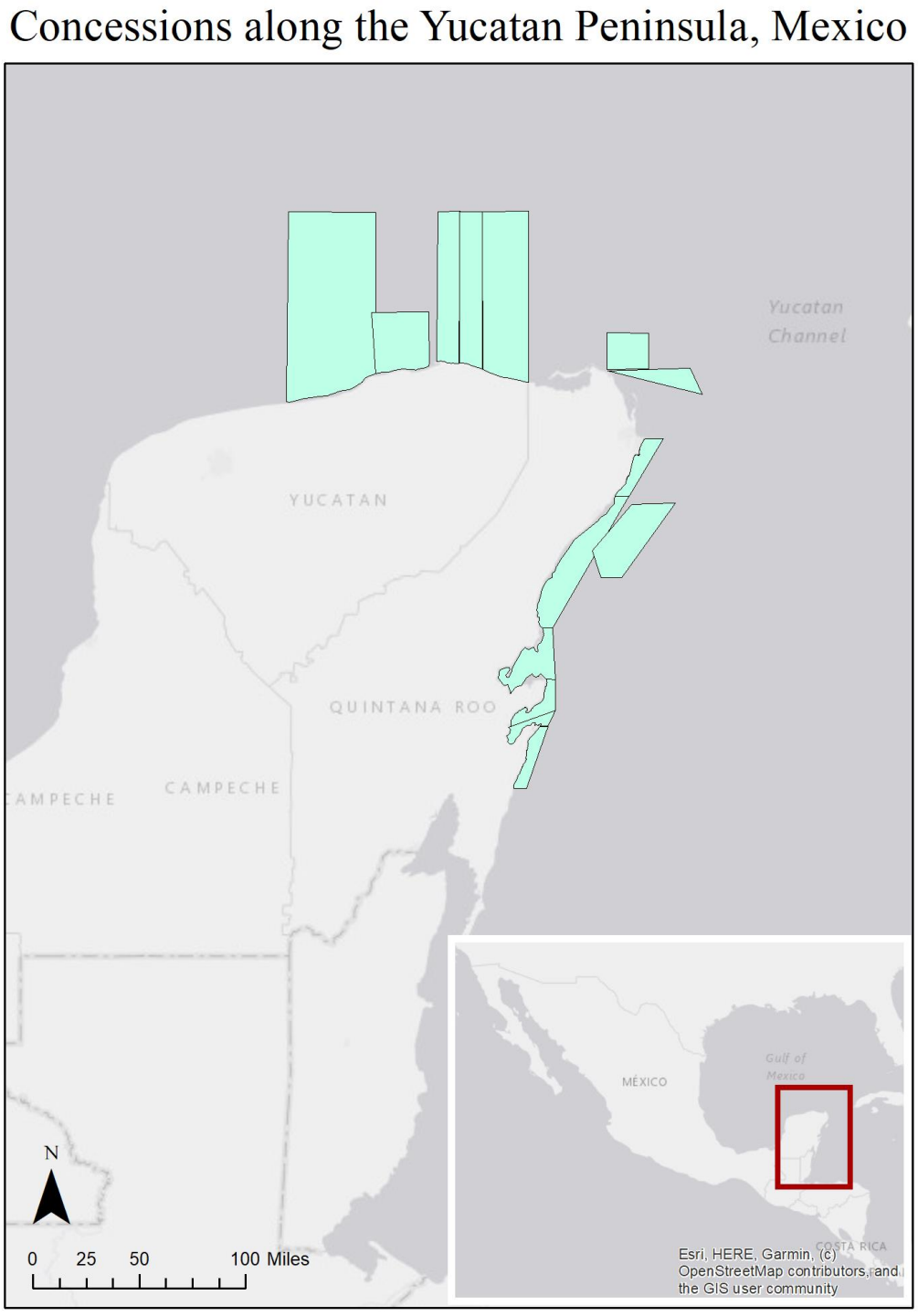

Figure 6: Concessions along the Yucatan Peninsula, Mexico. All concessions are identified by green polygons.

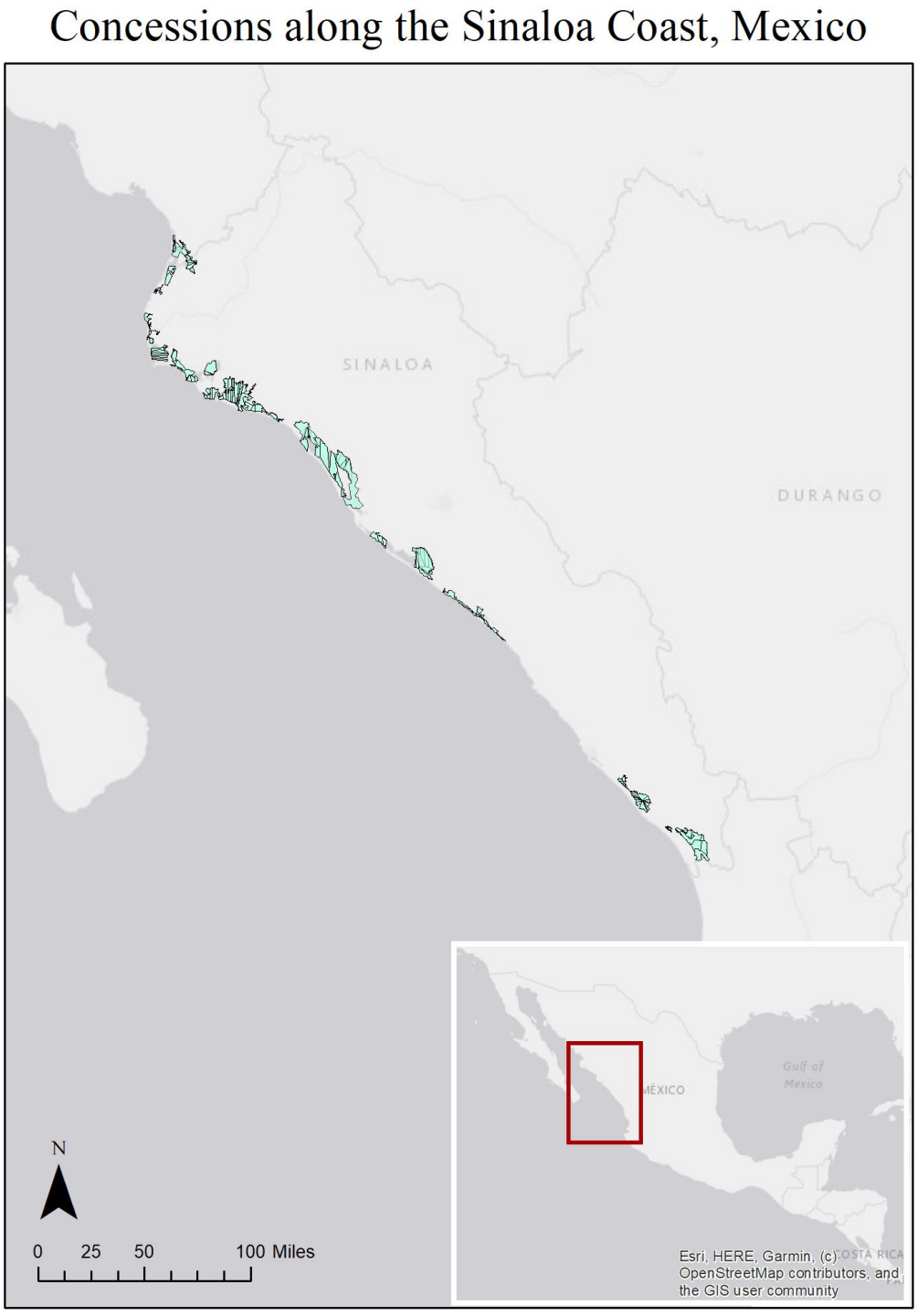

Figure 7: Concessions along the coast of Sinaloa, Mexico. All concessions are identified by green polygons.

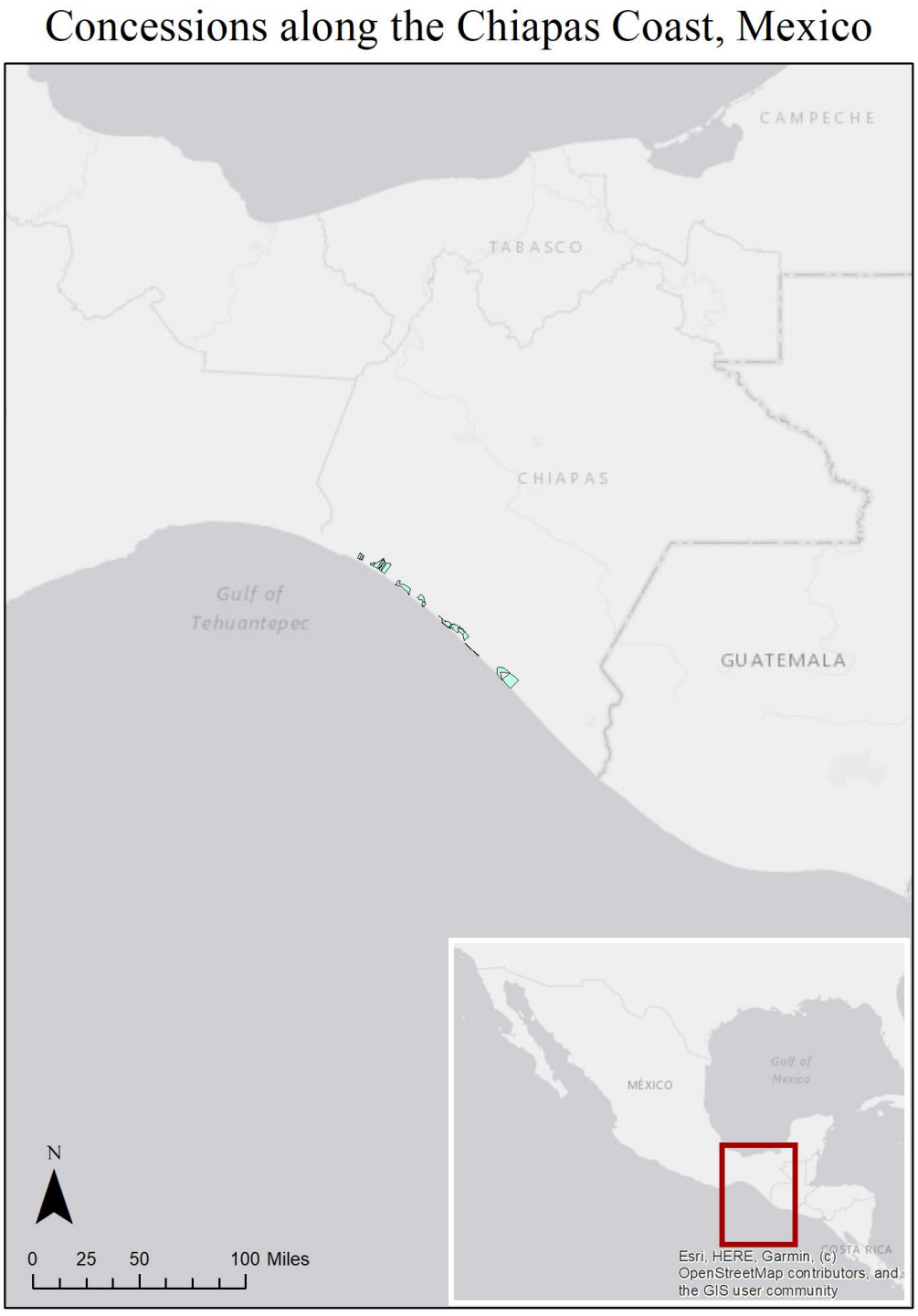

Figure 8: Concessions along the coast of Chiapas, Mexico. All concessions are identified by green polygons.

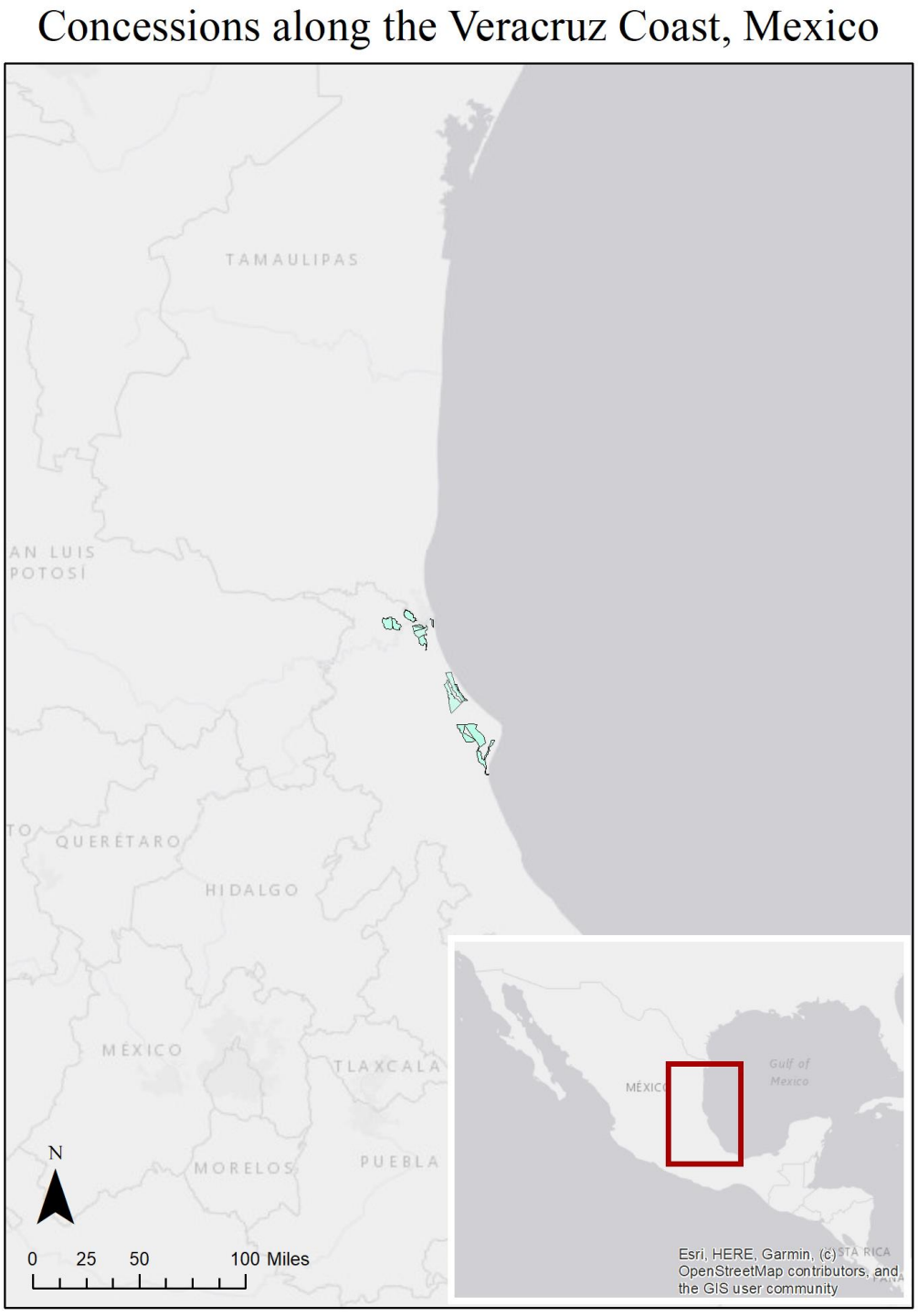

Figure 9: Concessions along the coast of Veracruz Mexico. All concessions are identified by green polygons.

Punta Allen Lobster Fishery Case Study – Archetype I

Physical, Biological, Ecological Characteristics

The concession for the Punta Allen spiny lobster fishery is managed by the Pescadores de Vigia Chico cooperative. The fishery and concession are located in the southeast of Mexico in Bahia de la Ascension, in the state of Quintana Roo (Figure 10). The territorial boundaries defining the concession are within the Sian Ka'an Biosphere Reserve, so fisheries within the reserve may only be accessed by their respective cooperatives owning a concession (Mendez-Medina et al. 2020). The bay is relatively large (760 km^2) and shallow (average depth 3.5 m and maximum depth 7 m), covered by a coral reef, and surrounded by estuarine vegetation (Briones-Fourzán et al., 2012). Meadows of mixed sea grasses and macroalgae provide necessary habitat for settlement of juvenile spiny lobster (*Panulirus argus*) (Briones-Fourzán et al., 2012). The estuary, in turn, functions as a nursery ground where spiny lobster eventually recruit to the harvestable stock along the coral reef in adult stages (Briones-Fourzán et al., 2012). Therefore, the physical, biological, and ecological characteristics of Bahia de la Ascension combine to create a critical habitat for spiny lobster in the Mexican Caribbean.

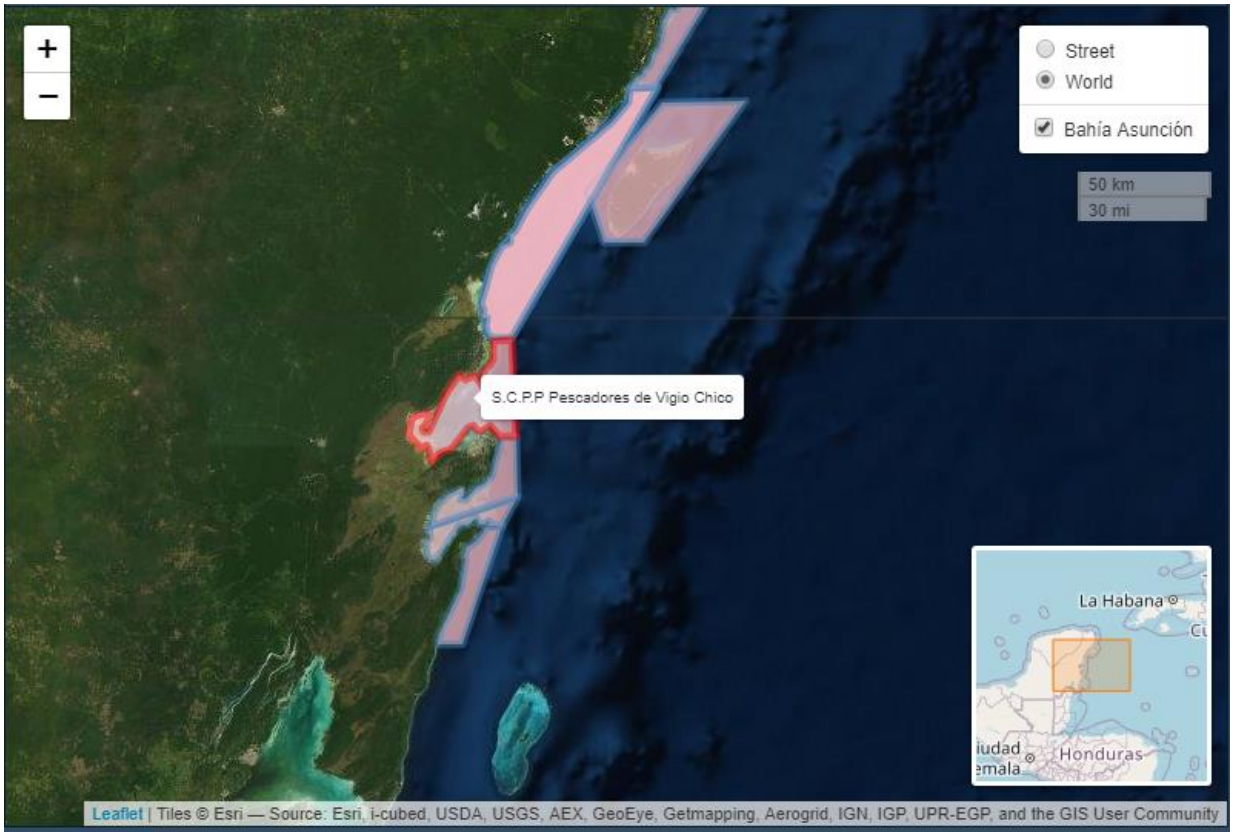

Figure 10: Location of the Pescadores de Vigia Chico cooperative and the Punta Allen spiny lobster concession in Bahia de la Ascension, Quintana Roo, Mexico.

The Artisanal Fishery

Along the entirety of the Bahia de la Ascension, there is only one small fishing village, which has roughly 500 to 600 people (Cunningham et al., 2013; Briones-Fourzán et al., 2012). Specifically, the Vigia Chico Cooperative is comprised of about 80 fishermen who use 55 small fishing boats known as pangas (Cunningham et al., 2013). The only target species permitted to be harvested by cooperative members of the concession is the Caribbean spiny lobster (*Panulirus argus*). For both Bahia de la Ascension and another bay to the south, Bahia Espiritu Santo, the principal fishing gear to harvest lobster is a system of artificial habitats, called “casitas”, where lobsters aggregate and this type of fishing gear was first introduced in the 1960s to the area (Sosa-Cordero et al., 2008; Cunningham et al. 2013). Aside from using casitas, the cooperative

members have established individual fishing zones called *campos* that have a 25-meter, no-take buffer area between each campo (Cunningham et al., 2013).

Overall, this system has allowed cooperative members to effectively perform a highly selective fishery through free diving to hand retrieve lobster (scuba and hookah are prohibited) facilitating the compliance with minimum size limits, protecting reproductive females and maintaining a high quality of their products (Defeo and Castilla 2006; Sosa-Cordero et al. 2008). Since 1982, the Pescadores de Vigia Chico cooperative has been known to be the most productive fishing cooperative for lobster in the Mexican Caribbean, particularly during the years 1982-1989, 1990-1999, and 2000-2005 (Sosa-Cordero et al., 2008). Their traditional fishing practices, regulations and efficient operation of the cooperative have allowed this fishery to become a model for sustainability. Given that the cooperative has reached performance standards established by the government, the Mexican National Commission on Aquaculture and Fisheries (CONAPESCA) has renewed the initial 20-year lobster concession that was granted in 1968 three times (Cunningham et al. 2013). In fact, their highly sustainable practices allowed them to obtain the MSC certification (Cunningham et al. 2013).

There is evidence of a strong collective action within the cooperative for managing the sustainability of this fishery. The cooperative provides the processing infrastructure, access to market and marketing tools and covers enforcement and monitoring costs for the concession (Sosa-Cordero et al. 2008; Cunningham et al. 2013). Decisions are made through democratic processes involving all of its members and include aspects of monitoring and enforcement. For example, the self-organizing nature of the cooperative was developed by local fishers themselves (Sosaa-Cordero et al., 2008) and the surveillance system within the Sian Ka'an Reserve is strengthened since local fishermen have the capacity to create rules and have independence from

the government, for example (Mendez-Medina et al., 2020). Particularly important design features to note for this cooperative and concession include the 20 year tenure that has a strong likelihood of renewal, "clearly defined co-management responsibilities between the federal government and the Cooperatives," and the use of individual marine plots, or campos, to maintain the accountability of members (Cunningham et al., 2013, p. 3).

Overall, the Punta Allen spiny lobster concession exemplifies a sustainable fishery which is spatially allocated exclusively amongst fishermen and represents TURF Archetype I, a concession owned by a single cooperative that targets only one species. For the evident sustainability of fishery, there are particular legal, ecological, and social enabling conditions that support the success of this concession and fishery (Table 1). For example, there is long-term exclusive access granted to cooperative members (on the order of 20 year renewals) for lobster harvesting based upon fishery performance and there are clearly defined biological units as well as defined fishing groups (i.e., campos) and selective fishing gear (i.e., casitas).

The Bahia Magdalena Lagoon Complex – Archetype II

Physical, Biological, and Ecological Characteristics

The Bahia Magdalena concession is owned by a single cooperative and has a multi-species focus for harvesting, which exemplifies TURF Archetype II. Specifically, Bahia Magdalena and also Bahia Almejas are located within the larger Bahia Magdalena lagoon complex (BMLC) which is a system of "shallow canals, intertidal sand flats, and embayments" along the Pacific coast of Baja California Sur and this system consists of ecologically productive and biodiverse waters (Bizzarro 2008, p.1). The lagoon complex is divided into three geomorphological areas which are the northwest channels, Bahia Magdalena in the central

portion, and then Bahia Almejas in the southernmost part of the system (Ojeda-Ruiz et al. 2018). The BMLC is considered a transitional area between both temperate and tropical regions because of its "subtropical location, intermittently dominant current regimes (California Current and California Countercurrent), and seasonal upwelling" of colder, rich waters (Bizzarro 2008, p.1). Within the BMLC, the shallow, warm waters are generally more productive than offshore waters and therefore create ideal nursery conditions for both vertebrate and invertebrate taxa (Bizzarro 2008). Mangroves are the dominant shoreline vegetation and both eelgrass (*Zostera marina*) and surfgrass (*Phyllospadix torreyi*) reach their southernmost boundary in the BMLC; therefore, seagrass beds and mangrove roots create habitats that improve the ecology of the lagoon complex (Bizzarro 2008). For example, Bahia Magdalena acts as critical nursery habitat and feeding grounds for marine species, such as abalone (*Haliotus* spp.), lobster (*Panulirus* spp.), pismo clams (*Tivela stultorum*), shrimp (*Penaeus* spp.), shark (*Squalus* spp), and Pacific calico scallop (*Argopecten circularis*) (Young 2001). As a result of this productivity, an abundance of marine fish and invertebrate populations occur and are harvested within the BMLC. Cooperative members have permits to take abalone (*Haliotis* spp.), red lobster (*Panuliru interruptus*), mackerel, and sardines within the concession. However, there is no official protection of the area or of the habitats it provides for the diversity of marine species present; the only protection is a refuge zone for loggerhead sea turtles which is located outside of the northernmost section of Bahia Magdalena and called Golfo de Ulloa (Ojeda-Ruiz et al. 2018). As a result of the unique physical, biological, and ecological characteristics defining the region, fisheries are present and take advantage of the productivity within these biodiverse waters.

Industrial and Artisanal Fisheries

The embayment is valued as one of the most critical fishing ports in Baja California Sur and produces between 55 and 60% of the total annual catch for the state, primarily from industrial catches of sardines and tuna (Bizzarro 2008, Ojeda-Ruiz et al. 2018). Both industrial and artisanal fisheries are present and artisanal fishers specifically use pangas to harvest their catch and "reside among the many coastal towns and fishing camps" along the lagoon (Bizzarro 2008, p.3). Even though, industrial sardine and tuna fisheries are valued as the main landings in this area, artisanal fisheries have, in recent decades, increased their contribution to catches to 40% of the total seafood production in the lagoon complex (Ojeda-Ruiz et al. 2018). Over time, the coastal communities in the area have experienced an influx of people from mainland Mexico to work in fisheries, and there exists a few main communities where the majority of people reside. The total population across all the communities in this lagoon complex is about 8,500 people and many individuals depend entirely on fishing activities, whether the activities are fishing or fish processing (Ojeda-Ruiz et al. 2018). The three principal communities are Puerto San Carlos with 5,558 residents, Puerto Adolfo Lopez Mateos with 1,111 residents, and Puerto Chale with 373 residents (Ojeda-Ruiz et al. 2018). The establishment of commercial fisheries occurred fairly recently and local fishing communities have grown in the last few decades as a result of state-led development policies (Young 2001).

Cooperative members of the Bahia Magdalena concession are allowed to take abalone (*Haliotis* spp.), red lobster (*Panuliru interruptus*), mackerel, and sardines. Over the last decade, however, traditional fisheries like lobster and abalone have contributed less to the overall biomass production of artisanal fisheries (Ojeda-Ruiz et al. 2018). Unfortunately, the BMLC system is experiencing the overexploitation of marine resources, which is attributed to the

understanding that there is an "absence of a long-term vision of sustainability, a multi-fishery management strategy, and a lack of planning and regulation of strategies for local fisheries" in the area (Ojeda-Ruiz et al. 2018, p. 1). Further, an incursion of industrial fisheries upon local fisheries has created tensions (Young 2001, Ojeda-Ruiz et al. 2018). Overharvesting target species is occurring within the embayment; only a few cooperatives own permits in the region for abalone and lobster as a result of the current state of these fisheries (Ojeda-Ruiz et al. 2018). Aside from permits and regulations, environmental variables can affect the biomass caught for a given species; for example, in 2008, there was a reduction in artisanal fisheries production in the BMLC due to El Nino conditions and Hurricane Norbert (Ojeda-Ruiz et al. 2018). Concerns by fishermen have arisen over their ability to adapt to the environmental changes that are happening in the area (Ojeda-Ruiz et al. 2018).

Fishing Rights and History

The Mexican government initially granted concessions to the very first fishing cooperatives in the Baja California peninsula during the late 1930s, even though the mainland shrimp fishery was the principal focus of state-led development initiatives (Young 2001). In the 1970s, inshore commercial fisheries grew throughout Baja California Sur after the government made efforts to encourage the establishment of new fishing cooperatives (Young 2001). From the increase in commercial fisheries and growth in the state's fishing population, the tragedy of incursion ensued between cooperative members and free fishermen as well as the tragedy of the commons followed with the overexploitation of marine resources, as previously noted. In the 1980s, an influx of immigrants from Sinaloa helped form two other fishing cooperatives in 1985 to harvest shrimp, Pacific calico scallops, and other shellfish and fish in the area (Young 2001).

The Bahia Magdalena concession represents TURF Archetype II, where the concession is owned by a single cooperative yet has a permit to take multiple species within the exclusive fishing territory. The fisheries within this concession are experiencing overexploitation because there is an absence of critical enabling conditions that support the sustainability of the system (Table 1). There is no multi-fishery management strategy and there are no clearly defined fishing groups or boundaries. For example, a multi-fishery management plan would take into account how to sustainably manage the various species harvested by the fishery. Lastly, the tensions between industrial and artisanal fishermen within the embayment create conflict and interfere with fishing operations. Although, the Bahia Magdalena Lagoon Complex has the physical and biological characteristics for productive fisheries, certain enabling conditions remain absent to help the cooperative achieve sustainability in its fisheries.

Table 1: Ecological, Social, and Legal Enabling Conditions for Sustainability of Concessions				
	Enabling conditions	**Description**	**Punta Allen**	**Bahia Magdalena**
Ecological	Clearly defined biological units	1. A key aspect of TURF success is the presence of well-defined biological units. This is easier to achieve when the number of targeted species is low 2. Low mobility in the targeted species allows a higher level of exclusivity and the clear definition of biological units 3. Fishery impacts are not translated to other species	Y	N
	Low targeted species vulnerability	Facilitates the sustainability of the fishery	Y	-
	Clearly defined fishing groups	Clearly defined membership facilitates assigning fishing rights	Y	Y
	Clearly defined fishing ground boundaries	Facilitates the definition of the TURF polygons	Y	N
Social	Fishing group spatially isolated (reduced conflict with outsiders)	Reduces conflicts with other groups during the exclusion process	Y	N
	Selective fishing gear	Facilitates the definition of access rights and sustainability of the fishery	Y	N
	High profitability (valuable catch and low costs)	Allows the development of a fishery able to cover administrative and establishment costs	-	-
	Spatial Traditional use	The presence of traditional spatial definition of fishing grounds facilitates TURF design	Y	-
	High social capital (organized fishing groups)	Increases the success of the cooperative	Y	N
	Capacity of resource monitoring	Facilitates fisheries sustainability and adaptation	Y	-
	Presence of alternative activities	Facilitates resilience	N	N
Legal	Legal long-term exclusive access	Facilitates exclusivity	Y	Y
	Performance based renewal	Performance based renewal of the concession allows maintaining those concessions that manage their resources sustainably	Y	-

Discussion

The Mexican concession landscape is extensive, but can be clustered into distinct groupings or concession types. Concessions are found across several regions of Mexico where their size and location (open waters or estuaries) align with the type of species harvested within the exclusive fishing territory. Further, concessions can be categorized into different archetypes according to their governance structure (single or jointly owned concessions) and resource focus (single or multi-specific). We identified five archetypes that were based on existing data and knowledge; however, continued data collection may allow the recognition of additional archetypes, such as concessions located in inland waters or lagoons. This thesis focused on Archetypes I and II, and explored their social-ecological characteristics through case studies. Archetype I consists of a concession that is owned by a single cooperative where members are permitted to take a single species, as exemplified by the Punta Allen spiny lobster case study. Archetype II comprises a concession that is owned by a single fishing cooperative but has a multi-specific resource focus; the Bahia Magdalena concession that targets four different species is an example of this archetype. It is critical to evaluate the conditions that enable the sustainability of concessions in order to inform design and management of future concessions.

The dependence of cooperatives upon concessions "provides a strong incentive to sustain long-term biological and economic productivity" and, further, fishermen "take greater responsibility and stewardship for the resources they depend upon and gain increased local authority in the management of decision-making processes" for fisheries (Ojeda-Ruiz et al. 2018, p.7). In fact, trust and strong leadership relating to authority are two critical factors that lead to the success of concessions and positive social transformations in communities (Sanchez et al. 2020). Another benefit to fishermen as a result of the fishing sector being organized into

cooperatives, for example, is the access to health care from formal employment (Ojeda-Ruiz et al. 2018). Therefore, cooperatives and concessions can largely help mitigate the problem of overexploiting marine species in an area while also advancing the social equity of its members and surrounding community by sustaining resources and livelihoods over time.

Although Mexico is home to many successful concessions, there is room for improvement in particular case studies. The long-term sustainability of a concession and its fisheries depends upon the legal, social, and ecological enabling conditions. In the case of the Punta Allen spiny lobster concession, the cooperative and its fishery have become a reference for sustainability because of their traditional fishing practices (i.e., casitas), effective regulations, and efficient operations and organization (i.e., campos). For the multispecies concession in Bahia Magdalena, challenges prevail with sustainability. There are no clearly defined fishing groups and boundaries or a lasting vision of a multi-fishery management strategy. Further, tensions exist between different fishermen in the embayment; there is an incursion of industrial fishermen and poachers upon artisanal fishermen in the cooperative. The need for clarity in concession boundaries as they overlap with species distributions may be critical to achieving exclusivity in access and facilitating enforcement.

This project is an important start to exploring the Mexican TURF landscape, as it is the first to map the distribution and types of TURFs and identify archetypes based on social, ecological, and governance criteria. For future work, it may be important to add to the case study portfolio of Mexican TURFs and use a comparative case study approach to explore diversity within individual archetypes.

References

Arias, Natalia, and Wolfgang Stotz. "Sustainability Analysis of the Benthic Fisheries Managed in the TURF System in Chile." *International Journal of the Commons* 14.1 (2020).

Basurto, Xavier, et al. "The emergence of access controls in small-scale fishing commons: A comparative analysis of individual licenses and common property-rights in two Mexican communities." *Human Ecology* 40.4 (2012): 597-609.

Bizzarro, Joseph J. "A review of the physical and biological characteristics of the Bahia Magdalena lagoon complex (Baja California Sur, Mexico)." *Bulletin, Southern California Academy of Sciences* 107.1 (2008): 1-24.

Briones-Fourzán, Patricia, et al. "Influence of local habitat features on disease avoidance by Caribbean spiny lobsters in a casita-enhanced bay." *Diseases of Aquatic Organisms* 100.2 (2012): 135-148.Sosa-Cordero, E, et al. "The Punta Allen lobster fishery: current status and recent trends." *Case studies in fisheries self-governance* 149 (2008).

Canty, Steven WJ, and Jessica L. Deichmann. "Do small-scale fisheries have the capacity to provide food security to coastal populations?." *Fish and Fisheries* 23.3 (2022): 708-718

Costello, Christopher, Steven D. Gaines, and John Lynham. "Can catch shares prevent fisheries collapse?." *Science* 321.5896 (2008): 1678-1681.

Cunningham, Erica, et al. "Mexican Vigía Chico Cooperative spiny lobster territorial use rights for fishing program." *Environ. Defense Funct* (2013).

Defeo, Omar, and Juan Carlos Castilla. "More than one bag for the world fishery crisis and keys for co-management successes in selected artisanal Latin American shellfisheries." *Reviews in Fish Biology and Fisheries* 15.3 (2005): 265-283.

Escamilla-Pérez, B. E., et al. "Cultural importance of marine resources subject to fishing

exploitation in coastal communities of Southwest Gulf of Mexico." *Ocean & Coastal Management* 208 (2021): 105605.

Grafton, R. Quentin, et al. "Incentive-based approaches to sustainable fisheries." *Canadian Journal of Fisheries and Aquatic Sciences* 63.3 (2006): 699-710.

Hilborn, Ray, et al. "State of the world's fisheries." *Annual review of Environment and Resources* 28.1 (2003): 359-399.

Méndez-Medina, Crisol, et al. "Achieving coordination of decentralized fisheries governance through collaborative arrangements: A case study of the Sian Ka'an Biosphere Reserve in Mexico." *Marine Policy* 117 (2020): 103939.

McCay, Bonnie J., et al. "Cooperatives, concessions, and co-management on the Pacific coast of Mexico." *Marine Policy* 44 (2014): 49-59.

McCay, Bonnie J. "Territorial use rights in fisheries of the northern Pacific coast of Mexico." *Bulletin of Marine Science* 93.1 (2017): 69-81.

Ojeda-Ruiz, Miguel Ángel, et al. "Development of fisheries in Bahía Magdalena-Almejas: the need to explore new policies and management paradigms." *Ocean & Coastal Management* 161 (2018): 1-10.

Pauly, Daniel, Reg Watson, and Jackie Alder. "Global trends in world fisheries: impacts on marine ecosystems and food security." *Philosophical Transactions of the Royal Society B: Biological Sciences* 360.1453 (2005): 5-12.

Poon, S. E. and Bonzon, K. (2013). Catch Share Design Manual, Volume 3: Territorial Use Rights for Fishing. Environmental Defense Fund

Quynh, Chi Nguyen Thi, et al. "Territorial Use Rights for Fisheries (TURFs): State of the art and the road ahead." *Marine Policy* 75 (2017): 41-52.

Sosa-Cordero, Eloy, M. L. A. Liceaga-Correa, and Juan Carlos Seijo. "The Punta Allen lobster fishery: current status and recent trends." *FAO Fisheries Technical Paper* 504 (2008): 149.

Uchida, Hirotsugu, and Mitsutaku Makino. "Japanese coastal fishery co-management: an overview." *FAO Fisheries Technical Paper* 504 (2008): 221.

Yamamoto, Tadashi. "Development of a community-based fishery management system in Japan." *Marine Resource Economics* 10.1 (1995): 21-34.

Young, Emily. "State intervention and abuse of the commons: Fisheries development in Baja California Sur, Mexico." *Annals of the Association of American Geographers* 91.2 (2001): 283-306.