Co-managing small-scale fisheries: a global overview and a case study in Chiapas, Mexico

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PhD Dissertation

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Abstract

Small-scale fisheries, understood as fisheries using relatively small amount of capital and energy and employing small fishing vessels to make short trips, are critical for the livelihoods, culture and survival of about 34 million fishers and their families worldwide. Small-scale fisheries provide around half of the global seafood catch, which means a production of approximately 90.9 million tonnes, and they critically contribute to food security and nutrition. However, small-scale fisheries face growing threats including climate change, habitat loss, overfishing and competition with industrial fleets. Both governments and coastal communities have not been completely successful in managing them adequately and prevent declining catches.

To counteract these trends, the *co-management* of small-scale fisheries has emerged as a potential management strategy in many countries over the last two decades. By bringing together local fishers, governments, and other stakeholders in joint decision making, co-management is expected to provide greater effectiveness than centralized or locally-based fisheries' management regimes and consequently result in more positive ecological and social outcomes. As of today, evidence backing these claims is still scarce, and little is known about which contextual factors determine the social and ecological effectiveness of co-managed small-scale fisheries, to what extent co-management is grounded on equity principles and results in fair outcomes, and how social diversity affects the consensual understanding and performance of co-management.

This thesis addresses these evidence gaps by, first, investigating the context and characteristics of small-scale fisheries co-management through a systematic review of peer-reviewed cases around the world and, second, by examining the performance of a specific co-managed small-scale fishery located in *La Encrucijada* Biosphere Reserve, Chiapas, Mexico. This small-scale fishery is an interesting case study because the protected area has an important fish production that is the main source of livelihoods for the communities living within the core areas. It also attracts a high diversity of actors with different conservation and development goals, which has produced resource-use conflicts. Methodologically, the dissertation is informed by a systematic review protocol, and by the implementetion of focus groups, interviews, diagrammatic representations of mental models and participant observation in the case study site over a fieldwork period of seven months.

Chapter 4 of the thesis presents a systematic review of documented case studies worldwide and demonstrates that co-managed small-scale fisheries deliver overall positive social and ecological outcomes and strengthens the adaptive capacity of fisheries. Co-management results both in increased abundance and habitats of fish populations and contributes to increased catches and economic benefits. Co-management also translates into higher social participation, better fit between management norms and local conditions, and strengthens compliance with management rules. However, the review also demonstrates that case-study based research on small-scale fisheries co-management has so far paid insufficient attention to investigating the effects on power asymmetries and distribution of co-management benefits. It also highlights the importance of embracing the diversity of social actors and implementing adaptive management principles for co-management to be successful.

The following empirical chapters of the thesis investigate the early years of the co-managed small-scale fishery of *La Encrucijada* Biosphere Reserve, and they make explicit the strengths and weaknesses of this initiative, building on the insights derived from the systematic review. Chapter 5 demonstrates that the initiative has strengthened the decision-making power of some actors over others in the management of the local fishery through two new decision-making forums at the fishery level. The comparison of two fishing cooperatives involved in co-management shows that the cooperative with higher power asymmetries and inner conflicts faces more problems to achieve positive outcomes, such as the recovery of fish populations.

Finally, chapter 6 explores how the participants in the case study fishery understand the co-management scheme, through the analysis of their mental models, i.e. internal representations of an external reality. The analysis sheds light onto a diversity of understandings of co-management with some overlapping elements which reflect, in turn, the diversity of participants. Surprisingly, their consensual understandings continue to reflect a centralized management system with two main stakeholder types: government agencies and fishers. Government agencies are represented as supporting fishers, mostly in economic terms, and fishers having little agency. The findings suggest that the old centralized management scheme remains in the consensual understandings of participants and that decision-making mechanisms are poorly known and used.

Taken together, the findings of this dissertation advance co-management research in several ways. First, through the systematic review and qualitative insights from the case study, the dissertation confirms theoretical expectations and shows that co-management

can indeed deliver positive social and ecological outcomes. It also highlights the importance of social equity and social diversity in delivering such outcomes. Second, it stresses how previous power relationships and conflicts shape co-management outcomes. Finally, it shows that, when a diversity of co-management understandings exists, well-stablished centralized management schemes may remain in the consensual understanding of participants.

Methodologically, the dissertation demonstrates the importance of combining several analytical frameworks and methods to capture the complexity of co-management approaches and their ensuing outcomes. First, it presents a comprehensive framework informed by Common-Pool Resources theory and adaptive management research to assess conditions, attributes and outcomes of small-scale fisheries co-management. Second, it incorporates equity-informed criteria into the analysis of co-management development and outcomes. Finally, and through mental models, it uses a cognitive approach to assess the impact of social diversity in co-management performance.

Key words: coastal fisheries, coastal lagoon, environmental justice, governance, marine area, shared understanding, Southern Mexico, Tropical Pacific.

Resumen

Las pesquerías artesanales, aquellas que usan cantidades relativamente pequeñas de capital y energía y emplean barcos pesqueros pequeños para hacer viajes cortos, son cruciales para el sustento, cultura y supervivencia de unos 34 millones de pescadores y sus familias en el mundo. Las pesquerías artesanales aportan la mitad de la pesca global, es decir, una producción de unos 90,9 millones de toneladas, y contribuyen de forma decisiva a la seguridad alimentaria y la nutrición. Aun así, las pesquerías artesanales tienen que hacer frente a amenazas cada vez mayores, que incluyen el cambio climático, la pérdida de hábitats, la sobrepesca y competencia con flotas industriales. En muchos casos, ni los gobiernos ni las comunidades costeras han logrado gestionarlas adecuadamente para prevenir el declive de las capturas.

Para contrarrestar estas tendencias la *cogestión* de pesquerías artesanales ha surgido, desde inicios del 2000, como una estrategia de gestión esperanzadora en muchos países. Juntando pescadores locales, gobiernos y otras partes interesadas en la toma de decisiones conjunta, se prevé que la cogestión sea más efectiva que regímenes de gestión centralizados o exclusivamente comunitarios y, consecuentemente, aporte más resultados ecológicos y sociales positivos. Hoy en día, hay escasas evidencias apoyando estas afirmaciones y se conoce poco sobre los factores contextuales que contribuyen a la efectividad de las pesquerías artesanales cogestionadas en términos sociales y ecológicos. Tampoco sabemos del cierto si la cogestión se basa en principios de equidad y en resultados equitativos y cómo afecta la diversidad social a la comprensión consensuada y el funcionamiento de la cogestión.

Esta tesis aborda estas faltas de evidencia, primero, investigando el contexto y las características de las pesquerías artesanales cogestionadas mediante una revisión sistemática de casos alrededor del mundo descritos en la literatura científica y, segundo, examinando el funcionamiento de una pesquería artesanal cogestionada concreta, situada en la Reserva de la Biosfera La Encrucijada, en el estado de Chiapas, México. Esta pesquería artesanal es un interesante caso de estudio porque el área protegida alberga la mayor diversidad de peces de todos los sistemas lagunares y estuarinos del Pacífico mexicano, siendo además el sustento principal de las comunidades que viven en las zonas núcleo. Además, la reserva de la biosfera atrae una alta diversidad de actores con distintos objetivos de conservación y desarrollo, que han producido conflictos sobre el uso de los recursos. Metodológicamente, la tesis se basa en un protocolo para la revisión sistemática, y grupos focales, entrevistas, representaciones diagramáticas de modelos mentales y observación participante en el caso de estudio por un período de trabajo de campo de siete meses.

El capítulo 4 de la tesis presenta una revisión sistemática de casos de estudio documentados a nivel mundial y demuestra que las pesquerías artesanales cogestionadas ofrecen resultados sociales y ecológicos positivos y mejoran la capacidad adaptativa de las pesquerías. La cogestión produce tanto un incremento de la abundancia de las poblaciones de peces como un aumento de las capturas y los beneficios económicos. La cogestión también comporta una mayor participación social, un mejor encaje entre las normas de gestión y las condiciones locales, y refuerzan el cumplimiento de las reglas de gestión. No obstante, la revisión también demuestra que la investigación de casos de estudio de pesquerías artesanales cogestionadas ha prestado hasta el momento una insuficiente atención a investigar los efectos de la cogestión en las asimetrías de poder y la distribución de los beneficios. También destaca que, para que la cogestión sea exitosa, tiene que acoger la diversidad de actores sociales involucrados e implementar principios de gestión adaptativa.

El siguiente capítulo empírico de la tesis investiga los primeros años de la pesquería artesanal cogestionada de la Reserva de la Biosfera de La Encrucijada, y explicita las fortalezas y debilidades de la iniciativa, complementando los resultados de la revisión sistemática. El capítulo 5 demuestra que la iniciativa ha reforzado el poder de decisión de algunos actores sobre los otros en la gestión de la pesquería local, estableciendo dos nuevos foros de decisión a nivel de la pesquería. La comparación de dos cooperativas de pescadores implicadas en la cogestión, no obstante, muestra que la cooperativa con mayores diferencias de poder y conflictos internos tiene más dificultades para conseguir resultados, como la recuperación de las poblaciones de peces.

Por último, el capítulo 6 explora cómo los participantes del caso de estudio comprenden el esquema de cogestión, mediante el análisis de sus modelos mentales, es decir, las representaciones internas de una realidad externa. El análisis muestra una diversidad de comprensiones de la cogestión con algunos elementos que se superponen y que reflejan, a la vez, la diversidad de participantes. Sorprendentemente, sus comprensiones consensuales aun reflejan un sistema de gestión centralizada con dos actores principales: agencias de gobierno y pescadores. Las agencias de gobierno se representan dando apoyo, principalmente económico, a los pescadores, y los pescadores con poca acción. Estos hallazgos sugieren que, el antiguo esquema de gestión centralizada presente anteriormente, permanece en las comprensiones consensuales de los participantes sobre la iniciativa de cogestión y que los mecanismos de decisión son poco conocidos y usados.

En conjunto, los hallazgos de esta tesis significan un avance en la investigación sobre cogestión en varios sentidos. Primero, mediante la revisión sistemática y las aportaciones cualitativas del caso de estudio, esta monografía confirma las expectativas teóricas y demuestra que la cogestión

puede, efectivamente, traer resultados sociales y ecológicos positivos. También destaca la importancia de la equidad social y la diversidad social para la consecución de estos resultados. Segundo, enfatiza cómo las relaciones de poder y conflictos existentes pueden interferir considerablemente en la consecución de resultados. Tercero, demuestra que, cuando hay una diversidad de comprensiones de la cogestión, los esquemas de gestión centralizada pueden estar fuertemente arraigados y permanecer en las comprensiones consensuales de los participantes.

Metodológicamente, este manuscrito combina varios marcos y métodos analíticos para captar la complexidad de los enfoques de cogestión y sus resultados. Primero, presenta un extenso marco que se nutre de la teoría de los recursos comunes y la investigación sobre gestión adaptativa para evaluar las condiciones, atributos y resultados de la cogestión de pesquerías artesanales. Segundo, incorpora de forma innovadora criterios de equidad en el análisis del desarrollo de la cogestión y sus resultados. Por último, mediante modelos mentales, usa un enfoque cognitivo para evaluar el impacto de la diversidad social en el desarrollo de la cogestión.

Palabras clave: área marina, comprensión compartida, gobernanza, justicia ambiental, laguna costera, Pacífico Tropical, pesquerías costeras, sur mexicano.

Resum

Les pesqueries artesanals, aquelles que utilitzen quantitats relativament petites de capital i energia i utilitzen vaixells petits per fer viatges curts, són crucials per al sosteniment, la cultura i la supervivència d'uns 34 milions de pescadors i les seves famílies al món. Les pesqueries artesanals aporten la meitat de la pesca global, això és, una producció d'uns 90,9 milions de tones, i són determinants per a la seguretat alimentària i la nutrició. Així i tot, les pesqueries artesanals han de fer front a amenaces cada vegada més grans, incloent-hi el canvi climàtic, la pèrdua d'hàbitats, la sobrepesca i la competència amb flotes industrials. En molts casos, ni els governs ni les comunitats costaneres han aconseguit gestionar-les adequadament per prevenir el declivi de les captures.

Per contrarestar aquestes tendències, la cogestió de pesqueries artesanals ha sorgit, des dels anys 2000, com una estratègia de gestió esperançadora en molts països. Unint pescadors locals, governs i altres parts interessades en la presa de decisions conjunta, es preveu que la cogestió sigui més efectiva que els règims de gestió centralitzada o exclusivament comunitaris i, en conseqüència, aporti més resultats ecològics i socials positius. No obstant, avui en dia hi ha escasses evidències que sostinguin aquestes afirmacions i es coneix poc sobre els factors contextuals que contribueixen a l'efectivitat de les pesqueries artesanals cogestionades en termes socials i ecològics. Tampoc no se sap del cert si la cogestió es basa en principis d'equitat i en resultats equitatius, ni tampoc com afecta la diversitat social a la comprensió consensuada i el funcionament de la cogestió.

Per fer front a les faltes d'evidència, aquesta tesi investiga, en primer lloc, el context i les característiques de les pesqueries artesanals cogestionades mitjançant una revisió sistemàtica de casos de tot el món descrits a la literatura científica i, en segon lloc, el funcionament d'una pesqueria artesanal cogestionada situada a la Reserva de la Biosfera de La Encrucijada, a l'estat de Chiapas, Mèxic. Aquesta pesqueria artesanal és un cas d'estudi interessant perquè l'àrea protegida acull la major diversitat de peixos de tots els sistemes lacunars i estuaris de la Costa del Pacífic de Mèxic que, alhora, és el sosteniment principal de les comunitats que viuen a les zones nucli. A més, la reserva de la biosfera atrau una alta diversitat d'actors amb objectius diferents de conservació i desenvolupament, cosa que ha produït conflictes sobre l'ús dels recursos. Metodològicament, la tesi es basa en un protocol per a la revisió sistemàtica i en grups focals, entrevistes, representacions diagramàtiques de models mentals i observació participant en el cas d'estudi durant un període de treball de camp de set mesos.

El capítol 4 de la tesi presenta una revisió sistemàtica de casos d'estudi documentats a escala mundial i demostra que les pesqueries artesanals cogestionades tenen resultats socials i ecològics positius i milloren la capacitat adaptativa de les pesqueries. La cogestió produeix un increment de l'abundància de les poblacions de peixos i un augment de les captures i beneficis econòmics. La cogestió també comporta una major participació social, un millor encaix enter les normes de gestió i les condicions locals i reforça el compliment de les regles de gestió. No obstant, la revisió també demostra que, fins ara, la investigació basada en casos d'estudi de pesqueries artesanals cogestionades ha parat poca atenció als efectes de la cogestió en els desequilibris de poder i la distribució dels seus beneficis. També destaca que, perquè la cogestió sigui exitosa, és necessari acollir la diversitat d'actors socials implicats i implementar principis de gestió adaptativa.

El següent capítol empíric de la tesi investiga els primers anys de la pesqueria artesanal cogestionada de la Reserva de la Biosfera de La Encrucijada, i explicita les fortaleses i les debilitats de la iniciativa, cosa que complementa els resultats de la revisió sistemàtica. El capítol 5 demostra que la iniciativa ha reforçat el poder de decisió d'alguns actors sobre els altres en la gestió de la pesqueria local mitjançant dos nous fòrums de decisió. La comparació de dues cooperatives de pescadors implicades en la cogestió demostra que la cooperativa amb diferències més grans de poder i conflictes interns té més dificultats per aconseguir resultats, com ara la recuperació de les poblacions de peixos.

Finalment, el capítol 6 explora com els participants del cas d'estudi comprenen l'esquema de cogestió mitjançant l'anàlisi dels seus models mentals, és a dir, representacions internes d'una realitat externa. L'anàlisi mostra una diversitat de comprensions de la cogestió amb alguns elements que se sobreposen, i que reflecteixen la diversitat de participants. Sorprenentment, les seves comprensions consensuals encara mostren un sistema de gestió centralitzada amb dos actors principals: agències governamentals i pescadors. Les agències governamentals es representen donant suport, principalment econòmic, als pescadors, els quals tenen poca acció. Aquests resultats suggereixen que l'antic esquema centralitzat de gestió roman en les comprensions consensuals dels participants sobre la iniciativa de cogestió i que els mecanismes de decisió són poc coneguts i utilitzats.

En conjunt, els resultats d'aquesta tesi signifiquen un avenç en la recerca sobre cogestió en diversos sentits. En primer lloc, mitjançant una revisió sistemàtica i les aportacions qualitatives del cas d'estudi, aquesta monografia confirma les expectatives teòriques i demostra que la cogestió pot, efectivament, comportar resultats socials i ecològics positius. També destaca la importància de l'equitat social i la diversitat social per a la consecució d'aquests resultats. En segon lloc, fent èmfasi en com les relacions de poder i conflictes existents poden interferir

considerablement en la consecució de resultats. En tercer, demostrant que, quan hi ha una diversitat de comprensions de la cogestió, els esquemes de gestió centralitzada poden estar fortament arrelats i romandre en les comprensions consensuals dels participants.

Metodològicament, aquesta tesi combina diversos marcs i mètodes analítics per copsar la complexitat dels enfocaments de cogestió i els seus resultats. D'entrada, presenta un marc extens que es nodreix de la teoria dels recursos comuns i la investigació sobre gestió adaptativa per avaluar les condicions, els atributs i els resultats de la cogestió de pesqueries artesanals. A més, incorpora criteris d'equitat a l'anàlisi del desenvolupament de la cogestió i els seus resultats. Per acabar, mitjançant models mentals, adopta un enfocament cognitiu per avaluar l'impacte de la diversitat social en el desenvolupament de la cogestió.

Paraules clau: àrea marina, cogestió, comprensió compartida, governança, justícia ambiental, llacuna costanera, Pacífic Tropical, pesqueries costaneres, Reserva de la Biosfera de La Encrucijada, resultats, sud mexicà.

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Acronyms

ACMT *Acción Cultural Madre Tierra*

Mother Earth Cultural Action

CASFA *Centro de Agroecología San Francisco de Asís*,

Agroecological Centre Saint Francis of Assisi

CONANP *Comisión Nacional de Áreas Naturales Protegidas*

National Commission of Natural Protected Areas

CONAPESCA *Comisión Nacional de Acuacultura y Pesca*

National Commission of Aquaculture and Fishing

CPR(s) Common-pool resource(s)

ECOSUR *El Colegio de la Frontera Sur, CONACYT-Mexico*

The Southern Frontier College of the National Ministry of Sciences and Technology, Mexico

FAO Food and Agriculture Organization of the United Nations

FMCN: *Fondo Mexicano para la Conservación de la Naturaleza*

Mexican Fund for the Conservation of Nature

INAPESCA *Instituto Nacional de Pesca*

National Institute of Fishing

Laseg Laboratory for the Analysis of Social-Ecological Systems in a Global World

LEBR *Reserva de la Biosfera de La Encrucijada*

La Encrucijada Biosphere Reserve

NGO(s) Non-government organization(s)

NRM Natural resource management

SEPESCA *Secretaría de Pesca y Acuacultura*

Secretary of Fishing and Aquaculture

UNACH *Universidad Autónoma de Chiapas*

Autonomous University of Chiapas

UNICACH *Universidad de Las Ciencias y Las Artes de Chiapas*

University of the Sciences and the Arts of Chiapas

USAID United States Agency for International Development

1. Introduction

"*Por eso me acordé esto de manejar juntos. Porque o manejas tú o manejo yo. Si no, nos vamos a matar.*"

"It is for this reason that I remembered us managing together. Because, either you manage, or I do. Otherwise, we will kill each other."

(N02, leader of a local NGO, Chiapas)

1.1. Research context

Since the origin of human societies, people living close to water bodies have relied on fish for consumption. Nowadays, fish is still important for human consumption worldwide. A recent report of the Food and Agriculture Organization of the United Nations (FAO) shows that the 88% of the 171 million tonnes of fish harvested in 2016 were allocated to direct human consumption, which means 20.3 kg per capita, the highest level ever registered (FAO, 2018). The importance of human consumption is even more evident in small-scale fisheries, where about 90-95% of the fish caught is for human consumption (World Bank, 2012).

Small-scale fisheries are commonly conceptualized as fisheries with fishing activities that are decentralized and dynamic in space, time and technology, with relatively low levels of capitalization, and with an enterprise structure focused on the household or the community (Mills *et al.*, 2011). Despite their small size, these fisheries are highly relevant because they contribute about half of global fish catches (FAO, 2015) and are key for the livelihoods of many communities, especially in developing countries. Around 90% of the people employed in the fisheries sector worldwide operate in small-scale fisheries, and 97% of these people live in developing countries (World Bank, 2012). Small-scale fisheries do not only sustain many coastal communities, but they are also important spaces of their cultural heritage and identity (Jentoft and Chuenpagdee, 2015).

Despite the importance of small-scale fisheries, they do not draw sufficient attention in research and policy and they suffer from scarce information (Pauly and Zeller, 2016). Existing fisheries information systems fail to capture the diversity and complexity of activities and environments that characterize them (Jentoft and Chuenpagdee, 2015). Such a diversity also implies that the official definitions of small-scale fisheries vary according to countries and contexts (Chuenpagdee and Jentoft, 2015) and that there is no universally agreed definition at policy level (FAO, 2015).

Overall, small-scale fisheries differ from industrial fisheries in terms of size and the kind of technology, the social organization of fishing units, the economic motivations and the market linkages (Chuenpagdee and Jentoft, 2015). Small-scale fisheries are usually operated by fishing households, as opposed to commercial companies, use relatively small amount of capital and energy, and employ relatively small fishing vessels that make short trips close to the shore (Kolding, Béné and Bavinck, 2014). Harvest and post-harvest practices are people-intensive and often involve men, women and children, if not the whole community (Chuenpagdee and Jentoft, 2015). Small-scale fisheries can be for commercial purposes when the catch is predominantly sold or for subsistence when the catch is predominantly consumed by the fishers and their families (Pauly and Zeller, 2016). Recreational, non-commercial fisheries whose major purpose is enjoyment (Pauly and Zeller, 2016) are beyond the scope of this dissertation.

The small-scale fishery sector faces challenges that exacerbate the lack of reliable data. A major threat affecting these and other fisheries is overexploitation. Only 66,9% of marine fish stocks are fished within biologically sustainable levels, a figure that has been worsening in the last 40 years (FAO, 2018), and unassessed small-scale fisheries are considered to be in worse condition (Costello *et al.*, 2012). Overexploitation of small-scale fisheries goes hand-in-hand with the decline of fisheries resources, degradation of aquatic habitats, competition with more powerful sectors, unequal power relations, lack of access to services and limited participation in decision making (FAO, 2016c), which directly affects an often poor and vulnerable population (Jentoft and Eide, 2011).

Top-down governance regimes have often failed to face such challenges (FAO, 2016c; Pita, Villasante and Pascual-Fernández, 2019). They have predominantly focused on large-scale and single-stock fisheries, which require expensive monitoring and enforcement methodologies (Kolding, Béné and Bavinck, 2014; Selig *et al.*, 2014). For instance, acquiring exhaustive knowledge of small-scale fishery ecosystems to establish appropriated fishing regulations and enforce them would require a high financial investment that governments are usually not willing to do to manage small areas (Mahon, 1997; Allison, 2001).

To face the challenge of managing small-scale fisheries, many hard legal and soft instruments have been launched globally since the second half of the 20th century. Some examples of these instruments are the global and regional seas conventions and agreements such as the 3rd United Nations Convention on the Law of the Seas (1982) and the Convention on Biological Diversity (1992), and voluntary agreements such as Agenda 21 (chapter 17, 1992), the FAO Code of Conduct for Responsible Fisheries (1995), the Rome Declaration on World Fisheries (1999) and the FAO Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries (2014). Moreover, the 2030

Agenda for Sustainable Development also highlights the importance of providing institutional frameworks to recognize and protect access rights for small-scale artisanal fishers (UN, 2015).

One of the most promising governance tools to improve small-scale fisheries management is co-management. Co-management consists of sharing the responsibility and authority over a given, usually small-scale, resource system between at least the government and local users (Pomeroy and Williams, 1994; Berkes, 2009). Co-management initiatives have been promoted by a diversity of actors, e.g. governments, local users or non-government organizations (NGOs). They can emerge as local isolated initiatives, a result of specific national programmes or through development projects funded by international donors. There are no official reports about the implementation of small-scale fisheries co-management around the world. The "Too Big To Ignore" (TBTI) research partnership offers estimations based on 1702 voluntary contributions of researchers and practitioners working in small-scale fisheries. The dataset shows that co-management is particularly prominent in Africa, where 62% of reported small-scale fisheries are governed under this approach. Half of the small-scale fisheries in Asia and Oceania are co-managed while the percentage in Latin America and the Caribbean is about 38%. The world regions with the fewest documented co-managed small-scale fisheries are Europe, and the U.S. and Canada, accounting for the 31% and 30% of the total of small-scale fisheries, respectively (Rocklin, 2016).

By sharing management rights between government and users, it is expected that fishers increase their responsibility for resource use (Plummer and Armitage, 2007a). By ensuring users' input on fishing regulations, monitoring and control, it is also expected that co-management improves the fit of the fishery's management rules with local ecological conditions, knowledge and other related institutions (Jentoft, 1989). By doing so, co-management is expected to be regarded by local resource users as a more legitimate management approach, and it is expected to increase compliance with management rules, at least when compared with any previously existing and often centralized management regimes (Cinner *et al.*, 2012).

These and other expected outcomes in small-scale fisheries, however, have not been sufficiently analysed or assessed to date, and study of the contextual and procedural factors shaping co-management outcomes is still in its infancy. This makes the co-management of small-scale fisheries an interesting and fruitful research topic. It also justifies the research approach adopted in this dissertation, which consists of combining a global overview of co-management outcomes with a case study in Chiapas, Mexico. There is a need to advance global research on the co-management of small-scale fisheries by synthesizing existing knowledge, identifying research

gaps to set research and policy priorities, and exploring existing local initiatives to understand in more depth what drives the success or potential failures of this resource management approach.

Mexico has been chosen as the country in which to develop this dissertation because the country has no specific legal framework promoting fisheries co-management at the local scale. This contrasts with other Latin American countries where the co-management of small-scale fisheries has been promoted and thus has been more studied. For example, through the investigation of 'marine extractive reserves' (Brazil), 'management areas for the exploitation of benthic resources' (Chile) and 'marine areas of responsible fishing' (Costa Rica) (Gelcich *et al.*, 2008; Fargier, Hartmann and Molina-Ureña, 2014; Partelow *et al.*, 2018).

In Mexico, the basis for co-management are the regional councils of fishing and aquaculture (*Consejos estatales de pesca y acuacultura*), established by the General Law of Sustainable Fishing and Aquaculture (*Ley DOF 24-07-2007 General de Pesca y Acuacultura Sustentables*). Such committees, however, had not been yet implemented at the time of starting this thesis (Espinoza-Tenorio *et al.*, 2011), but some pioneer small-scale fisheries co-management initiatives were being developed and documented, specifically in existing biosphere reserves. For instance, in El Vizcaíno Biosphere Reserve, in the state of Baja California Sur, seven fishing cooperatives partnering with regional scientific centres, the national government, and NGOs, were proved to be able to respond to signals of environmental change and stabilize the populations of specific lucrative species, such as abalone (*Haliotis* spp.) and spiny lobster (*Panulirus interruptus*) (McCay *et al.*, 2014; Álvarez *et al.*, 2018). Similarly, in the Sian Ka'an Biosphere Reserve, in the state of Quintana Roo, collaboration between one fishing cooperative and local marine authorities to co-manage the spiny lobster (*Panulirus argus*) fishery at Punta Allen resulted in high persistence and stability during 17 years of daily data (Castilla and Defeo, 2001; Defeo *et al.*, 2016). This emerging evidence could thus be further expanded by developing a new case study and, in so doing, provide insights for further policy development at the national level in the future.

This dissertation explores the co-managed small-scale fishery of *La Encrucijada* Biosphere Reserve (LEBR), in the state of Chiapas. The establishment of a co-management initiative in the fishery of the LEBR ten years ago provided a sufficiently long temporal perspective to describe its origins and early outcomes in detail. Furthermore, the LEBR shelters a high biological diversity that sustains the livelihoods of the communities living in the core areas of the biosphere reserve. The protected area has also attracted conservation concerns, which makes the reserve and the co-management initiative a relevant research and development hotspot. Additionally, the fact that the co-management initiative and the protected area had brought a diversity of actors together

who had not collaborated before and held conflicting views over the use of local resources, made the case an interesting laboratory to understand the transformative potential of co-management.

1.2. Research objective and questions

The main aims guiding this thesis are to examine the social-ecological outcomes resulting from co-management schemes in small-scale fisheries and to analyse how the contextual and inherent characteristics of co-management shape its outcomes. These aims are addressed at global and local scales, through a systematic review of published cases and through a case study of the co-managed small-scale fishery in the LEBR, respectively. Three research questions, which are respectively addressed in three empirical chapters, achieve the dissertation's main aims:

1) *Which are the context, attributes and outcomes of co-managed small-scale fisheries and how do the former affect the latter?*

In chapter 4, I address this question by conducting a systematic literature review of peer-reviewed published empirical research about co-managed small-scale fisheries worldwide. Informed by Ostrom's framework for the analysis of the sustainability of social-ecological systems (Ostrom, 2007, 2009), I describe the main contextual and inherent characteristics of co-managed small-scale fisheries and synthesize the ecological, process, socio-economic and generic outcomes of co-management approaches. I also discern key variables influencing co-management outcomes. The review also permits me to identify two research gaps in the empirical literature, which I address through the LEBR case study: the extent to which co-management schemes are equitable, and, specifically, how effective they are in integrating different interests and knowledges in decision-making.

2) *How fair is the design and implementation of the co-management scheme in La Encrucijada and how equitable are its outcomes?*

In chapter 5, I address this research question by adopting a multi-dimensional definition of social equity and investigating how fair the institutional design and implementation of small-scale fishery co-management in LEBR is, and how equitable its outcomes are. I analyse the social and ecological outcomes of the co-management scheme both at the fishery and the fishing cooperative levels and the differences in outcome distribution between two studied fishing cooperatives: *La Palma* and *Luchadores del Castaño*.

3) *What are the shared elements and the main divergences of understandings within and among representatives of the four main types of stakeholders in co-management and the members of two main cooperatives?*

In chapter 6, by assuming that a diversity of interests is reflected in a diversity of understandings about the co-management initiative, I address this research question by analysing the different understandings of the co-management scheme in LEBR through the analysis of the participant actors' mental models. I explore the understandings of the representatives of four types of participants, i.e. fishing cooperatives, government, NGOs and research centres, I explore the mental models of the members of two studied cooperatives to reflect the vision of the most marginalized actors. Subsequently, I discuss the implications of shared or conflicting aspects of the understandings for the future of the fishery.

1.3. Dissertation structure

This dissertation is divided into seven chapters. After this general Introduction, chapter 2 introduces the theoretical approach of the research. First, it introduces Common-Pool Resources (CPRs) theory by describing Ostrom's typology of goods, outlining the challenges of managing CPRs, and describing the different property rights regimes that often underpin different types of goods. Next, it describes Ostrom's framework for analysing the sustainability of social-ecological systems. The chapter then dips into the process of decentralization of CPRs that many countries have undergone since the 1970s and it describes the challenges faced and the outcomes obtained. The third section focuses on defining co-management of natural resources, outlining the adaptive co-management approach and presenting theorized and empirical outcomes of co-management. Finally, the chapter introduces the study of equity in co-management and presents the multidimensional framework for assessing social equity that informs chapter 5.

Chapter 3 presents the analytical scales and the methods employed to answer the research questions. It first describes the three analytical scales and justifies the selection of the case study and the two fishing cooperatives. The second section presents the main steps of the systematic literature review, including the scoping, the screening, data extraction and data analysis. Then, it describes the methodological tools used during fieldwork, i.e. participant observation, semi-structured interviews, focus groups, and structured interviews. The third section elaborates on ethical considerations of the PhD research, especially those related to doing research that involves

human beings. Finally, the last section delves into more personal issues of the PhD process which have influenced the development of this dissertation.

Chapter 4 provides a systematic literature review of 91 cases of co-managed small-scale fisheries around the world. The review follows an analytical framework which adapts Ostrom's framework for analysing social-ecological systems to suit the characteristics and outcomes of small-scale fisheries co-management. The results show that the co-management benefits of involving a diversity of actors and adaptive management practices include preventing conflicts and increasing the adaptive capacity of the fisheries. The review confirms that, overall, co-management results in an improvement of the governance of small-scale fisheries, and delivers positive social and ecological outcomes, including improvements in fish abundance, catches and the wellbeing of the fishers. As mentioned above, findings also highlight two research gaps that are addressed in the next chapters: social equity and social diversity. This chapter has been published in the top-ranked journal in Geography, *Global Environmental Change*, as: d'Armengol, L., Prieto Castillo, M., Ruiz-Mallén, I., Corbera, E., 2018. A systematic review of co-managed small-scale fisheries: Social diversity and adaptive management improve outcomes. *Global Environmental Change* 52:212–225 (IF: 10.29, Q1).

Chapter 5 investigates the emergence, development and outcomes of the co-management scheme in the fishery of the LEBR, through the analytical lenses of social equity. It investigates the fairness of the institutional design and implementation of co-management and its distribution of outcomes at fishery and cooperatives' levels. The findings highlight the importance of recognition among actors in the early stage of co-management, as a pre-requisite for a fair access to decision-making at the fishery level. At the cooperative level, the inability of co-management to address existing power asymmetries and conflicts undermine the achievement of fair distribution of benefits. This chapter will be submitted to an Environmental Science and/or Conservation journal, such as *Conservation and Society*, in due course.

Chapter 6 explores the diverse understandings of the co-management scheme at the level of the fishery by eliciting the mental models of the representatives of the main participants in the LEBR co-management scheme, i.e. fishing cooperatives, government agencies, research centres and NGOs, as well as at the cooperative level by focusing on the members of two studied fishing cooperatives, i.e. *La Palma* and *Luchadores del Castaño*. The analysis of individual and group mental models reveals that the consensual understanding of stakeholders mainly reflects a centralized scheme of government agencies that subsidise local fishers. The lack of perceived negotiation mechanisms to accommodate divergent interests is worrisome and could lead to the emergence of conflicts or a rise in power asymmetries. The results emphasize the need to ensure

that all participants, particularly fishers, have *de facto* access to decision-making in LEBR and other co-management schemes. This chapter is under review in the journal *Ecology and Society* as of June 2019: d'Armengol, L., I. Ruiz-Mallén, C. Barnaud and E. Corbera (revisions needed). Mental models of a fishery co-management system in La Encrucijada Biosphere Reserve, Mexico. *Ecology and Society* (IF: 4.81, Q1).

Chapter 7 concludes the dissertation by summarizing its findings, outlining its theoretical and methodological contributions, and suggesting a few policy implications and future research avenues.

2. Theoretical approach

"Co-management has been over-romanticized and under-estimated."
(McCay, 1993)

This chapter introduces the conceptual lenses guiding my research. The first section introduces the concept of common-pool resources and exposes its main management challenges. The second section reviews the literature on decentralization of natural resource management (NRM) together with the main management challenges and expected outcomes. The third section presents co-management as a form of decentralized NRM, introduces the adaptive approach to co-management and reviews both the theoretical and actual outcomes of co-management in the light of existing studies. Finally, the last section introduces the concept of social equity in co-management.

2.1. Defining common-pool resources

NRM deals with the challenge of allocating natural resources like land, water, soil, coal, plants, and animals among potentially distinct users, without damaging the capacity of resource self-regeneration (Poudel, 2012). Therefore, NRM arrangements and regulations depend on the relations of access which govern the resources. In this regard, some natural resources can be defined as *common-pool resources*, also known as CPRs (Figure 2.1). CPRs are not excludable and subtractable, i.e. it is extremely costly to exclude actors[1] from accessing them whilst resource use by some actors constraints the potential use of the resource by others (Ostrom, 2005). A classic example of CPR is fish: in some contexts, it can be relatively easy to fish for subsistence or commercialization regardless of the property rights one holds over fishing grounds, and the amount of fish that a fisher harvests becomes immediately unavailable to other fishers.

Excludability and subtractability make CPRs more complex and difficult to manage compared to other kinds of goods and thus have generated a vast literature on the problems and challenges of, as well as design principles for, successful management. Two main reasons why CPRs management is challenging are the cost of exclusion and the lack of incentives to comply when

[1] I use interchangeably *actors* and *stakeholders* to refer to organizations participating in co-management. As a rule of thumb, in this chapter, I use the word most used in the literature I cite.

they are not well managed. First, since exclusion is costly, those who hold property rights over fishing grounds might experience the challenge of excluding others from accessing the resource and of both identifying and sanctioning "free-riders", i.e. individuals who gain from exploiting the resource but do not wish to contribute to the successful management of the resource, for example with labour or taxes. In turn, since all those who invest in the resource do not have guarantees to enjoy all potential benefits, the resource may face underinvestment in capital and its maintenance (Ostrom, 2005).

A second reason underlying the challenge in CPRs management is the so-called *tragedy of the commons* (Hardin, 1968). This rather well-known argument, rooted on utilitarian principles, predicts that users of a particular CPR have incentives to increase the individual use of the resource because the individual gain surpasses the negative effects of such use, which are shared by all users. This rationale inevitably can lead to overexploitation as happens in most fisheries worldwide, which also usually face the problem of illegal fishing. To avoid resource depletion, Hardin pointed to two possible solutions: either turn these resources into private property or keep them public property with allocation of access rights by the government. This argument has been challenged by many scholars, including Nobel prize winner Elinor Ostrom, who have successfully shown that Hardin's argument are relevant in contexts of open access resources, where property rights have not been allocated, but not as relevant to CPRs. If the latter have a well-defined property system, and benefit from commonly agreed rules and mutual coercion mechanisms, their management can be socially and ecologically sustainable (Ostrom, 1990).

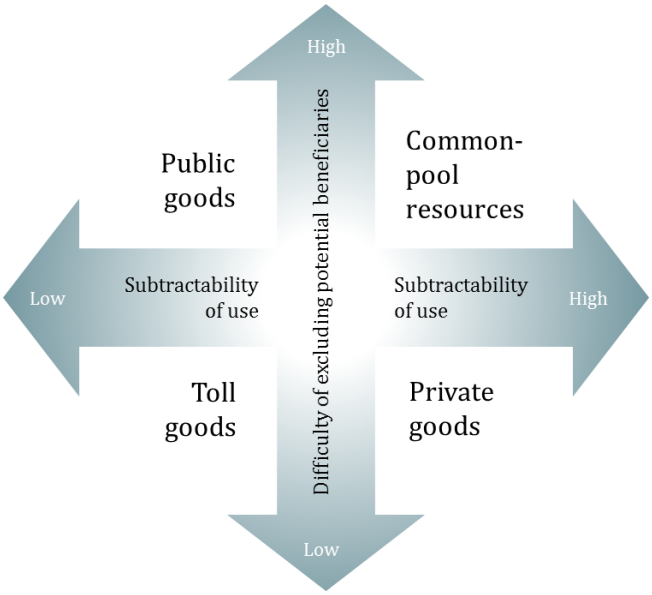

Figure 2.1 Typology of goods (Ostrom, 2005)

Property rights can be generally understood as social relations that determine how a natural resource is used, managed, owned and potentially transferred. Specifically, Schlager and Ostrom (1992) defined five property rights that are particularly relevant for CPRs: access and withdrawal at the operational-level, and management, exclusion and alienation at the collective-choice level. *Access* is the right to enter to where the resource is located. *Withdrawal* is the right to obtain products from the resource. *Management* is the right to transform the resource and regulate internal use patterns. *Exclusion* is the right to decide who will have an access right and how this right can be transferred. *Alienation* is the right to sell or lease exclusion and/or alienation rights.

Four property rights *regimes* can be described depending on who has property rights for a particular CPR: either a person or a company, a group of people, the state or nobody. In *private property regimes*, the resources are owned by individuals who rights to use, dispose of and exclude others from the resource, such as a fishery in a private lake. *Common property regimes* are those in which the resources are owned by a group of persons who cannot exclude each other but can exclude outsiders, for example a community forest or a shared irrigation system. *Public or state property* is a special form of common property in which the resource is owned by all the citizens but controlled by elected officials or bureaucrats who decide upon access and withdrawal, like many coastal fisheries worldwide. Finally, in *open access regimes*, resources do not have any owner, and no one can exclude anyone else. Some coastal fisheries, although being *de jure* state-owned resources, are treated as *de facto* open-access resources because the government does not have enough personnel and economic resources to defend their ownership (Cole, 1999).

No type of ownership is a guarantee to halt the deterioration of CPRs (Ostrom, 1990; Dietz, Ostrom and Stern, 2003). Ostrom (2005, 1990) described eight design principles for successfully managing CPRs: 1) clearly defined boundaries of the resource system by users; 2) congruence of rules with local conditions; 3) collective-choice arrangements in which most individuals affected by harvesting and protection rules can participate in modifying these rules; 4) accountable monitors; 5) graduated sanctions according to the seriousness and context of the offense; 6) low cost conflict-resolution mechanisms; 7) minimal recognition of users' rights to organize by external governmental authorities, and, for resources that are part of larger systems; and 8) nested enterprises that allocate authority at multiple levels. Dietz et al. (2003) add that users should support monitoring and rule enforcement and that this should be verified and understood at relatively low prices, that dense social networks or social capital should provide mutual trust and compliance, and, finally, that change in the availability of the resource, the number of users or consumers and the technology used happens at moderate rates.

Ostrom and her colleagues' approach to CPRs, which was based on the apparent reductionism of rational choice theory and methodological individualism, has been challenged by the interpretivism of anthropological and historical research. Some have argued Ostrom and similar others' understanding of CPRRs removed important aspects of context, culture and meaning (Forsyth and Johnson, 2014). However, the disciplinary divide in CPRs research between economists and anthropologists highlight their social dimension but often neglects its biophysical dimension. In this regard, Lélé (2008) suggests that a three-way conversation is necessary to approach CPRs problem, based on transdisciplinary research among economists, anthropologists and natural scientists.

Ostrom's (2009, 2007) framework for analysing the sustainability of social-ecological systems attempts to provide an analytical tool that also accounts for the social history and natural conditions of such systems organized into four main groups of variables: resource system (including predictability of systems dynamics), resource units (including growth or replacement rate), governance system and users (including history of use and mental models). Compared to other frameworks to analyse social-ecological systems, it is the only framework that treats the social and ecological systems in almost equal depth and provides a frame for developing different degrees of specificity (Binder *et al.*, 2013).

CPR theory underlies the research of this thesis. The theoretical concepts and debates highlighted above so far inform several aspects of this research. First, the thesis investigates the effectiveness of a property-rights scheme that combines community and state property, i.e. co-management, for reducing the decline of fish resources and providing broader social and ecological outcomes. Second, this research, although grounded on social methods, adopts a transdisciplinary focus to encompass the social and biophysical dimensions of co-management outcomes, in chapters 4 and 5. Finally, Ostrom's framework for the analysis of social-ecological system is used and extended in the systematic review of co-managed small-scale fisheries presented in chapter 4.

2.2. Decentralized management of CPRs

Prior to contemporary management, most local communities and tribal groups managed their resources through rules agreed and shared collectively (Wilson *et al.*, 1994; Berkes, 2010b). By the mid-18th century, however, the need to take control over NRM by centralized governments dramatically increased, when demands for natural resources grew in a context of rapid growth of human population and economic wealth. Centralized governments and *command-and-control*

approaches, i.e. socioeconomic institutions that respond to erratic or surprising ecosystem behaviour with more control (Holling and Meffe, 1996), spread out in the industrializing world and colonized countries with the aim to enhance ecosystem's productivity, predictability, controllability and economic efficiency (Berkes, 2010b). This was framed in an increasing view of natural resources as commodities or services to humans (Zimmermann, 1951) that could not be depleted because nature would replenish them after humans' use (Berkes, 2010b). Over time, government-centred management have come to co-exist with local institutional frameworks of resource management by direct users or communities in both developed and developing countries (community-based management).

Since the 1970s, the performance of governments was increasingly questioned by the rise of NGOs and some academics who challenged the governments' capacity to manage CPRs in a way that was sustainable and equitable. This coincided with grassroots demands for participation arising from social movements, such as the feminist and civil rights movements, which were increasingly demanding to take part in formal political and decision-making processes (Danielson, 2015). As a result, the decentralization of NRM was highly encouraged both in developed and developing countries, with more than 60 countries decentralizing some aspects of NRM in specific geographies and for specific resources, including and most relevantly CPRs (Ribot, 2002b). In many Latin American, African and Asian countries, such decentralization efforts were encouraged by multilateral organisations, especially the World Bank (Larson, 2005).

Decentralization can be understood as the transfer of powers and resources in a political-administrative and territorial hierarchy from central government to actors and institutions at lower levels that can be regional branches of the central government, local or municipal governments, state governments in federal systems and regional autonomous governments (Ribot, 2002a; Larson and Soto, 2008). Following the classic division of government powers, i.e. legislative, executive and judicial, decision-making powers that can be delegated are the power to create new rules or modify existing ones, to decide how to use a particular resource or opportunity, to implement rules and ensure compliance, and to adjudicate conflicts that arise from the exercise of previous powers (Agrawal and Ribot, 1999).

Where enacted, decentralization has been justified on three main grounds. First, there is a *substantive* reasoning, which holds that managing complex social-ecological systems such as CPRs requires the use of all social and ecological knowledge available, which is dispersed among local, regional, national and international agencies and groups. Furthermore, through deliberation, participants can improve their understanding of resource management and develop stronger and more inclusive views on how to best manage such resources. Second, there is a *normative*

interpretation, which considers that people should have their say in decisions that concern them. This is associated with the environmental justice movement and the conviction that participation can help to equalize power relations between dominant and marginalized groups. Finally, there is an *instrumental* perspective, for which decentralization is a means to potentially achieving more consensus among stakeholders with conflicting views (Fiorino, 1990; Agrawal and Ribot, 1999; Berkes, 2010a; Danielson, 2015). Relatedly, it has been argued that decentralization can facilitate the involvement of the private and voluntary sectors in NRM, which should in turn become more economically efficient and linked to performance-based indicators (Béné and A. E. Neiland 2004, 2006).

In chapters 4 and 5, this dissertation contributes to the debate of whether decentralization has improved the performance of centralized governments in managing CPRs. The three reasonings supporting decentralization of CPRs underlie different aspects of the research. Although the *normative* approach has been a driving force for the elaboration of the thesis, the empirical chapters relate to *substantive* and *instrumental* aspects of decentralization. While chapters 4 and 5 are based on a *substantive* approach to decentralization, chapter 6 adopts an *instrumental* focus.

Despite the claimed benefits of decentralization, it has not always provided the expected results. In the two following sections I describe outcomes and some key challenges of decentralization.

2.2.1. Outcomes and challenges of decentralization

The promises of decentralization highlighted above have unfortunately not always been realized. For example, decentralization of the management of Cameroon forests since the 1990s has not had beneficial ecological effects (Oyono, 2004). Similarly, a long-term decentralization process in the province of Yunnan, China, resulted in increased deforestation in the short-term due to tenure insecurity and the fear that the rights to manage the forest were removed, but that trend reversed in the long term (Dachang and Edmunds, 2003). Positive outcomes on ecological sustainability seem to come with time (Larson, 2005). These may also depend on the interest of dominant groups to protect the environment, which can be strengthened with accountability towards the people who elected them (Bazaara, 2003). In this regard, a recent study in Bolivia shows that deforestation in decentralized contexts is reduced if local forest users are actively engaged with local politicians (Wright *et al.*, 2016).

An insufficient transfer of powers to lower levels of administration or community resource governance has been highlighted as a critical failure of decentralization efforts (Moore and Putzel,

1999; Larson, 2005). Somewhat ironically, decentralization has often implied that the central government has strengthened rather than reduced its control over local communities and natural resources, most prominently where the state's presence was weak and local people managed resources under customary systems (Ribot, Agrawal and Larson, 2006; Larson and Soto, 2008). Furthermore, in specific contexts, decentralization has allocated power to social groups or individuals who are not necessarily democratic or accountable to local people, such as membership-based organizations, single-purpose committees or NGOs (Fisher, 1997; Béné and Neiland, 2006). When new resource management powers are transferred to the community, the risk of elite capture increases if the community lacks the necessary capacities to exercise such powers as a result, for example, of low levels of accountability, entrenched gender inequalities and ethnic-based membership (Crook and Sverrison, 2001; Pretty and Ward, 2001; Béné and Neiland, 2006).

In the light of decentralization problems and challenges, the last three decades have witnessed the emergence of a specific form of decentralized resource management, known as co-management, which is the central focus of the rest of this chapter and of the overall dissertation. In co-management approaches, the expectations of improving ecological sustainability and human wellbeing remain central, whilst decision-making powers should be shared between government and local users rather than the former devolving such powers to the latter (Béné and Neiland, 2004). This dissertation shows that some of the shortfalls of earlier decentralization approaches have not been necessarily addressed by co-management. In this sense, chapter 4 addresses the effects of co-management when, rather than devolving power, it strengthens states control over communities. Also, the three empirical chapters address directly or indirectly the risk of elite capture that occurs with co-management.

2.3. Co-management of natural resources

Collaborative management or co-management was proposed in the 1980s (Kearney, 1985) and it has gained momentum since then. Co-management is an institutional framework of power and responsibility sharing between the government and local resource users (Carlsson and Berkes, 2005; Berkes, 2010a). It is typically referred as the joint management of CPRs but it has also been used for referring to collaborative arrangements –not necessarily involving local people– in the conservation of biodiversity and ecosystem services or the management of natural areas (IUCN, 1997; Gadgil *et al.*, 2009).

Co-management is considered to be a blend of communal and government property and is increasingly thought of as a successful solution to the management of CPRs, including wildlife (e.g. Popp et al., 2019), forests (e.g. Akamani and Hall, 2019) and protected areas (e.g. Oldekop *et al.*, 2016). However, co-management has overall being studied in small-scale fisheries contexts.

Very often, the need to initiate a co-management arrangement comes after the recognition of a resource management problem, which may be resource deterioration, conflicts between stakeholders, conflicts between management agencies and local fishers, governance problems in general or a combination of them (Pomeroy and Berkes, 1997; Castro and Nielsen, 2001; Wilson *et al.*, 2006). Co-management can also be established as a legal mandate by the government or triggered by a third party. Other preconditions of co-management can arise from the user group, such as the willingness to contribute in decision-making, the rise of a strong leadership and the emergence of a common vision (Plummer and Fitzgibbon, 2004). In the context of CPRs, co-management implies, at least, the involvement of local users or communities on the one side and a governmental agency, either local, regional or national, on the other (Berkes, George and Preston, 1991; Pinkerton, 1992). It combines the control of the government with local decision making and accountability and should foster the strengths and mitigate the weaknesses of each party (Singleton, 1998).

Table 2.1 brings together four distinct definitions of co-management. All definitions emphasize that co-management is about collaboration over natural resources, and almost all acknowledge that, at least, government and local users are involved. Some definitions include other actors such as research institutions or NGOs. This dissertation follows the broader understanding of these definitions: the systematic review in chapter 5 includes both co-management schemes involving only government and local users and also involving other third parties in fisheries management. The co-management scheme analysed in chapters 5 and 6 is a multi-party agreement with several actors, including government agencies and local fishers' organizations.

Table 2.1 Definitions of co-management

Source	Definition
Pomeroy and Williams, 1994	The sharing of responsibility and authority between the government and local fishers/community to manage a fishery or other natural resources.
Borrini-Feyerabend et al., 2000	A situation in which two or more social actors negotiate, define and guarantee amongst themselves a fair sharing of the management functions, entitlements and responsibilities for a given territory, area or set of natural resources.
Jentoft, 2003	A collaborative and participatory process of regulatory decision-making between representatives of user-groups, government agencies, research institutions, and other stakeholders.
Fischer et al., 2014	Resource governance that is shared by multiple actors, typically including both community and governmental actors, but often also involving private sector enterprises or NGOs.

Following the most restricted definition of co-management involving only government and local users, different authors have described typologies of co-management according to the degree of power shared among the two main parties (e.g. McCay, 1993; Pomeroy and Berkes, 1997). The most widespread are described by Sen and Nielsen (1996) and McConney et al. (2007). The first two authors distinguish between five degrees of co-management from higher government control to higher user group control: 1) *instructive*, there are mechanisms for information sharing in which the government informs users on the decisions they plan to make, 2) *consultative*, the government consults the users but keeps taking all the decisions, 3) *cooperative*, government and users cooperate together as equal partners in decision-making, 4) *advisory*, government endorses the decisions of users, and 5) *informative*, user groups make decisions and inform the government (Figure 2.2).

Figure 2.2 Spectrum of co-management arrangements (Sen and Nielsen, 1996)

In contrast, McConney et al. (2007) distinguish between three types of co-management: 1) *consultative*, where government interacts often with local resource users but makes all the decisions, 2) *collaborative*, where government and resource users work closely and share decisions, and 3) *delegated*, where government formally grants organized users to make decisions (Figure 2.3). In chapter 5, this thesis adopts the typology by Sen and Nielsen (1996) because it is used more in small-scale fisheries co-management literature than the typology by McConney et al. (2007).

Figure 2.3 Types of co-management (McConney, Mahon and Pomeroy, 2007)

These two typologies differ in the name given to the type of co-management with equal power sharing, i.e. *cooperative* and *collaborative*. This reflects a change of meaning in the prefix *co-* of *co-management*: whereas the first authors interpreted it as *cooperative* management (Jentoft, 1989; Pinkerton, 1989), many authors nowadays assume that it refers to *collaborative* management (Berkes, 2017; Plummer, Baird, Dzyundzyak, *et al.*, 2017). The concept of *collaboration* implies the existence of multiple stakeholders with a shared interest interacting and pooling resources to solve problems (Plummer and FitzGibbon, 2004). *Collaboration* occurs when stakeholders recognize a problem that is too complex and too protracted to be resolved unilaterally and agree to collectively search solutions that go beyond their own limited vision of what is possible (Kofinas and Griggs, 1996). A particular form of *collaboration* is *cooperation*, in which actors hold very different opinions and interests requiring deliberation and negotiation to reach common agreements (Bodin, 2017).

Co-management schemes can thus range from government-user partnerships to other public or private actors at different scales, including NGOs, governments at different administrative levels, research institutes and/or commercial actors, and thus can be approached as co-management networks or governance structures (Jentoft, McCay and Wilson, 1998; Carlsson and Berkes, 2005), either formally or informally established (Pinkerton, 1989; Plummer and FitzGibbon, 2004). Figure 2.4 represents an example of a co-management network in which different government agencies interact with groups of resource users, NGOs, academics and other private actors in diverse management tasks related with a fishery. In such co-management networks, information

and resources flow among actors, decision making can be informal and diffuse, and the relative influence, positions and activities of the parties continuously re-adjusted (Carlsson and Berkes, 2005).

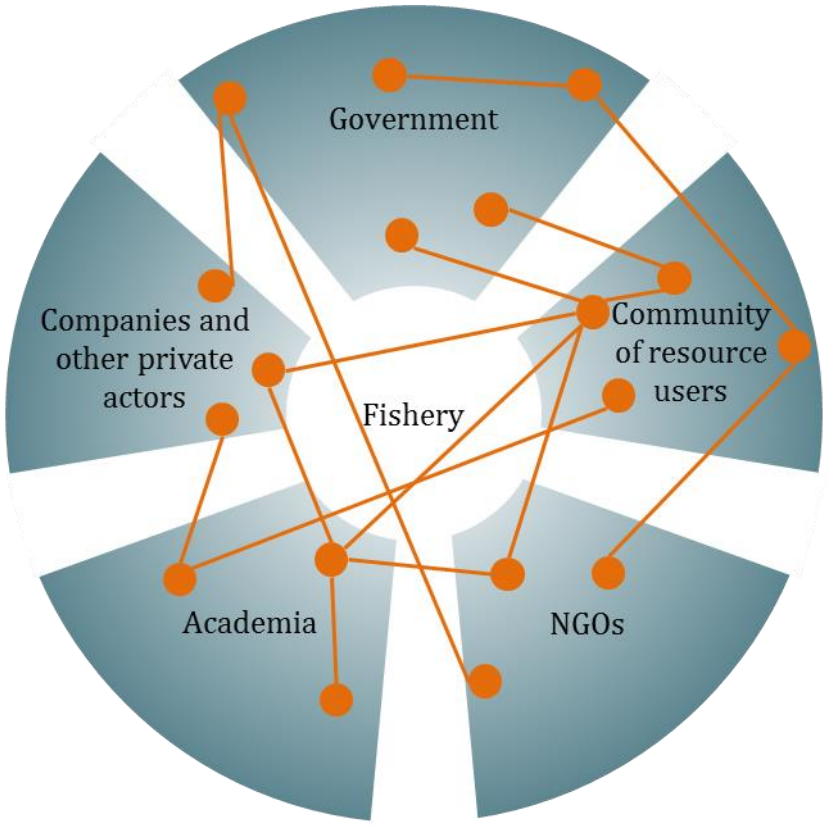

Figure 2.4 Co-management network (based on Bodin and Crona, 2009; Carlsson and Berkes, 2005). Triangular slices represent different sectors of society, the dots represent individual organizations, groups of persons or persons within each sector, and the lines represent relational ties among them.

The emergence and endurance of social networks in a co-management initiative can be explained by the interest of actors to exchange resources, like knowledge, information or legitimacy in return for another (Thrasher and Dunkerley, 1982; Carlsson and Berkes, 2005). For instance, fishers hold information about harvest volumes and status of the resource that governments or NGOs might lack whereas government and NGOs can provide technology, scientific expertise and information that fishers desire. This exchange of resources embeds a configuration of power relations in which the resources in possession of one actor can be used to affect the behaviour of another (Dahl, 2007). Therefore, from the perspective of social networks, co-management can be

regarded an evolving process of on-going negotiation and problem solving in which power sharing is not the starting point but the result (Carlsson and Berkes, 2005).

Understood as a process of problem-solving and power sharing, co-management involves: 1) pluralism, i.e. the inclusion of the diversity of stakeholders' interests and inputs; 2) communication and negotiation leading to consensus or shared understanding; 3) transactive decision making, i.e. decisions result from integrating pluralistic inputs and multiple knowledge systems; 4) collaborative learning by actors through sharing values, developing strategies, implementing actions, and reflecting upon feedback; and 5) shared action by actors that jointly undertake a series of events (Plummer and Fitzgibbon, 2004). From this perspective, co-management is increasingly approached as adaptive co-management, which is defined in the next section, followed by the description of the most cited outcomes of co-management.

The LEBR case study described in chapters 5 and 6 refers to an evolving social network of multiple actors that involve problem-solving and power-sharing. Chapter 6 specifically address aspects of pluralism and collaborative, i.e. social, learning, which is further described in next.

2.3.1. Adaptive co-management

Since the late 1990's, co-management has evolved incorporating the principles of adaptive management. Adaptive management emerged from ecological sciences and is characterized by the recognition that the behaviour of ecosystems is not linear, they can respond to resource exploitation and other disturbances in very unpredictable ways, and thus ecosystem processes are dominated by uncertainty (Gunderson and Holling, 2002; Berkes, Colding and Folke, 2003). To deal with uncertainty and surprises, the adaptive management approach treats policies as hypotheses and management actions as experiments, resulting in learning by managers (Holling, 1978; Carlsson and Berkes, 2005). By combining collaborative and adaptive management, participation of local users and communication between them and government managers, as stressed by co-management, is blended with adaptive management's experimental actions for learning to deal with ecosystems' uncertainty (Berkes, 2009).

Table 2.2 displays a number of definitions of adaptive co-management. Taken together, they highlight that adaptive co-management is a flexible institutional framework based on multi-stakeholder collaborations that facilitate learning through experimentation, reflection and deliberation. The result is a management system that can enhance the sustainability and resilience

of natural resource systems, i.e. it can absorb any disturbance and reorganize retaining its function, structure, identity, and feedbacks (Charles, 2007; Olsson, 2007).

Table 2.2 Definitions of adaptive co-management

Source	Definition
Ruitenbeek and Cartier, 2001	A long-term management structure that permits stakeholders to share management responsibility within a specific system of natural resources, and to learn from their actions
Folke *et al.*, 2002b	A process by which institutional arrangements and ecological knowledge are tested and revised in a dynamic, ongoing, self-organized, process of trial-and-error
Armitage *et al.*, 2009	A method [that] draws explicit attention to the learning (experiential and experimental) and collaboration (vertical and horizontal) functions necessary to improve our understanding of, and ability to respond to, complex social-ecological systems
Hasselman, 2017	A type of adaptive management that empowers resource users and managers in experimentation, monitoring, deliberations and responsive management of local scale resources, supported by, and working with, various organizations at different levels

Adaptive co-management is thus characterized by complex cross-scale linkages, the use of all sources of ecological knowledge available, integration of multiple perspectives and dynamic social learning (Folke, S. Carpenter, *et al.*, 2002; Olsson, Folke and Berkes, 2004). Table 2.3 shows further similarities and differences between co-management, adaptive management and adaptive co-management.

Table 2.3 Comparison of co-management, adaptive management and adaptive co-management (Berkes, 2009)

	Co-management	Adaptive management	Adaptive co-management
Linkages	Primary focus: vertical institutional linkages	Linking science and management for learning-by-doing	Horizontal and vertical links joint by learning-by-doing
Temporal scope	Short to medium: tend to produce snapshots	Medium to long: multiple cycles of learning and adaptation	Medium to long: multiple cycles of learning and adaptation
Organizational level	Bridging between local and government levels	Focus on managers' needs and relationships	Multi-level, with self-organized networks
Capacity building focus	Resource users and communities	Resource managers and decision-makers	Needs and relationships of all partners

The six key characteristics of adaptive co-management have been theorized as follows: 1) joint control and shared responsibility; 2) cross-scale linkages; 3) bridging knowledge; 4) flexibility and experimentation; 5) collaborative learning; and 6) shared understanding. Following co-management, adaptive co-management is aimed at sharing authority, power and decision making among two or more groups of actors (Plummer and Armitage, 2007b). This power sharing is the basis for building social, institutional and ecological connections among individuals and organizations across geographical space (horizontal linkages) and different levels of organization (vertical linkages) that configurate management networks (Armitage *et al.*, 2009). Such networks allow the constant input of all the knowledge available to manage the complexity of natural resources which is dispersed among multiple scales, from local to international (Berkes, 2009). The resulting institutional framework evolves and changes considering feedback from developing, testing, and reflecting upon management actions.

Social learning, a key characteristic of adaptive co-management, is "a change in understanding that goes beyond the individual to become situated within wider social units or communities of practice through social interactions between actors within social networks" (Reed *et al.*, 2010). It is the result of two processes: combining knowledge from different disciplines, cultural and social divides and levels of governance, and deliberative processes that reflect on the results of management actions (Keen and Mahanty, 2005; Berkes, 2007). It has been argued that such

deliberative processes can prompt three types of social learning: *cognitive*, *normative* and *relational*. *Cognitive* learning involves changes in individuals and groups' understanding of issues, relevant facts, problems and opportunities, and areas of agreement and disagreement. *Normative* learning implies that participants change their own values and norms. *Relational* learning refers to participants enhancing their trustworthiness and developing new networks and norms of interaction, and includes *diplomatic recognition*, i.e. recognizing that others' interests are as legitimate as one's own (Forester, 1999; Schusler, Decker and Pfeffer, 2003; Baird *et al.*, 2014). Table 2.4 summarizes the main characteristics of each learning type.

Table 2.4 Learning types (Baird *et al.*, 2014)

Cognitive learning	Acquisition of new knowledge and restructuring existing knowledge
Normative learning	Changes in norms, change in values, change in paradigms and convergence of group cognition
Relational learning	Improved understanding of mindsets of others; building relationships, enhanced trust and cooperation

An example of cognitive social learning that happens when actors collaborate in co-management is the development of a common purpose or shared understanding of the management system, including the problems to be addressed and the actions and behaviours to make positive change possible that provides guidance to all participants for sustained collaboration and joint action (Schusler, Decker and Pfeffer, 2003; Plummer and Armitage, 2007b; Armitage *et al.*, 2009). In contrast, if competing visions co-exist, conflicts can emerge that can hinder the emergence of development of a management process (Olsson, 2007).

This dissertation embraces adaptive co-management approaches in a number of ways. In chapter 4, the characteristics of adaptive co-management are included among other co-management and context characteristics to assess their contribution to co-management outcomes. chapter 6 elaborates on the concept of shared understanding as a result of cognitive social learning in co-management.

2.3.2. Co-management outcomes

As argued above, co-management can materialize in many different formal or informal institutional arrangements with different numbers and types of parties involved and a varying degree of power sharing among parties. Despite this institutional variability, some outcomes of co-management have been theorized and demonstrated empirically. However, co-management outcomes can take time: a meta-analysis of fisheries co-management in the Philippines revealed that most outcomes such as compliance and equity took between 6 and 10 years to visualize, and resource well-being and income improved after 14 and 15 years respectively (Yang and Pomeroy, 2017).

Primarily, co-management is regarded as a solution to the depletion of resources and achieving ecological sustainability of natural resource systems (Jentoft, 1989; Berkes *et al.*, 2001; Gutiérrez, Hilborn and Defeo, 2011). However, existing research shows mixed results. For instance, a study carrying underwater visuals in 42 coral reef fisheries across Kenya, Tanzania, Madagascar, Indonesia and Papua New Guinea revealed that co-managed fisheries maintained a greater standing of fish biomass than fisheries without local management (Cinner *et al.*, 2012). Similarly, a meta-analysis of 90 co-managed small-scale fisheries in developing countries showed that most of them performed positively in resource well-being (Evans, Cherrett and Pemsl, 2011). However, fishers perceived a decrease of fish abundance in 16 co-managed marine protected areas in the Philippines, which was explained by the lack of management outside the borders of these areas (Maliao, Pomeroy and Turingan, 2009). Other cases of co-management failure to enhance the resources are explained by the effects of price fluctuations in fisheries highly dependent of global markets (Defeo *et al.*, 2016).

Positive social outcomes of co-management are more broadly demonstrated in practice. First, several studies confirm that co-management initiatives result in increased compliance with NRM objectives, since a higher involvement of resource users in the definition of such objectives and any accompanying management principles facilitates their understanding and commitment to such objectives and principles (Pomeroy and Ahmed, 2006; Maliao, Pomeroy and Turingan, 2009; Cinner *et al.*, 2012). However, it has also been observed that the level of compliance is also influenced by other factors, including the probabilities of users being caught in fraudulent resource appropriation, the existence of coercive enforcement measures, and a process of decision-making and enforcement which is perceived as fair (Jentoft, McCay and Wilson, 1998; Sutinen and Kuperan, 1999; Hoefnagel, Burnett and Wilson, 2006).

Second, existent evidence suggests that co-management does not eliminate conflict by itself but can provide platforms for the resolution of conflicts among involved parties, e.g. between the government and the users, through processes of negotiation, bargaining and reaching agreements (Carlsson and Berkes, 2005; Maliao, Pomeroy and Turingan, 2009). Also, conflicts among stakeholders can be resolved with the intervention of the government as an outside legal authority (Wilson *et al.*, 2006). A quantitative study of selected coastal communities with and without fisheries co-management in Indonesia, the Philippines, Thailand and Vietnam found that co-management is an effective tool in reducing resource conflict and that when conflicts are reduced, food security improves (Pomeroy *et al.*, 2007). Other meta-analyses evaluating outcomes of co-management corroborate these findings (Maliao, Pomeroy and Turingan, 2009; Wamukota, Cinner and McClanahan, 2012).

Third, co-management can potentially reduce management transaction costs in the long term. If compliance is strengthened and conflicts reduced, little resources need to be invested in implementation, monitoring and enforcement, i.e. *ex post* costs, as compared to centralized management approaches. For example, a likely reduction of conflicts about access or appropriation among community members will reduce the need to invest time and resources resolving such conflicts. However, design, or *ex ante* costs, are likely to increase in the endeavour of distributing management responsibilities among government and user groups. So, it is expected that transaction costs will diminish when co-management is fully implemented (Hanna, 2003; Carlsson and Berkes, 2005). Empirical studies support these expected outcomes (Pomeroy and Ahmed, 2006; Kuperan *et al.*, 2008).

Fourth, co-management can lead to an increase in resource managers' income (Evans, Cherrett and Pemsl, 2011; Wamukota, Cinner and McClanahan, 2012; Defeo *et al.*, 2016). A meta-analysis of fisheries co-management in developing countries found that household income generally increased, however this increase could not be only attributed to co-management and could be influenced by external factors such as micro-credits schemes, fisheries enhancement, or other revenues originated outside the fishery sector (Evans, Cherrett and Pemsl, 2011).

Other theorized but less empirically demonstrated outcomes of co-management are resource users' improved ability to exercise self-determination at the local level, particularly through their involvement in all aspects of decision-making (Plummer and Fitzgibbon, 2004). Also, a better use of the different skills and knowledges possessed by the diversity of actors at different scales enhance efficiency in decision-making and can reduce the time required for consultation and negotiation and handle potential confrontation (Plummer and Fitzgibbon, 2004; Carlsson and Berkes, 2005). This thesis has a strong focus on empirically demonstrating co-management

outcomes through the review of documented cases in scientific literature (chapter 4) and by zooming into the case study of LEBR (chapter 5). Social equity, a last theorized outcome of co-management, is elaborated in the next section.

2.4. Co-management through an equity lens

It has been argued that equity is brought about through empowerment and active participation of local users in planning and implementing co-management (Brown, Staples and Funge-Smith, 2005; Pomeroy and Rivera-Guieb, 2006). By widening the number of actors that participate in management, co-management is expected to improve procedural equity, i.e. access to decision-making (Sen and Nielsen, 1996; Pomeroy and Ahmed, 2006). By enhancing procedural equity, it is argued, distributional equity aspects will also be ameliorated.

Although often assumed, procedural and distributive equity in co-management is little inquired (Quimby and Levine, 2018). An exception are three meta-analyses examining equity outcomes in co-managed fisheries (Evans, Cherrett and Pemsl, 2011; Yang and Pomeroy, 2017; Whitehouse and Fowler, 2018). They report positive impacts of co-management on procedural equity but describe mixed results on distributional equity. Whitehouse and Fowler (2018) found that the most successful cases were community-based co-management schemes were local users and government shared management equally. They also found that involving the community from the start, establishing core groups of participants to guide the implementation of co-management and providing enough economic support were key successful characteristics. Yang and Pomeroy (2017) found a positive relation between years of attendance to school and improvements in procedural equity and argued that local users need to be empowered with knowledge and skills to actively and effectively participate in fisheries co-management. They also found that equity outcomes are shown to improve when the duration of the co-management scheme is longer than 6-8 years. Remarkably, improvements in income needed 15 years of implementation.

These meta-analyses reflect, as Quimby and Levine (2018) state, that, research examining equity in fisheries co-management is still scarce and there is a lack attention to the plurality of forms of co-management discussed in broader conservation literature. Thus, the issue of equity in co-management remains an important consideration (Plummer and FitzGibbon, 2004; Béné and Neiland, 2006). In broader conservation contexts, it is increasingly accepted that pursuing social equity needs to overpass the focus on participation and benefit distribution and look at the underlying causes of unfair access to participation and unjust distribution, taking into account

marginalization and oppression within and between groups (Young, 1990). Recognition, understood as respect to identities and cultural difference, is the basis for distributive and procedural justice (Fraser, 1997; Fraser and Honneth, 2003). However, recognition is still comparatively poorly understood and neglected in co-management and in conservation research in general, and requires more equitable spaces of engagement (Martin *et al.*, 2016).

In this thesis, I adopt a three-dimensional approach to addressing equity in co-managed small-scale fisheries, including *recognition*, *procedure* and *distribution*. I adopt the definition of these three dimensions by Pascual et al. (2014), according to them, *recognition* denotes the respect for knowledge systems, values, social norms and the rights of all stakeholders in the design and implementation of management actions; *procedure* relates to the degree of involvement and inclusiveness in rulemaking and decisions, and *distribution* refers to the allocation of costs, benefits, burdens and rights.

The systematic review in chapter 4 includes distributional equity as one of the assessed outcomes of co-management, because this is the dimension of equity that has been most studied in small-scale fisheries research so far. In chapter 5, I develop an analysis of the institutional design and outcomes of co-management in LEBR based on the three aforementioned variables.

3. Methodological approach

"If you are a successful participant observer, you will know when to laugh at what people think is funny; and when people laugh at what you say, it will be because you meant it to be a joke."

(Bernard, 2006)

This chapter explains how the theoretical framework developed in the previous chapter has been operationalized through three analytical scales: global (i.e., the world), fishery (i.e., the *La Encrucijada* Biosphere Reserve co-managed fishery), and community (i.e., the two selected cooperatives: *La Palma* and *Luchadores del Castaño*). The systematic review of co-managed small-scale fisheries was useful for detecting areas of certainty (i.e. small-scale fisheries co-management is effective in improving governance-related outcomes) and research gaps. The case study approach based on *La Encrucijada* Biosphere Reserve builds on the review findings by investigating two main research gaps highlighted, i.e. the uncertainty about the performance of co-management in terms of social equity (chapter 5) and the need to embrace social diversity to make co-management more legitimate and effective in the long term (chapter 6).

This chapter is divided into four sections: the first describes the analytical scales and justifies the selection of the studied systems, providing additional information for a better understanding of the case study; the second explains the research schedule and methods; the third describes the ethical aspects of my work, and, finally, the fourth reflects on my experience as a PhD researcher.

3.1. Analytical scales

The research strategy of this dissertation is grounded on three analytical scales. In chapter 4, I adopted a systematic review approach to analyse documented cases of small-scale fisheries co-management in the peer-reviewed scientific literature. Chapters 5 and 6 adopt a single case study approach: the co-managed fishery of *La Encrucijada* Biosphere Reserve. These two chapters follow a 'one-shot case study design' (Bernard, 2006) to assess the effects of an intervention at the fishery and community scales, i.e. the implementation of a new institutional design based on collaborative management. Based on an objectivist epistemology, the case study research follows an explanatory strategy to search for explanations of a phenomena, which involves testing elements of a theory that has already been proposed in the literature (Johnson, 1998). As

mentioned, the case study enquiry is divided into two scales, i.e. the fishery system level and the community' level, to further describe the characteristics and effects of the intervention at both scales. The comparative case study design at the community level compares the results of the intervention and discuss possible interpretations (Newing *et al.*, 2011). These two levels of case study analysis appear intertwined in chapters 5 and 6.

3.1.1. Co-managed small-scales fisheries around the world

Existing information on the characteristics and outcomes of co-managed small-scale fisheries globally is compiled in a meta-analysis of co-managed small-scale fisheries (Evans, Cherrett and Pemsl, 2011) and a literature review of co-managed fisheries (Gutiérrez, Hilborn and Defeo, 2011). Evans et al. (2011) reviewed 221 studies in more than 50 developing countries. After a systematic selection of case studies having available and appropriate data for the analysis, they reduced the sample to 29 cases in 10 countries, with an overrepresentation of Asian countries. Their analysis shows positive trends over time in process indicators such as rule compliance and resource control, and outcome indicators such as household income, and fishery yield or resource harvest.

Gutiérrez et al. (2011) looked at conditions for successful artisanal and industrial fisheries and identified 130 co-managed fisheries in 44 countries. Their review encompassed cases from consultation mechanisms between government and users to self-governance initiatives. They found that the most important variable contributing to successful co-managed fisheries is strong community leadership, followed by individual or community quotas designed and implemented within the co-management regime, social cohesion and formal or community-based protected areas. Other less important variables were enforcement mechanisms, long-term management policies, life history of the resources, and influence of fishers in local markets. They conclude that both strong governance systems and local community attributes are necessary for success.

The systematic literature review in chapter 4 builds on these previous studies but advances their findings in three ways. First, the previous two articles rely on scientific articles, grey literature and consultation with experts to identify their study sample, which is useful to gather a high number of case studies but might imply lack of scientific rigour in the way authors or informants assess outcomes of each case study. In contrast, I developed the study sample in chapter 4 with articles from two scientific databases (Scopus and Web of Science), which ensured consistency in the type of research gathered and increased the reliability of the findings. Second, Evans et al.

(2011) study co-management interventions in small-scale fisheries whilst Gutiérrez et al. (2011) include small-scale and industrial fisheries and apply a broad definition of co-management that includes community-based management. In contrast, I followed the narrow approach of Evans et al. (2011) and focused only on small-scale fisheries (whose characteristics differ enormously to those of industrial fisheries) that are strictly co-managed, where local users and government at least collaborate in one way or another. Third, while Evans et al. (2011) explore co-management outcomes and Gutiérrez et al. (2011) describe conditions affecting success, I investigated both outcomes and conditions affecting outcomes, following a comprehensive analytical framework.

3.1.2. The co-managed fishery of *La Encrucijada* Biosphere Reserve

La Encrucijada Biosphere Reserve (hereafter LEBR) is a Mexican natural protected area, since 1996, and has been declared a UNSECO Biosphere Reserve and RAMSAR wetland. Located on the Pacific coast of Southern Mexico, in Chiapas, its 144,868 ha encompass 82 community settlements spread across six municipalities (*Acapetahua*, *Pijijapan*, *Mazatán*, *Huixtla*, *Villa Comaltitlán*, and *Mapastepec*), which in turn represent more than 26,882 inhabitants (Instituto Nacional de Ecología, 1999). The main characteristic of the Biosphere Reserve is the estuarine system drawn by the 29.536 ha of mangrove forest (Tovilla-Hernández *et al.*, 2009), which result in a network of channels, ponds and islands. The Reserve's brackish waters support the populations of 153 fish species (Gómez González *et al.*, 2012) of which up to 46 species have commercial value, together with 5 crustaceans and 2 bivalves (Rodríguez Perafán, 2014). Fishing is the main commercial and subsistence activity of the 12 settlements and 1.725 inhabitants living in the mangrove area (Tovilla-Hernández *et al.*, 2009). Two main lagoon systems, *Carretas-Pereyra* and *Chantuto-Panzacola*, encompass 16 fishing cooperatives (Instituto Nacional de Ecología, 1999).

The co-management initiative started in 2009 and it has gone through four stages, which I briefly describe below. Figure 3.1 shows the actors involved in each phase.

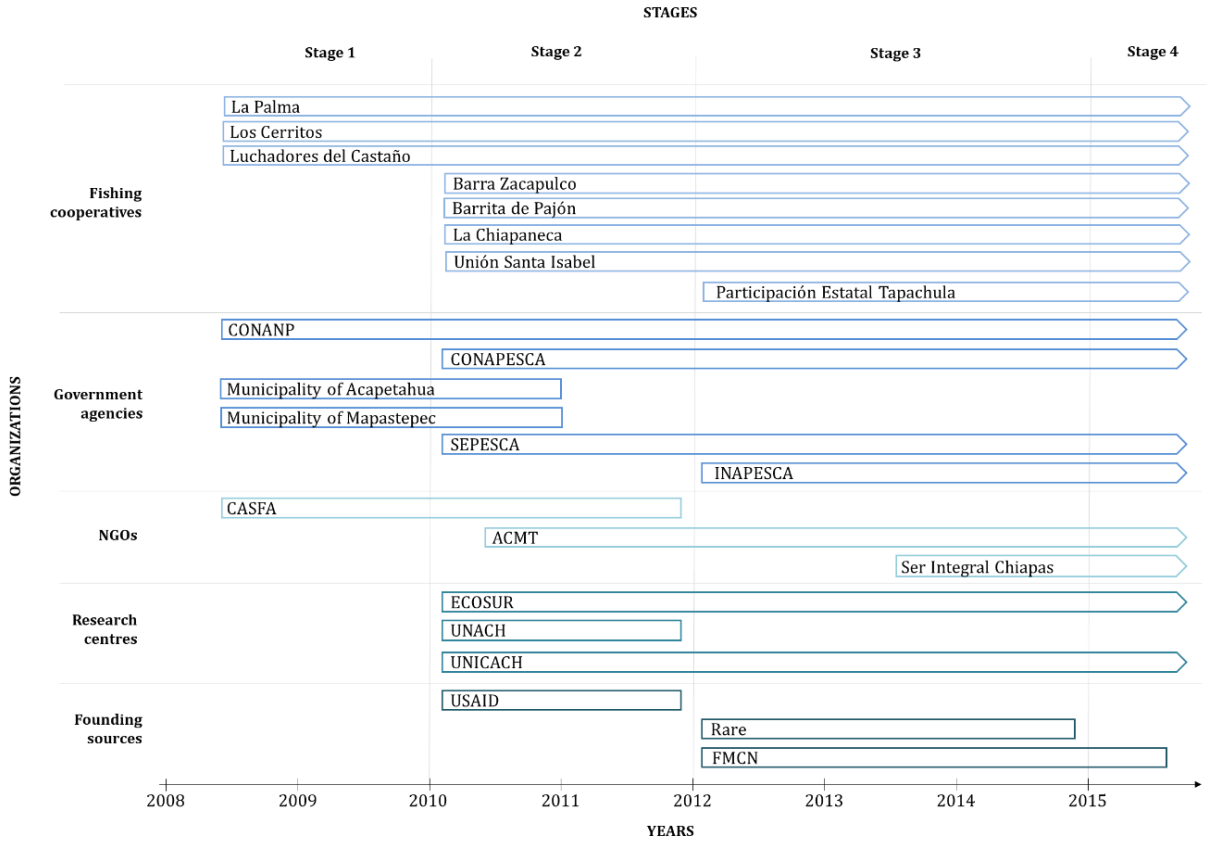

Figure 3.1 Main actors involved in the co-management process

Stage 1 Window of opportunity

In 2008, the *Centro de Agroecología San Francisco de Asís* (CASFA), a local NGO, invited Naturland, an NGO promoting fair trade in European markets, to explore the potential of certifying existing aquaculture production in LEBR. CASFA also invited local officers of the National Commission of Natural Protected Areas (CONANP) and three leaders of fishing cooperatives: the leader of the *La Palma* fishing cooperative was at that time the director of fisheries in the municipal fishing agency of *Acapetahua*, the leader of the fishing cooperative of *Luchadores del Castaño* (hereafter *Luchadores*) had the same position in the municipality of *Mapastepec*, and the third leader from the fishing cooperative of *Los Cerritos* represented the Federation of fishing cooperatives of *Soconusco* (*Federación regional de sociedades cooperativas pesqueras del Soconusco*). After visiting LEBR, Naturland did not see any commercial interest in the aquaculture production but saw exportation potential in the products of the wild fishery. However, certifying wild fish catches for international export required adjusting existing fishing practices in ways that would make them more sustainable. The actors involved agreed on starting a joint initiative to promote a more

sustainable fishery under the concept of 'sustainable fisheries', following the FAO Code of conduct for responsible fisheries (FAO, 1995).

According to the fishers' representatives, the only governmental ally that believed that fishing practices in *La Encrucijada* could be improved was CONANP. In this pre-implementation phase, neither national nor regional fishing authorities were present and only the local municipalities were involved because, as noted above, some cooperative members had temporary jobs at the municipal level.

Stage 2 Building a network

The co-management initiative formally started in 2010 with a series of workshops organised by CASFA and CONANP with the financial support of the United States Agency for International Development (USAID). These workshops brought together actors related to fisheries management, i.e. the National Commission of Aquaculture and Fishing (CONAPESCA) and the regional Secretary of Fishing and Aquaculture (SEPESCA), eight fishing cooperatives of the *Chantuto-Panzacola* lagoon system, national and regional academic institutions, i.e. *El Colegio de la Frontera Sur* (ECOSUR), *Universidad Autónoma de Chiapas* (UNACH) and *Universidad de las Ciencias y las Artes de Chiapas* (UNICACH), and an NGO, i.e. *Acción Cultural Madre Tierra* (ACMT) (see Figure 3.1). Other actors such as the Federation of fishing cooperatives *Unidos por Mapastepec*, the National Commission of Water (CONAGUA) and the National Commission for the Development of Indigenous Peoples (CDI) attended between one and three meetings but did not get further involved in the process.

The workshops were mostly one-way communication sessions led by experts from government and academic institutions, which nonetheless resulted in spaces for discussion, knowledge-sharing and decision-making. For example, ECOSUR researchers presented an inventory of fish species in the *Chantuto-Panzacola* lagoon system, which prompted knowledge-sharing among researchers and fishers who discussed about the presence of those fish species in their fishing areas, fishing seasons, gears used, and typical sizes and weights. Table 3.1 presents the main outputs of the workshops, among which stands out the agreement on the 20 inter-cooperative norms to promote a sustainable fishery.

Table 3.1 Workshops (CASFA, 2011a, 2011b, 2011c, 2011d, 2011e, 2010a, 2010b, 2010c, 2010d, 2010e)

Workshop	Place	Date	Outputs
1. Introduction to responsible fishing	*Tapachula*	8-10/3/2010	Fishers accounted the fish production per cooperative during the years 2008 and 2009; participants draw a first draft of the inter-cooperative norms of responsible fishing.
2. Diagnosis of responsible fishing	*La Palma*	22-23/4/2010	Participants exchanged information about the main commercial species, including which fishing cooperatives targeted such species, the spawning periods, and usual and maximum weights; fishers stated the number of members, boats, engines and nets in fishing cooperatives.
3. Developing rules for responsible fishing	*El Castaño*	25-26/5/2010	Fishers presented internal cooperative agreements; participants discussed about possible actions and norms towards a more sustainable fishery and agreed on the 20 inter-cooperative norms of responsible fishing.
4. Quality certification for responsible fishing	*Tapachula*	28-29/6/2010	Participants discussed about actions to improve the quality of the harvest and advance towards certification of fishing products.
5. Strategies for adding value to the products of responsible fishing	*La Palma*	5-6/8/2010	Fishers stated fishing daily times, gears used and post-harvest practices; participants discussed about current and potential post-harvest practices to increase the value of the fish.
6. Sustainable commercialization of the products of responsible fishing	*Tapachula*	20-21/9/2010	Fishers stated further information about the most commercial species in each fishing cooperatives, maximum and minimum production per month, maximum and minimum size, postharvest treatment, fishing areas, closed seasons, fishing techniques and fishing gears used.
7. Developing a catalogue of products of responsible fishing	*El Castaño*	6-7/4/2011	Fishers stated minimum production per month of the two most commercial species: shrimp and snook.

8. Setting-up of an integrating company	*Barra Zacapulco*	29-30/6/2011	-No info-
9. Developing a business plan for responsible fishing	*Los Cerritos*	6-7/9/2011	-No info-
10. Business diagnostic for supporting fishing cooperatives	*La Palma*	1-2/8/2012	-Talks about organization and commercial issues-
11. Sustainable commercialization of the products of responsible fishing	*Barrita de Pajón*	8-9/11/2012	-No info-

Besides the main activities of training, information-sharing, and decision-making, the workshops were a platform for the establishment of what had to later become more stable co-management committees. They served to test which actors contributed more to a respectful and collaborative process and were willing to participate actively in the future. The organizers, i.e. CONANP and CASFA, invited all the actors with a stake in the process and could check whether they were interested or not based on their attendance. For instance, the National Commission of Water (CONAGUA) was invited to two workshops and the National Commission for the Development of Indigenous Peoples (CDI) was invited to three workshops but both only attended one workshop. The number of attendants fluctuated from the first to the last meeting, with a peak in workshops 3 and 6, when enthusiasm about the process was highest, and a drop off of the least interested actors towards the last workshops (see Figure 3.2). Towards the end of this stage, a network of organizations was created, some organizations kept strongly involved in the process, e.g. CONAPESCA and ECOSUR, whereas other organizations left the process, e.g. UNACH.

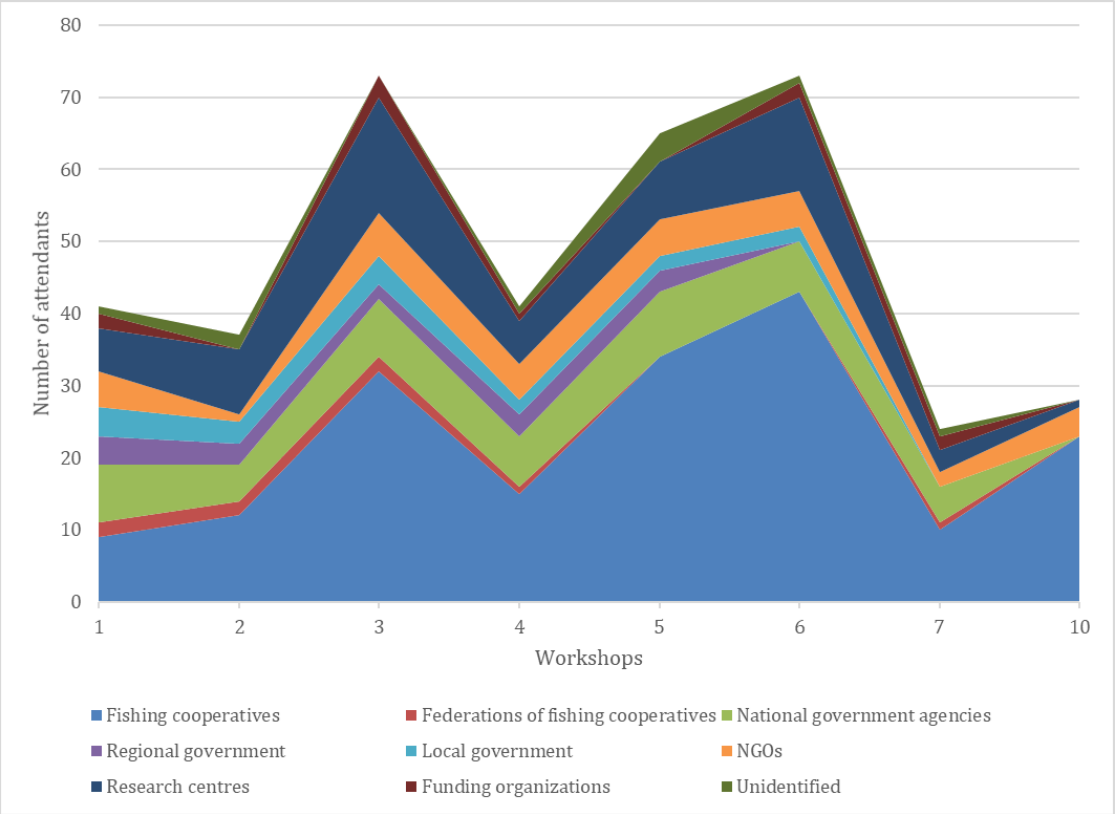

Figure 3.2 Number of attendants per organization during the workshops (CASFA, 2010f, 2010e, 2010d, 2010c, 2010b, 2010a, 2011b, 2011a)**.** Information on workshops 8, 9 and 11 could not be found.

Stage 3 Building the institutional design

In 2012, CONANP and ACMT got funding from the international organization Rare and the Mexican Fund for the Conservation of Nature (FMCN), which was employed in hiring three full time officers: CONANP hired a fisheries' officer and ACMT hired a fisheries' officer and a leader of the fishing cooperative of *Los Cerritos* who had been involved in the process since the very beginning. These three people started working in the local office of CONANP in *Acapetahua* and were charged with the organization of several social events in the fishing communities to increase support towards new fishing norms and forms of local monitoring and compliance. These activities included workshops, informal talks, wall paintings and leisure activities, such as sport competitions. Figure 3.3 shows a picture of a wall painting to promote no-take areas (*áreas de reserva pesquera* in local Spanish) in the community of *La Lupe*.

Figure 3.3 Image of a wall painting to promote no-take areas

In 2013, CONANP created two co-management committees that were facilitated by ACMT. These committees replaced the workshop series held during the previous stage, creating a more stable institutional design. The inter-cooperative committee was established to bring the leaders of the

eight fishing cooperatives together three or four times a year to promote and discuss fishing norms, coordinate management actions and promote joint commercialization of fish produce. The technical-scientific committee met twice a year and involved representatives of fishery governmental bodies, e.g. CONAPESCA and the National Institute of Fishing (INAPESCA), academic institutions, e.g. ECOSUR and UNICACH, CONANP, ACMT and representatives of the fishing cooperatives (Figure 3.4 shows a meeting of the committee). The technical-scientific committee was established to discuss the activities done within co-management and provide technical advice to the fishing cooperatives (see the different co-management forums at Figure 3.5). A key achievement in this phase was the creation of local no-take areas by the eight fishing cooperatives involved in the process.

Figure 3.4 Image of a meeting of the technical-scientific committee

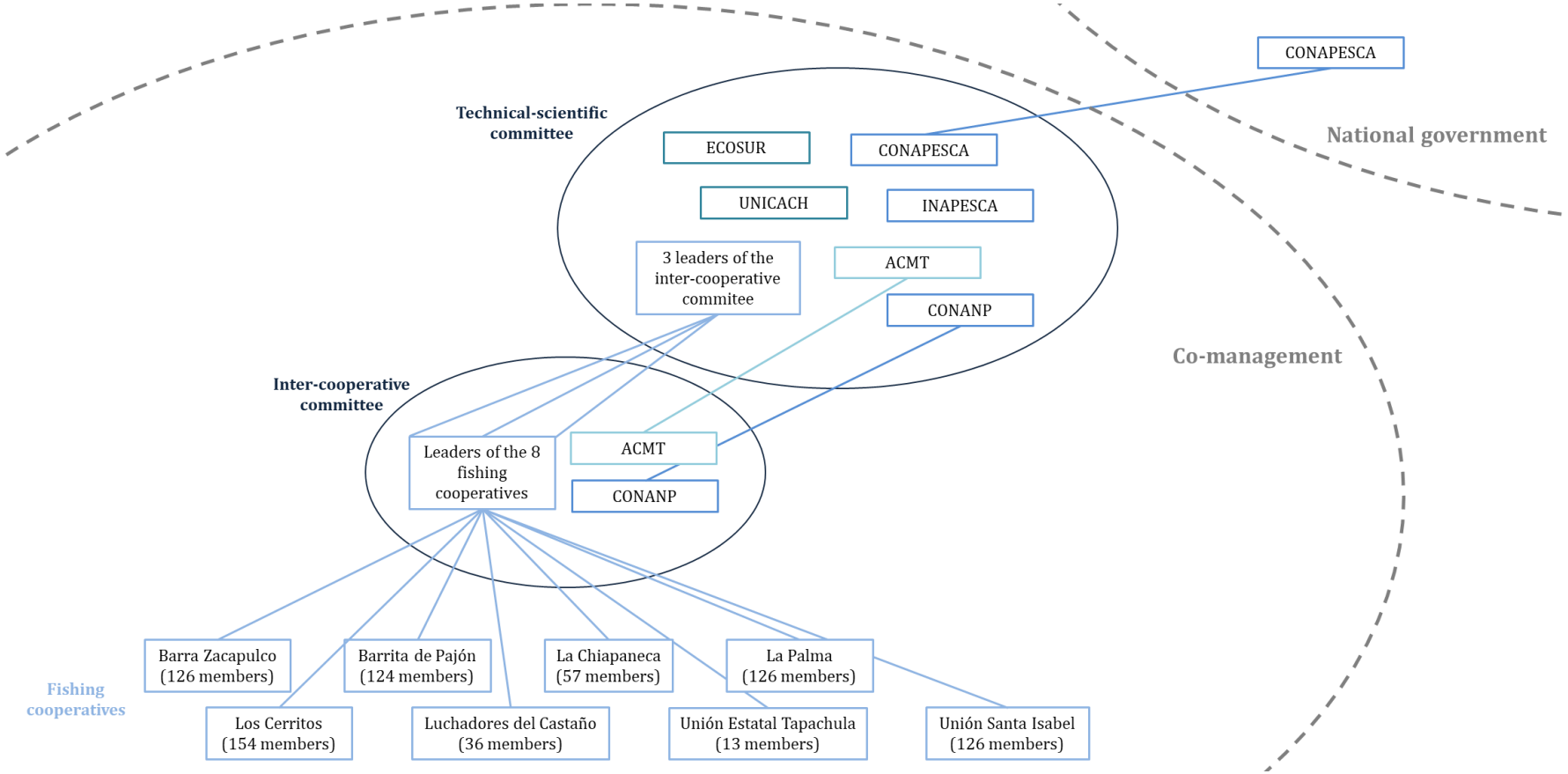

Figure 3.5 Co-management institutional design. Straight lines unite the same organizations at the different decision-making and advisory levels

During this phase, CONANP and ACMT also promoted the creation of monitoring and compliance-seeking teams in each cooperative and hired two young part-time fishers to lead these monitoring efforts. Figure 3.6 shows an image of a monitoring trip to the no-take area of the *Participación Estatal Tapachula* cooperative. Collaborative monitoring was aimed at: 1) enforcing compliance of the 20 inter-cooperative norms; 2) controlling illegal fishing in no-take areas; 3) monitoring productivity of the no-take areas; and 4) monitoring fish catches in each cooperative. The data resulting from monitoring trips was analysed by CONANP and ACMT and the resulting information was returned to fishers in the inter-cooperative committee, the fishing assemblies, and presented in the meetings of the technical-scientific committee.

Figure 3.6 Monitoring trip to a no-take area

Stage 4 Consolidating the co-management scheme

Funding from Rare concluded in 2014 and funding from the FMCN lasted until 2015, which implied that ACMT would leave the process by the end of 2015. However, CONANP continued organizing the two co-management committees and strengthening local monitoring activities led by fishers. In the following years, the co-management scheme would expand by incorporating

other fishing cooperatives. This subsequent stage of co-management will need to be studied by a future research project.

Based on the above described emergence and development of the co-management fishery in LEBR until 2015, I argue that this initiative is unique in several ways, which justify its selection as a case study. First, it is an interesting illustration of a co-management initiative that emerges without a legal framework, which is considered one of the main factors facilitating the emergence of co-management. As explained in the introduction, although the Mexican fisheries law (*Ley DOF 24-07-2007 General de Pesca y Acuacultura Sustentables*) opens the door to co-management committees at regional levels, they have not been implemented yet. Second, the co-managed fishery in LEBR is located in Chiapas, the second most marginalized state in Mexico, and thus differs from other Mexican co-managed small-scale fisheries which are located in Baja California Sur and Quintana Roo, with low and medium levels of marginalization, respectively (Téllez Vázquez *et al.*, 2016). Third, thanks to the protected area context, the co-management scheme has brought together a diversity of actors, including actors with conflicting views due to the designation of the biosphere reserve. Finally, to my knowledge, there are no other studies addressing this co-management case study. Previous social research in the area has focused on the archaeological findings and a few studies have described the organization of the fishing activity (e.g., Alcalá Moya, 1999; Ortiz, 1984; Rodriguez-Perafan et al., 2013).

3.1.3. The fishing cooperatives of *La Palma* and *Luchadores del Castaño*

To further study the dynamics and outcomes of a co-managed small-scale fishery, I chose two cooperatives that had been involved since the beginning and kept highly committed to the co-management initiative when fieldwork was conducted (2015). Interviews with CONANP and ACMT officers revealed that *La Palma*, *Luchadores* and *Los Cerritos* were the first fishing cooperatives to engage with the co-management process, but the latter's interest had decreased over time.

La Palma was the first fishing cooperative to be established in the LEBR in 1941, and was founded in the community with the same name, i.e. *La Palma*, which had been inhabited since the late 1890s (Pronatura Sur, 2013) and fell within the municipality of *Acapetahua*. Figure 3.7 shows the map of the community. At present, the community of *La Palma* encompasses 678 people, with a high level of marginalization (Secretaría de Desarrollo Social, 2010). The cooperative has 126 members of which only 100 are currently active, because old fishers keep their membership to

benefit from government's economic subsidies channelized through the cooperative. Cooperative members own about 400 cast nets, 70 outboard motors and 30 stow nets (CASFA, 2010e) and also fish with trammel nets and hooks. Figure 3.8, Figure **3.9**Figure 3.10 show different fishing techniques in *La Palma* fishing waters. The cooperative also recognizes about 50 free fishers (*eventuales* in local Spanish) who are usually relatives of cooperative members. These *eventuales* fish in the waters of the cooperative and often trade through the fishing cooperative, although they do not participate in the cooperative assemblies and do not receive any of the benefits that members usually have, such as economic support for buying new fishing equipment and temporary jobs offered by government agencies.

Figure 3.7 Map of *La Palma* community. Source: CNES / Airbus, DigitalGlobe, INEGI, Google 2019 (https://www.google.com/maps/@15.1751455,-92.8346937,3049a,35y,47.17h,4.97t/data=!3m1!1e3)

Figure 3.8 Cast net fishers

Figure 3.9 Trammel net fishers

Figure 3.10 Hook fishers

Luchadores is a younger cooperative legally constituted in 1995 in the community of *El Castaño*, *Mapastepec*. The community encompasses 75 people and suffers from a high level of marginalization (Secretaría de Desarrollo Social, 2010). Figure 3.11 shows a map of the community. *El Castaño* consisted of a few isolated houses until the 1970s, when a large family of migrants from Guerrero, in north-west Mexico, established themselves in the area. The fishing cooperative now has 32 members and three free fishers. The cooperative of *Luchadores* owns a shrimp corral (*tapo* in local Spanish) which is a fishing technique widespread in the region. This technique consists of a net or a fence that blocks the exit of a lagoon and captures shrimp and other fish in their path towards the ocean. All cooperative members are allowed to fish in the shrimp corral the days of the month when this fish migration happens, according to the tides. The membership is split into two groups, each group fishes every second day, and rotates along the 15 fishing spots. The *tapo* fishing activity is highly profitable and only demands fishers to throw a cast net from a fixed point during the hours that the tide is receding and participate in periodic activities of maintenance. Figure 3.12 shows the *tapo* in *Luchadores del Castaño* fishing waters. *La Palma* does not have a suitable lagoon in its fishing waters to build a shrimp corral. Instead, some fishers use the stow net (*copo* in local Spanish), an individual and illegal fixed net that captures all

fish and shrimp transported by the tide. However, this fishing gear is expensive and only the wealthiest fishers can afford it.

Figure 3.11 Map of *El Castaño* community. Source: DigitalGlobe, Geoeye, Google 2019 (https://www.google.com/maps/@15.2877881,-92.966793,879a,35y,5.02t/data=!3m1!1e3)

Figure 3.12 Shrimp corral

Fishing activities have a cultural impact that surpasses the fishing cooperatives and spreads to the whole community, providing a strong cultural identity to *La Palma* and *El Castaño*. *La Palma*, for example, has a collective memory of the old glorious past of the fishery, as described by a leader of the cooperative, who recalls the fishing campaigns in the big lagoon *Chantuto* and the celebrations after the successful fishing campaigns. Later, when the concessions divided up the fishing waters among cooperatives, *La Palma* was removed from that lagoon:

> "In 1993-94, we worked together with *Barra de Zacapulco* [fishing cooperative]. We harvested a lot of shrimp. We did the dance of the shrimp, every 30 of May, when the fishing season was over. There were music bands, every [cooperative] member contributed with 100 pesos of that time, and you got beers, soft drinks, food, the dance, a table for your family and shrimp for everybody." (P16, leader of *La Palma* cooperative)

All economic activity in the communities revolves around the fishing activity and children learn the fishing techniques from their parents (see Figure 3.13), as this fisherwoman from *El Castaño* explains:

"I started fishing when I was 11-years-old. I liked it or maybe I did it out of necessity. I used to fish cichlids but then I learned to fish other fish species. I fish with a hook (…). She is my fishing partner and sometimes I go fishing with my father. (…) We use her boat. I do not have any because I am a new [cooperative] member, I joined two years ago. Sometimes I buy fish of the cooperative and I sell it to *Mapastepec* [the closest town centre], it is my business. I have a van and I go and sell it with my uncle or my husband. It is a good extra income." (C14, member of *Luchadores del Castaño* cooperative)

Figure 3.13 Children fishing with hooks

I believe that zooming into the community level can inform broader co-management debates about the development and outcomes of co-management. These two cooperatives offer great insights for two main reasons. First, they represent very different conditions in terms of histories of the communities and cooperatives, the number of cooperative members and the kind of gear used. Second, although both cooperatives are actively involved to co-management, they exhibited different engagement, as explained by CONANP officers during the preliminary fieldwork.

3.2. Research methods

The three empirical chapters (chapters 4, 5 and 6) describe the methods used to answer each specific research question, and chapters 5 and 6 include the methodological limitations of the research. Therefore, this section describes aspects that could not be included in the chapters, such as the schedule of the PhD research, a detailed description of the review process carried out in chapter 4 and the methodological tools employed in chapters 5 and 6.

I spent two periods in Mexico: the first fieldwork period lasted from 23 September to 14 October, 2014, and the second and main fieldwork period lasted from 16 April to 21 September, 2015. During the first period, I contacted CONANP as the leading organization of the co-management initiative in LEBR to present my research project; got in touch with a regional research institution, i.e. ECOSUR, to involve a local academic partner in my project; visited LEBR to confirm the co-management initiative as the main case study of this dissertation; and arranged practical issues for the future, e.g. accommodation. During the main fieldwork period, I spent intermittent periods in San Cristobal de las Casas, the second largest city in Chiapas, and in *Acapetahua*, the coastal town where the local office of CONANP is located. I also spent about one month in the communities of *La Palma* and *El Castaño*. Figure 3.14 shows the two main fieldwork periods in the context of other PhD activities.

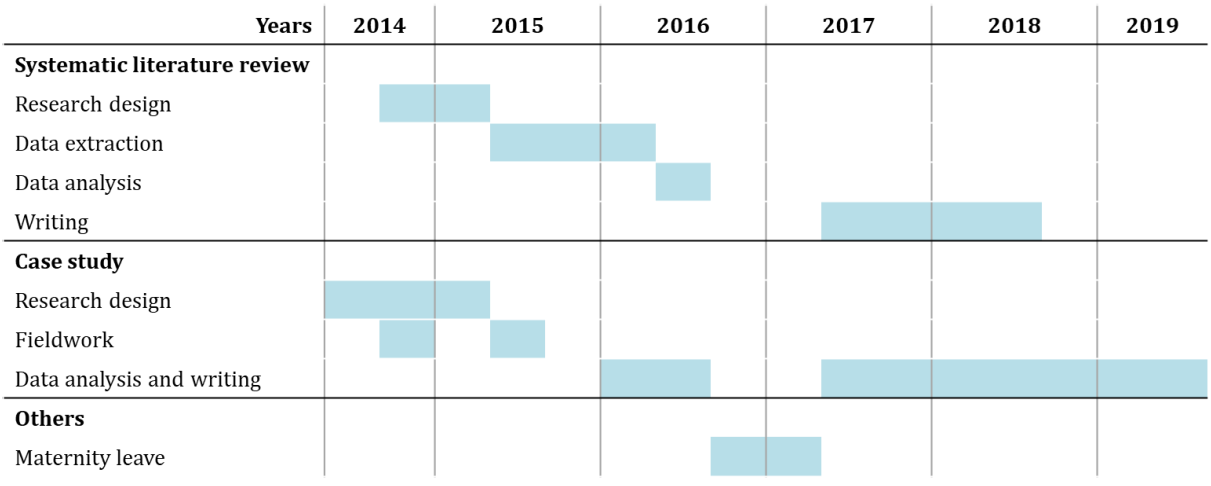

Figure 3.14 Overview of the research activities, 2014-2019

3.2.1. A systematic literature review

Prior to conducting the case study research, I performed a systematic literature review to investigate the context and attributes in which small-scale fisheries co-management happen, their outcomes, and how the former influenced the latter, as described in the introduction and chapter 4.

Systematic reviews are a useful method for working with large bodies of information and can answer questions about what works and what does not in a given intervention. They can detect areas of certainty and, interestingly, areas in which we thought there was certainty but there is not (Petticrew and Roberts, 2006). In this sense, theory and practice are often based on assumptions about what works and conducted in schools of thought which direct the type of science that is conducted and can control the outcomes to some extent. Challenging these paradigms is difficult but systematic reviews can be a useful tool by examining underpinning evidence. Finally, systematic reviews can also identify research gaps in which more research is needed (ibid.).

Next, I present the study inclusion criteria that guided the search for case studies to include in the systematic review, the search strategy, the screening process, and data extraction. The study inclusion criteria refer to the relevant subject, the type of intervention, the relevant outcomes and the relevant types of study design. I further describe these criteria in the following list:

a) Relevant subject: small-scale fisheries. Studies had to define the fishery as small-scale, local, traditional, artisanal or subsistence, but not industrial in any case. When there was no clear categorization by the author(s), I discerned whether it could be considered a small-scale fishery by applying the following criteria from Berkes et al. (2001) and Mills et al. (2011):
    - A mix of both commercial and subsistence fishing is expected, though it may be either one or the other;
    - The ownership of boats is distributed among many, who in turn are usually the operators (as opposed to ownership concentrated in few hands, often non-operators);
    - The enterprises are mainly structured around households or communities;
    - Boats are small, have low technology and may be non-motorized;
    - Equipment types may be hand or machine-made, and usually assembled by the operator;

- Fishing activities are decentralized and dynamic in space, time and technology;
- The catch may be none or little processed (e.g. drying, smoking, and salting) and its main destination is human consumption (as opposed to strongly processed fish with a high degree of fishmeal and non-human consumption);
- The levels of capitalization are relatively low;
- Operators are often multi-employees;
- The fishery may be partially integrated into the market economy;
- The extent of market is local or national.

a) Type of intervention: initiatives of collaborative management (co-management) involving at least government actors and local users aiming to improve the ecological and/or social conditions of the fishery.
b) Relevant outcomes: to be included as a case study, the article had to describe outcomes that resulted from the co-management initiative in an improvement or worsening of the social and/or ecological state of the fishery. Articles assessing the outcomes of an intervention, e.g. a no-take area, in a co-management context were discarded.
c) Relevant types of study design: only empirical studies with at least one case study, describing outcomes with first-hand data. To avoid duplication bias, when one case study was described in more than one article, the article covering more variables of the analytical framework was retained.

The literature search targeted two databases, Scopus and Web of Knowledge, using the terms listed in Table 3.2, resulting in 626 manuscripts. Four reviewers read the abstract and, when necessary, the full text to assess whether each manuscript met the study inclusion criteria. To ensure coherence among reviewers, 15 articles were screened by all four reviewers and the differences were discussed. 175 articles were accepted for data extraction. During data extraction, 108 more articles were discarded. The final dataset consisted of 67 articles describing 91 case studies.

Table 3.2 List of search terms

Intervention	Object	Outcomes
Co-management	"Small-scale fish*"	"Natural resourc*"
Comanagement	"Local fish*"	Biodiversity
"Collaborative management"	"Traditional fish*"	Conservation
	"Artisanal fish*"	Ecosystem
	"Subsistence fish*"	Environment

The review of the 67 articles followed the framework for the analysis of co-management in small-scale fisheries. Data analysis consisted of a descriptive analysis of the absolute frequencies and percentages of each variable and a statistical analysis with pairwise Fisher exact tests to analyse relationships between co-management conditions and outcomes. The description of the analytical framework that guided data extraction and further details about the analysis are displayed in chapter 4.

3.2.2. Participant observation

Participant observation is a humanistic and scientific method to produce experiential knowledge (Bernard, 2006). It is an "unstructured and interactive method for studying people as they go about their daily routines and activities" (Newing *et al.*, 2011). It requires the ability of the researcher to make people feel comfortable enough with their presence so they can observe and record information about their lives (Bernard, 2006). I conducted participant observation by getting invited to activities with officers of CONANP and ACMT, attending co-management forums and activities, and participating in the daily life of the two fishing communities of *La Palma* and *El Castaño*. The main activities that I attended, related to the co-management initiative and other fishery activities, are listed in Table 3.3. Figure 3.15 Figure 3.16 shows two images of participant observation activities. During both fieldwork periods, I took photographs and I used field notebooks to write down notes relating to situations or dialogues on fishery management. I tried to do this as soon as possible and at the latest at the end of the day so as to not forget the details. Data collected through participant observation was later harmonized with data from interviews and focus groups (Albuquerque, Farias Paiva de Lucena and Machado de Freitas Lins Neto, 2014).

Table 3.3 Main participant observation activities

Activity	Place	Date
Fieldtrip to fishing communities with CONANP and ACMT officers	*Pampa Honda* and *El Castaño*	21/5/15
Fieldtrip to *Unión Santa Isabel* cooperative with an ACMT officer	*Santa Isabel*	22/5/15
Fieldtrip to fishing communities with CONANP officers	*La Lup*e	23/5/15
Assembly of *La Palma* fishing cooperative	*La Palma*	6/6/15
Meeting of the technical-scientific committee	*Tonalá*	9/6/15
Monitoring trip with ACMT and fishers of *Participación Estatal Tapachula*	*La Palma* and open waters	26/6/15
Live in the community of *La Palma* (17 days)	*La Palma*	23/7 – 9/8/15
Live in the community of *El Castaño* (18 days)	*El Castaño*	10 – 28/8/15
Weekly meeting of *Luchadores del Castaño* cooperative	*El Castaño*	13/8/15
Fishing trip with a family of *El Castaño*	*El Castaño*	27/8/15

Figure 3.15 Field trip with CONANP officers

Figure 3.16 Fishing trip with a family of *El Castaño*

3.2.3. Semi-structured interviews

Semi-structured interviews are two-way conversations based on an interview guide in which the order of the points is not fixed and follow-up questions aim to prompt the conversation (Newing *et al.*, 2011). They provide in-depth information on the interviewee's views, perspectives and motivations (ibid).

I did 75 interviews with organisations (27) and fishers (48) involved in LEBR co-management following two lists of open-ended questions to get information of the variables of interest, such as their involvement in co-management and knowledge and compliance of fishing norms, respectively. I also did 20 interviews with other community actors, such as fishers not affiliated with the fishing cooperatives to understand their compliance with fishing norms, and intermediaries to get information about their knowledge and acceptance of co-management.

To introduce myself when I made interview appointments in advance, I followed a template to present myself and the topics to be covered in the interview, which can be found in Appendix 1. Appendix 2 presents the two interview guides, respectively, I followed with the representatives of the organizations involved in co-management and with the fishers of *La Palma* and *Luchadores*. I decided on the go what questions I would ask to encourage the flow of the conversation and the comfortability of the interviewee. Also, when I had enough information on one variable from other participants, I prioritized questions about other variables. For instance, this happened when asking about the main challenges of the fishing activity, I got a similar answer from every fisher, so I focused more on other aspects, such as the functioning of the fishing cooperative.

3.2.4. Focus groups

A focus group is a kind of semi-structured interview in which a group of people meet in an informal setting to discuss about a topic that has been set by the researcher (Longhurst, 2010). It involves a group interview that may be based on an interview guide or include group exercises to prompt discussion (Newing *et al.*, 2011).

I did three focus groups during my second fieldwork: two with leaders and members of *La Palma* (see Figure 3.17) and *Luchadores* (see Figure 3.18) with the aim of knowing the story of the cooperative and understanding their relationship with the government agencies with responsibilities for the fishery; and one with officers of CONANP and ACMT (see Figure 3.19)

aiming to know the story of the co-management initiative and the involvement of participant organizations (Appendix 3). Participants in the focus group should include a group of similar people that will interact easily (Newing *et al.*, 2011). In the cooperatives, I asked the leaders to attend the focus group with other fishers who were trusted by such authorities. In the CONANP offices I asked the participation of all CONANP officers who were or had been involved in the co-management initiative in LEBR. Since ACMT officers were also based in the CONANP offices, I also asked them to join the focus group. Between three and six participants attended each focus group and all lasted around two hours. Appendix 3 displays the diagrams resulting of the two exercises in each focus group with some pictures.

Figure 3.17 Focus group in *La Palma*

Figure 3.18 Focus group in *Luchadores del Castaño*

Figure 3.19 Focus group in the CONANP office

3.2.5. Diagrammatic interviews

Diagrammatic interviews are a type of structured interviews, which are defined as those using a fixed wording or other stimuli presented in the same way to all interviewees (Newing *et al.*, 2011). The limits on the interviewee's answers imposed by the researcher facilitate codification or categorization of the answers and enable the production of materials for analysis (Albuquerque, Farias Paiva de Lucena and Machado de Freitas Lins Neto, 2014). They aim to understand how people think about and define their world by uncovering local knowledge, its structure and variations (Newing *et al.*, 2011). Specifically, diagrammatic interviews consist of asking participants to draw a diagrammatic representation of their mental models using pictures, words, symbols, or a predefined set of concepts or cards, and arrange them into a representation (Jones *et al.*, 2011b).

In chapter 6 I use diagrammatic interviews (Figure 3.20) to directly elicit the interviewees' mental models. To avoid any bias produced by a predefined set of concepts or images, I asked participants to provide the names of the concepts that configured the co-management system in LEBR and described the relationships among them. As with other structured interview techniques, diagrammatic representations of mental models are often analysed using consensus analysis or content analysis to explore the degree of overlapping among representations. I analysed the similarities and differences of the elicited mental models through qualitative content analysis.

Figure 3.20 Diagrammatic interview

3.3. Ethical considerations

Any research endeavour requires due awareness of moral obligations at work (e.g., sponsors, employers and academic institutions), research (e.g., research community and academic profession), personal arenas (e.g., family, friends and oneself), and responsibility towards the world at large (Newing *et al.*, 2011). I always tried to take this into account during all phases of my research. However, balancing my family and research objectives has not always been compatible with accomplishing the research and personal expectations of my supervisors and family, although I always had their unconditional support. In other words, I had troubles harmonising family and research life (I develop this aspect of my PhD journey in the next section).

Additionally, research involving human beings requires special attention to the host community and organizations involved. At the community level, the researcher has responsibilities towards the community in which the research is being carried out, specific groups within that community (e.g., age groups, women, men and minorities), gatekeepers (i.e. people responsible for issuing permissions and guaranteeing the good will of the researcher) and individual informants (Newing

et al., 2011). In what follows, I describe how I did my best to behave responsibly towards the people and organizations that participated in my research.

To procure prior informed consent from the representatives of the researched groups to be interviewed. I presented myself, explained my research, including goals and expected outcomes, and asked for oral consent to undergo the research to: 1) the director of LEBR and the project leader of the co-management initiative (both CONANP officers); 2) the leaders of the eight fishing cooperatives participating in co-management; and 3) the leaders of the two selected cooperatives, i.e. *La Palma* and *Luchadores*. Before conducting each interview, I presented myself and the research. I asked permission to record the interview and I explained why this was helpful for me although not indispensable, as I could also take notes. I was never asked to take notes instead of recording. However, some interviewees requested me to turn off the recorder when they were about to talk about sensitive issues, which I respected. Finally, I informed the interviewee that their name and personal data were only for my records and that they would not appear in any public document (see Appendix 1).

During research design, fieldwork, data analysis and writing, I acted to guard against predictably harmful effects towards people and organizations. During fieldwork, I tried to make my presence in the co-management activities and communities as comfortable for the people involved as possible. I always respected local customs, behaved nicely and tried to create a relaxed and fun atmosphere. Also, I made clear, as often as needed, that my presence and interviews did not aim to judge their performance but to learn from their achievements. In this sense, and to avoid fishers answering and behaving as CONANP officers expected, I had to make clear several times that I did not work for CONANP and I did not have the same interests and goals that CONANP did.

During the writing phase, I avoided any references to names of individuals and I also avoided that the data provided by interviewees could be identified as particular individuals. Only when citing interviewees' quotes in chapter 5 I give details of the interviewee's position and organization (e.g. the delegate of X organization) in a way that a reader knowing the case study in detail could identify the person. In this case, I avoided anonymising further the informants because the information about their position and organization was important to contextualize the quotes and because I do not expect that the chosen quotes can have any harmful effect towards them.

During the writing phase, I also considered whether I should or should not mention the name of the two fishing cooperatives (i.e., *La Palma* and *Luchadores*). I decided to include their names for

several reasons. First, I was always clear to fishers about my aims to use the two cooperatives as examples in my research and they accepted and welcomed it. Therefore, anonymising their names could be disappointing to them. Second, I believe the results shown in chapters 5 and 6 can benefit them. On the one hand, the research reveals that fishers of *Luchadores* are successfully engaging with the co-management scheme and, consequently, they are getting more benefits than other cooperatives. I believe that this is a deserved appreciation and can be inspiring for other fishing cooperatives in the area. On the other hand, the research highlights the main obstacle faced by *La Palma* to achieve further co-management outcomes, namely, the use of the illegal stow net by the wealthiest fishers and the economic inequalities it entrenches. *La Palma* fishers are well aware of this and this research can only give them more arguments to change such a practice.

Besides trying to do no harm to the organizations and individuals involved in co-management, I also intended, when possible, to do some good, following the principle of beneficence (Newing *et al.*, 2011). CONANP officers and fishers' leaders greatly welcomed the expectation that my research would enhance the outreach and recognition of the co-management scheme at both national and international levels. They liked the idea that the research would encourage and inform similar processes at other places worldwide, as they had learned from other initiatives in the past. Finally, they also appreciated that my research could benefit and strengthen the co-management initiative in LEBR by suggesting ways to improve it.

I committed to send copies of the dissertation to CONANP and the two fishing cooperatives, with abstracts in Spanish. I also told them that I would try to visit them after the completion of the research to explain them the results, if I could obtain economic support. Although I will send them the three copies of the dissertation, I am now very pessimistic about the possibilities of travelling to the research area and presenting the results to participants. I am aware that this will undermine the possibilities that the results of this research can reach them, specially the fishing cooperatives, since they will probably have more difficulties to understand an English-written scientific text.

3.4. Reflexivity

> "Reflexivity: the fact of someone being able to examine his or her own feelings, reactions, and motives (= reasons for acting) and how these influence what he or she does or thinks in a situation." (Online Cambridge Dictionary)

In this final section, I elaborate on several characteristics of my own research, as well as familiar and emotional aspects, which have influenced the development of my PhD. The first two aspects are related with characteristics of the research activity, i.e. not being involved in a broader project and dealing with frustration. The third aspect, i.e. doing fieldwork in south-east Mexico, has more to do with emotional aspects, whereas the fourth aspect, i.e. having a baby, has a lot to do with balancing family and professional life as a woman.

I would like to start by mentioning that my project came a little bit out of the blue for my supervisors. While I was doing a Masters programme on social-ecological resilience and sustainable development in Sweden, I came across the existence of the Laboratory for the Analysis of Social-Ecological Systems in a Global World (Laseg group, that did not have this name at that time), led by Victoria Reyes-García and Esteve Corbera in the Universitat Autònoma de Barcelona. After finishing my Masters, I contacted Esteve Corbera and Isabel Ruiz-Mallén attracted by the overall research in Laseg and the COMBIOSERVE (Community-based Management Strategies for Biocultural Diversity Conservation) project in particular. They encouraged me to apply for the pre-doctoral grants offered by the Catalan government's research agency (*Agència de Gestió d'Ajuts Universitaris de Recerca*), which I finally got. In March 2014, I started my doctoral project outside any broader research project, and as such, I faced both challenges and incentives. For example, I lacked a well-established theoretical framework grounding my research and I had to build and negotiate it with my supervisors. I also lacked complementary funding that could potentially cover fieldwork expenses or attendance to conferences. Despite this, I am grateful to my supervisors who supported me economically when they could cover it with their own research funds. Additionally, I lacked a group of researchers interested in similar topics since no other Laseg member was working on sustainable fisheries. Nevertheless, this sort of autonomy gave me the opportunity to lead all the stages of my research and learn from it: searching and choosing the case study, making contacts in the field, building the theoretical framework and leading the articles.

Second, dealing with frustration has been a key aspect and main life learning of the PhD process. Throughout the PhD, I felt that the accomplishment of objectives took much longer than expected,

and that I could not meet my own set deadlines. For example, I was not used to having to re-write the same chapter several times, sometimes completely. I started the PhD with the firm belief that I should finish in the three years covered by my grant and take advantage of unemployment benefits for preparing my next professional step. By the end of my first year, as I realized that I was not going to be able to accomplish such a timeline, I had a personal crisis that made me question the direction of my research and even the option to drop out of the PhD. The support of my supervisors and family, as well as my kind of obstinacy to follow through on my decisions, made me stay with the PhD. Now, I am still not sure whether it was worth the effort (my own and of my relatives and supervisors'). However, as I am approaching the thesis handing deadline and I start visualizing the result of the 5 years, I am starting to feel a great sensation of happiness and reward.

Third, doing fieldwork in south-east Mexico also entailed some personal challenges. To explain them, I differentiate between doing fieldwork in south-east Mexico in general and doing fieldwork in the communities. The announcement of my fieldwork area to my relatives was received with some concern. They, and myself, had witnessed violent incidents in the news and, indeed, during my first fieldwork trip in Mexico occurred the killing of the 43 students of Ayotzinapa, in the region of *Guerrero*. Also, when I was in the *Soconusco* area (the coastal pacific region of Chiapas bordering with Guatemala where the LEBR is located), I noticed that it concentrated on the trafficking of people and drugs from South America to the USA, which I could eventually witness. Still, I dared to backpack alone, avoiding the most expensive travel and accommodation facilities, which sometimes led me to very uncomfortable situations. Now, I realized I underwent unnecessary risks which could have been avoided with some more caution from myself, being accompanied by trusted locals and having some more economic support. I, however, acknowledge the assistance from the local NGO Pronatura Sur and the two officers who allowed me to go with them in two of their visits to LEBR, during my preliminary fieldwork. I also had the guidance of one of my supervisors, Rocio Rodiles from ECOSUR, during my first visits alone to the region.

I spent about one month in the communities, first in *La Palma* and then in *El Castaño*. 'Parachuting' myself into *La Palma* community was an emotional effort as a European 'young' female researcher. My previous fears and reticence were somatised the days before travelling suffering a traveller's diarrhoea. The path towards feeling comfortable in the community involved getting used to the suffocating humid heat and the countless mosquitos. I also got used to the lush micro fauna, including my ever-feared cockroaches (and their rampant wild relatives). However, the most crippling fear I had to overcome were my fears towards potential physical and sexual aggressions,

in an area beyond mobile communication networks. After some days living in *La Palma*, though, I understood that social norms in such a small and isolated community were strong enough to prevent anyone behaving in a shameful way towards me. In this sense, I found key support with the daughter of the woman who cooked for me. Juany Ovalles was living in Mexico D.F. but at the time of my fieldwork she and her son were spending some time with her family. Thanks to her life in the city, I felt more culturally close to her. She opened up the door to me to the culture and lifestyle of the inhabitants in *La Palma* and *El Castaño*, which I missed very much when I left.

Finally, I acknowledge that being pregnant and rearing my first child and the pregnancy of my second child towards the end of my PhD has affected my progress in several ways. First, I suffered physical problems during the two pregnancies such as nausea and disgust towards food, low blood pressure and energy, and lower back pains, including sciatica. The latter affected my night rest, which I did not recover until two years after delivering, when I weaned my child. The pace of my work was lowered by these physical problems and by the responsibility I assumed to have the main role of childcaring. This was, in turn, affected by contextual circumstances. I, like most mothers in Spain and elsewhere, suffered from a social convention that expects mothers to carry the leading role in child raising and housework. Second, my low contribution to the family economy, especially since my grant finished, reinforced my role as being the main person responsible for looking after the house and child. Also, I lacked a social network to share some of these responsibilities because of my decision of moving to Gran Canaria (away from ICTA-UAB and my social roots) for family reasons in 2014 and because my parents were still active workers. However, I am grateful to my parents, who have often travelled to my hometown and supported me in several ways, especially after the birth of my child and during the last weeks of the PhD. I also acknowledge the support of my mother-in-law during the first months of motherhood.

A consequence of maternity was the prolongation of the PhD which, in turn, exacerbated my frustration with being unable to progress at the desired speed, translated into a lack of accomplishment of objectives towards supervisors, and made me financially vulnerable. Other consequences were reduced travelling to the ICTA-UAB, my home research institution, and the inability to attend conferences away from Spain for two years after delivering. However, I acknowledge that doing a PhD in such conditions, and balancing it with maternity, was my personal choice and responsibility, and that I do not regret it. Also, I owe gratitude to my family and supervisors for their support and the inconveniences I caused. Finally, I want to mention that discovering the people, culture and natural values of Chiapas and LEBR has been a gratifying

journey. It entailed many great experiences that I will carry with me wherever I go for my entire life.

4. Global overview of small-scale fisheries

"Emphasizing the potential of co-management to foster the sustainability of small-scale fisheries."

In:

d'Armengol, L., M. Prieto Castillo, I. Ruiz-Mallén and E. Corbera. 2018. A systematic review of co-managed small-scale fisheries: Social diversity and adaptive management improve outcomes. *Global Environmental Change* 52:212–225. https://doi.org/10.1016/j.gloenvcha.2018.07.009

4.1. Abstract

Small-scale fisheries are an important source of livelihoods, particularly among poor coastal populations. To improve fisheries' condition and maximize their contribution to human welfare, co-management approaches have proliferated worldwide. In this article, we conduct a systematic review of academic literature to examine the context and attributes of co-management initiatives in small-scale fisheries, and their expected outcomes. The review suggests that a supporting legal and institutional framework facilitates the emergence of co-management, because it contributes to clarify and legitimize property rights over fish resources. It is also found that co-management delivers both ecological and social benefits: it increases the abundance and habitat of species, fish catches, actors' participation, and the fishery's adaptive capacity, as well as it induces processes of social learning. Furthermore, co-management is more effective if artisanal fishers and diverse stakeholders become involved through an adaptive institutional framework. However, the review also suggests that more research is needed to discern when co-management initiatives can transform pre-existing conflicts, challenge power asymmetries and distribute benefits more equitably.

Key words: Adaptive co-management; collaborative management; small-scale fisheries; ecological outcomes; social benefits

4.2. Introduction

Small-scale fisheries support the livelihoods of many coastal communities around the world (Kittinger *et al.*, 2013). Ninety percent of the world's fishers are directly involved in small-scale fishing, i.e. about 34 million people, and another 100 million are involved in related activities (Béné, Macfayden and Allison, 2007; FAO, 2016b, 2016a). However, these fisheries face growing threats such as overfishing, competition with industrial fleets, water pollution, destruction of fish habitats, and an increasing human population and demand for land in coastal areas (FAO, 2016a). Increasing fishing pressure is leading to a reduction of marine biodiversity, which will over time make fisheries less resilient in a changing global climate (Brander, 2007). These threats are coupled with a limited capacity of many governments to develop and support management models that suit the multispecies character of small-scale fisheries and the numerous and dispersed landing sites characterizing them (Allison, 2001; Kolding, Béné and Bavinck, 2014).

The co-management of small-scale fisheries has emerged as a response to these threats and challenges, proliferating worldwide over the last decade (FAO, 2016a). Co-management promotes the joint management of the fisheries' resources by direct users, governments and other actors (Armitage, Berkes and Doubleday, 2007b; Berkes, 2009). It is regarded as a participatory management model able to foster the sustainability of fisheries in biological, social, and economic terms (Jentoft, 1989; Pinkerton, 1989; Costanza *et al.*, 1998; Muñoz-Erickson *et al.*, 2010; Gutiérrez, Hilborn and Defeo, 2011). Co-management can contribute to meet both fisheries and conservation objectives in marine ecosystems (Worm *et al.*, 2009). It has also been shown that co-management can deliver greater benefits to local communities in both terrestrial and marine protected areas because, by strengthening tenure rights and decision-making processes, it can result in increased and more equitably shared economic benefits (Oldekop *et al.*, 2016).

A previous review of industrial and artisanal fisheries (Gutiérrez, Hilborn and Defeo, 2011) identifies a number of co-management attributes that are conducive to positive outcomes, including the presence of community leaders, strong social cohesion, individual or community fish quotas, and community-based protected areas. A meta-analysis focused on small-scale fisheries (Evans, Cherrett and Pemsl, 2011) demonstrates that co-management results in positive impacts on fishers' income and other sources of material wellbeing, as well as on the fishery's ecological condition. The study also shows that co-management improves social participation, compliance with the fishery's management rules, and local control over resources while reducing conflict. These findings echo others who previously argued that co-managed fisheries enhanced social

equality (Loucks, Wilson and Ginter, 2003), resulted in more legitimate norms that better fit local conditions (Jentoft, 1989), fostered responsibility among resource users (Nielsen and Vedsmand, 1999), and reduced management costs (Carlsson and Berkes, 2005).

Further, in a context of climatic changes related to sea level rise, ocean temperature change and ocean acidification, which might modify coastal ecosystems and fish species' range and behaviours (Wong *et al.*, 2014; Savo, Morton and Lepofsky, 2017), the adoption of adaptive management principles can be critical for the sustainability of small-scale fisheries in the near future. Flexible, innovative and experimental management practices could in this context strengthen co-management initiatives and improve the capacity of the social-ecological system to better cope with uncertainty and surprise (Olsson, Folke and Berkes, 2004; Armitage, Berkes and Doubleday, 2007a).

Our systematic review builds on and contributes to co-management literature by examining the links between context, attributes and outcomes of co-managed small-scale fisheries through the lens of Ostrom's framework for the analysis of social-ecological systems (Ostrom, 2007, 2009; Mcginnis and Ostrom, 2014), which we complement with other indicators from adaptation and co-management literature (Plummer and Armitage, 2007a; Plummer and FitzGibbon, 2007; Gutiérrez, Hilborn and Defeo, 2011; Cinner *et al.*, 2012; Plummer *et al.*, 2012, 2014; Basurto, Gelcich and Ostrom, 2013; Ernst *et al.*, 2013; Partelow, 2015). To our knowledge, this is the first review of co-managed small-scale fisheries that includes adaptive management attributes to test how such attributes affect outcomes. Specifically, we ask: Which are the context and attributes of co-managed small-scale fisheries? Which outcomes does the co-management of small-scale fisheries result in? And, how are the context and attributes influencing co-management outcomes? By answering these questions, we contribute to a better understanding of how co-managed small-scale fisheries work as complex social-ecological systems while suggesting ways to improve their performance.

In what follows we introduce the analytical framework, explain the systematic review's protocol, and present our results organized according to our three questions. We first characterise the context and attributes of co-management, and we find that co-management usually develops in contexts of NRM decentralization, where co-management contributes to move away from an open access condition and it supports the creation of a new property regime and more legitimate management rules. Second, we show that co-management results in positive social and ecological outcomes overall, while its ability to resolve pre-existing conflicts, address power asymmetries or

distribute benefits more equitably is less certain because these issues are scarcely reported in the literature reviewed. Finally, when looking at which context and attribute variables might be influencing co-management effects, we find that involving a diversity of actors and implementing adaptive management practices contribute to more positive outcomes. We discuss these and other findings in the light of relevant literature and we conclude by emphasizing the potential of co-management to foster the sustainability of small-scale fisheries and highlighting research gaps.

4.3. Analytical framework and methods

4.3.1. Analysing co-management outcomes in small-scale fisheries

Ostrom's framework for the analysis of the sustainability of social-ecological systems (Ostrom, 2007, 2009; Mcginnis and Ostrom, 2014) provides a coherent and robust set of variables to analyse how attributes of a resource system, the resource units, the users, and the governance system affect interactions and resulting outcomes. We adapted the framework to better fit the study of small-scale fisheries co-management, following previous related research (Gutiérrez, Hilborn and Defeo, 2011; Cinner *et al.*, 2012; Basurto, Gelcich and Ostrom, 2013; Ernst *et al.*, 2013; Partelow, 2015) and including indicators from literature on the adaptive management of social-ecological systems (Plummer and Armitage, 2007a; Plummer and FitzGibbon, 2007; Plummer *et al.*, 2012, 2014; Thiel, Adamseged and Baake, 2015).

The resulting analytical framework contains: 1) basic information; 2) context; 3) co-management attributes; and 4) outcomes (Figure 4.1). Basic information includes key geographical and ecological descriptors of the fishery, while context variables refer to the *resource system*, *resource unit*, *governance system* and *users*. Co-management attributes are split across five categories (including Ostrom's *interactions* variables): *co-management features*, *interactions and decision making*, *participation*, *networks*, and *adaptive management*. Finally, outcomes encompass another four groupings: *ecological*, *process*, *socio-economic* and *generic outcomes*, each containing some self-added variables specific to small-scale fisheries' co-management. We have excluded from our analysis the two sets of variables from Ostrom's framework that refer to *related ecosystems* and *social, economic, and political settings* since almost none of the articles reviewed included information on their respective variables (e.g., climate trends, economic development or demographic trends, among others).

Basic information

World region | Country | Country region | Community/ies | Cooperative/s | Fishery | Main species

Context

Resource system
- Fishery type[b]
- Clarity of system boundaries
- Area[c]
- Productivity
- Predictability of system dynamic
- Storage capacity[c]
- Fishing cooperatives[d]

Resource unit
- Resource type[b]
- Diversity[d]
- Mobility outside the fishery[c]
- Species group[d]
- Overharvesting[c]
- Fishing at other scales[d]
- Economic value
- Price[c]
- Market[c]
- Spatial heterogeneity[c]

Governance system
- Co-management in law[b]
- Decentralization[d]
- Kind of decentralization[d]
- Previous institutions[c]
- Previous property rights[c]
- Post property rights[a]
- Operational rules
- Monitoring
- Long-term management policy[b]
- Protected areas[b]
- Restocking[b]
- Subsidies[d]
- Subsidies linked to co-management[d]
- Sanctions[a]
- Graduated sanctions[a]

Users
- Group size[d]
- Number of user groups[d]
- Number of users
- Primary livelihood[a]
- Occupational diversity[a]
- Leadership
- Social cohesion[a]
- Conflict among users[d]
- Motivation for conflict[d]
- Shared understanding of the social-ecological system[c]
- Long history of resource use[c]
- Fishing types[c]
- Indigenous users[d]
- Majority of indigenous[d]
- Illegal fishing[d]

Co-management attributes

Co-management features
- Goals[d]
- Changing goals[d]
- Years of co-management[b]
- Stage of co-management[b]
- Success or failure[d]
- Whole fishery[d]

Interactions and decision making
- Regime[d]
- Power-sharing[b]
- Previous collaboration[d]
- Willingness for co-management[d]
- Conflict-resolution mechanisms[d]
- Facilitative leadership[d]

Participation
- Participants' typology[d]
- Socio-economic diversity[d]
- Gender diversity[d]
- Age diversity[d]
- Ethnic diversity[d]
- Knowledge systems diversity[d]
- Diversity of interests[d]

Networks
- Cross-scale interactions[c]
- Knowledge sharing[c]
- Bridging organization[c]
- Bonding organization[c]

Adaptive management[b]
- Adaptive co-management[d]
- Systems orientation[d]
- Interaction[d]
- Integration[d]
- Innovation[d]
- Experimentation[d]
- Reflection[d]
- Flexibility[d]

Outcomes

Ecological outcomes
- Species
- Size[d]
- Abundance[d]
- Diversity[d]
- Functions
- Habitat[d]
- Key ecological processes[d]
- Pollution[d]

Process outcomes
- Participation
- Participation in management[d]
- Participation in problem solving[d]
- Participation in decision making[d]
- Participation in monitoring[d]
- Users involved[d]
- Women involved[d]
- Cooperation[d]
- Compliance[d]
- Legitimacy[d]
- Conflicts[d]
- Actors in conflict
- Kind of conflict
- Networks
- Existence of networks[d]
- Extended networks[d]
- Local fit
- Local knowledge[d]
- Local norms[d]
- Local conditions[d]
- Power asymmetries[d]
- Individual learning
- Skills and knowledge[d]
- Information[d]
- Individual knowledge on dynamics[d]
- Individual knowledge on rules[d]
- Social learning
- Collective knowledge on dynamics[d]
- Collective knowledge on rules[d]
- Shared values[d]
- Shared understanding[d]
- Social norms[d]
- Policies[d]
- Governing norms[d]

Socio-economic outcomes
- Catches
- Fishery catches[d]
- Collective catches[d]
- Individual catches[d]
- Income
- Fishery income[d]
- Collective income[d]
- Individual income[d]
- Equity
- Resources distribution[c]
- Income distribution[c]
- Transaction costs[d]
- Infrastructure
- Individual fishing equipment[d]
- Collective fishing equipment[d]
- Other fishing infrastructure[d]
- Other infrastructure[d]

Generic outcomes
- Wellbeing[d]
- Vulnerability[d]
- Adaptive capacity[d]

Figure 4.1 A framework for the analysis of co-management in small-scale fisheries. Each of the four variable domains includes variables and may also include categories (in bold). In the outcomes' domain, underlined words with variables underneath refer to variable groupings. Variables without superscript specify variables from Ostrom's framework (Ostrom, 2007, 2009), superscript a specifies variables adapted from Ostrom's framework by other authors, superscript b specifies variables included in other works (Gutiérrez, Hilborn and Defeo, 2011; Basurto, Gelcich and Ostrom, 2013; Ernst *et al.*, 2013; MacNeil and Cinner, 2013), superscript c specifies variables adapted from Ostrom's framework, and superscript d specifies our own proposed variables.

We defined most *context* and *co-management attributes* as categorical variables, deserving either a 'yes/no' or a closed list of given responses during the review process, whereas a few others were numerical variables (e.g. area of the system, number of users). *Outcomes* variables were also considered categorical, most including three possible answers, i.e. '*same*, *increased*, and *decreased*' or '*no*, *positive*, and *negative*', and a few with a '*yes*/*no'* option. The description of each variable and its possible values are provided in Appendix 4 (Table A.4.1).

4.3.2. Data sources

We grounded this article on well-established guidelines for the development of systematic literature reviews (Petticrew and Roberts, 2006; Collaboration for Environmental Evidence, 2013). To identify relevant research articles and book chapters to be included in the review, we conducted a keyword-informed search in Scopus and Web of Knowledge using the following strings: 1) For Scopus: TITLE-ABS-KEY (co-management OR comanagement OR "collaborative management") AND ALL ("small scale fish*" OR "local fish*" OR "traditional fish*" OR "artisanal fish*" OR "subsistence fish*") AND ALL ("natural resourc*" OR biodiversity OR conservation OR ecosystem OR environment), and 2) for Web of Knowledge: TOPIC: (comanagement OR co-management OR "collaborative management") AND TOPIC: ("Small-scale fish*" OR "local fish*" OR "traditional fish*" OR "artisanal fish*" OR "subsistence fish*") AND TOPIC: ("natural resourc*" OR biodiversity OR conservation OR ecosystem OR environment). These searches targeted all articles and book chapters published until December 2015 (Figure A.4.1 in Appendix 4). This rendered 544 publications in Scopus and 186 in Web of Knowledge. After bringing them together and eliminating duplicate entries, our dataset encompassed 626 articles and book chapters.

The two first authors screened the abstract of all manuscripts and, when necessary, the full text based on four inclusion criteria: 1) the focus of the case study was a small-scale fishery; 2) the fishery was co-managed, i.e. governed by at least local users and a government actor; 3) the study described a change in at least one variable within the four dimensions of outcomes considered by our analytical framework, i.e. ecological, process, socio-economic, and generic; and 4) the study was empirical and based on first-hand collected data (Figure A.4.2 in Appendix 4 for more information on the criteria appraisal process). As a result of this screening process, 556 out of the 626 manuscripts were discarded and our dataset was reduced to 70 articles.

4.3.3. Data collection and analysis

The 70 articles were split among the co-authors and the data collected was organized in a shared Excel file, in which each row had the information of one case study, since one article could include more than one case study. The first two columns indicated the article number and reference, i.e. author(s) and year, and the following columns were devoted one to each variable, starting with the variables of *basic information*, and followed by the categories *resource system*, *resource unit*, *governance system*, *users*, *co-management features, interactions and decision-making, participation, networks*, *adaptive management*, *ecological outcomes¸ process outcomes, socio-economic outcomes*, and *generic outcomes*. For each outcome category described in the reviewed articles, we also recorded information on the assessment methods.

To ensure consistency in data collection, the first two authors reviewed five randomly selected articles separately. The inconsistencies between the two authors were discussed among all authors and consensus was reached on how to document and code each variable. During data extraction, three articles were discarded because they included repeated case studies that were better described in other articles. The final dataset for the analysis included 67 articles, which in turn referred to 91 case studies (Table A.4.2 in Appendix 4).

Data analysis included three steps. First, categorical variables were quantified, when possible, by assigning to each response a numeric value. Second, we generated absolute frequencies and percentages for each variable. Third, we employed pairwise Fisher exact tests to test associations between co-management context and attributes (independent variables), and outcomes (dependent variables) (Tables A.4.3 and A.4.4 in Appendix 4). For those variables that showed significant associations in the Fisher exact tests ($p \leq 0.1$), we conducted multinomial logistic regressions to examine their individual and aggregated effects on each outcome variable.

To complement the analysis, we created variable groupings. Within *co-management attributes,* we created a group of variables called '*adaptive management*' by integrating the variables *adaptive co-management*, *systems orientation*, *interaction*, *integration*, *innovation¸ experimentation*, *reflection* and *flexibility*. This group was meant to test whether one or more variables of adaptive management had any effects on *outcomes*. In turn, within the *outcomes* dimension, we created several variable groupings at three levels: 1) a set of 11 groups (see underlined text in Figure 4.1) that gathered related variables, 2) four groups that gathered the variables of the four *outcomes* categories, and 3) one broad group of all *outcomes*.

The creation of these variable groupings was aimed at testing whether *context* and *co-management attributes* had any effects on these groupings. For instance, the grouping '*species*' was the result of bringing together the variables *size*, *abundance* and *diversity*, being *species* equal to 1 (improves) if at least one of the variables in this group improved and none of them worsened; equal to -1 (worsens) if at least one of these variables worsened and none improved; and equal to 0 (neutral) if at least one variable did not change and none improved or worsened or one worsened whereas another improved. The grouping '*ecological outcomes*' included the groups *species* and *functions*, being *ecological outcomes* equal to 1 if one group improved and the other one did not worsen; equal to -1 if one group worsened and the other one did not improve; and equal to 0 if one of the groups did not change whereas the other did not improve nor worsened or one group worsened whereas the other improved. Likewise, the grouping '*outcomes*' included the four dimensions groups: *ecological*, *process*, *socio-economic* and *generic outcomes*. None of the multinomial logistic regressions with more than one independent variables yielded significant results because of the low number of reported variables in many case studies.

4.4. Results

4.4.1. Basic information and context

The 91 cases of our dataset spread across 37 countries, mostly around the Pacific (Table A.4.5 in Appendix 4). Chile and Fiji have nine and eight cases, respectively, while the Solomon Islands, USA and Brazil have six case studies each and the Philippines, five (Figure 4.2).

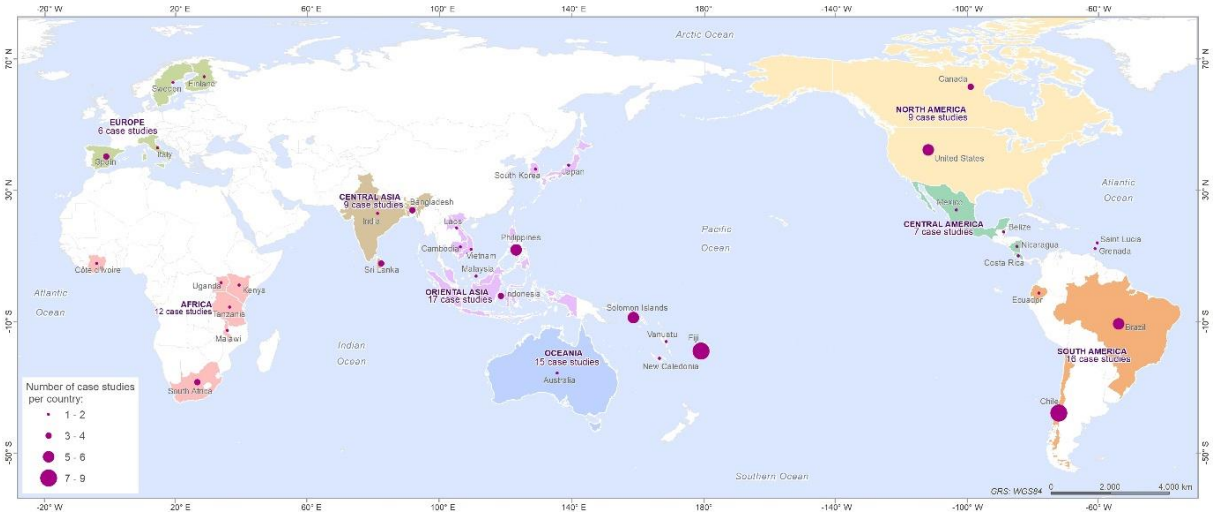

Figure 4.2 Location of the case studies in world's regions. Sources: GADM database of Global Administrative Areas (http://www.gadm.org/) and UN's Standard country or area codes for statistical use (M49) (https://unstats.un.org/unsd/methodology/m49)

Although context variables are not evenly reported across case studies (Figure 4.3 and Figure A.4.3 in Appendix 4 for a comprehensive list of all context variables), the results of the most reported variables provide an overview of the characteristics of the dataset. Variables reported in more than 75% of the cases are *fishery type* (mentioned in 88 cases), *post access rights* (76), *resource type* (73), *operational rules* (72), *co-management in law* (71), *previous access rights* (70), and *previous institutions* (68). Co-management is most reported in fisheries with a multispecies character, as it is shown in 57 cases versus 16 cases where the fishery only targets one species. Co-management is mostly adopted in coastal (61 cases) rather than in inland fisheries (23), whereas off-shore fisheries are rare as they represent only one case. Co-management initiatives target above all shellfish (39) and finfish (34), although a few cases also report resources such as algae, marine mammals or reptiles (11). Co-management seems more likely to crystalize in countries with favourable national legislation (67) and well-defined operational rules (68). However, there are also four cases where co-management has been established without a supporting legal framework and another four cases where operational rules are lacking.

Most cases report the fishery's previous property rights regime (60 out of 91). Before the establishment of co-management, most fisheries were an open access regime (31 cases), or they were managed through territorial use rights (21) and species fishing permits (8). With the embracing of co-management, 35 cases report the implementation of territorial use rights, nine the use of fishing permits for targeted species, and 12 the combination of both territorial use rights

and fishing permits. Among the reviewed cases, one fishery returned to an open access regime after the co-management initiative failed, and seven continued to operate in an open access regime but experienced difficulties to enforce regulations. The reviewed cases indicate that co-management initiatives happen mostly in fisheries that were previously managed by the government (33 cases) or the local community (25), five cases had both governmental and local institutions and five more cases report the absence of previous institutions.

In 50 cases, the authors mention that the co-management initiative has evolved in a context of state-driven NRM decentralization. However, only 35 of these cases describe what kind of decentralization takes place: 20 are inserted in a wider process of resource rights' devolution to local governments; seven are part of ongoing efforts to delegate more resource management powers to local government officers; five represent a transfer of rights to local civil society organizations or private enterprises; and another three consist of transferring management responsibilities to governmental regional and field offices.

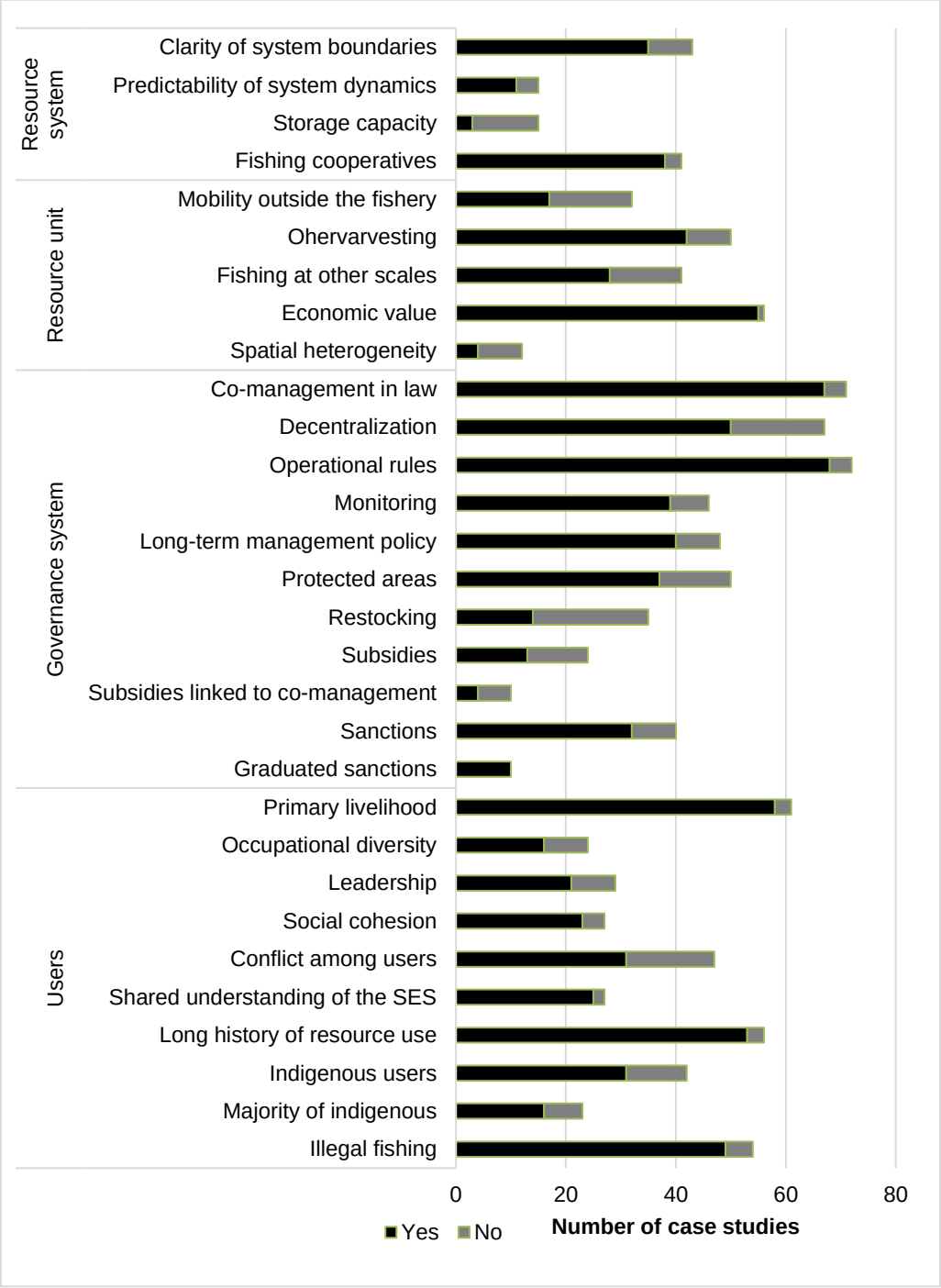

Figure 4.3 Number of cases studies reporting context variables with yes/no answers (Figure A.4.3 in the Appendix 4 for the whole set of context variables).

There are other context variables defining the characteristics of the co-managed small-scale fishery, but these are less frequently reported and should thus be interpreted with caution. For instance, only 33 cases document the area of the fishery, which usually does not reach 1000

km^2 (26 cases), and 35 fisheries have boundaries that are clearly defined by biophysical conditions, such as fisheries in a lake or around an island. In eight cases, these boundaries are not so clear. Thirty-seven case studies explicitly acknowledge that the co-managed fishery overlaps with a marine protected area while another 13 explicitly indicate that they do not overlap with any kind of protected area.

The presence of fishers' cooperatives or unions is stated in 38 out of 41 cases referring to this variable. Only 32 (out of 40) and 39 (out of 46) cases document enforced sanctions and functional monitoring systems, respectively, which is surprising given the need to monitor co-management initiatives as a means to understand their outcomes. The fish resource is overharvested before co-management in 42 of the 50 cases reporting on this variable. In 13 cases, the resource is only harvested in the fishery under study, whereas in 28 it is also fished outside. In our dataset, only one case reports a fishery without local economic value whereas 55 cases report that fish has economic value -beyond subsistence, and other cultural values-, and 14 of these emphasise that fish is traded in regional and/or international markets.

Whenever mentioned, fishing is the primary income source for users in most case studies (58 out of 61 cases), but there are often other sources of income reported (16 out of 24 cases). Artisanal, commercial and subsistence fishing are the most common fishing practices, mentioned in 63, 55, and 53 cases of our dataset, respectively. Industrial and recreational fishing are reported in only 6 and 9 of the 91 cases. The presence of indigenous fishers is explicitly described in 31 cases whereas 11 cases explicitly report their absence.

Fifty-four cases in our dataset make explicit mention to the existence of illegal fishing practices, and only five highlight the absence of such practices before co-management was introduced. Conflict is documented in 31 cases and inexistent in 16 cases. Causes of conflict are varied, but these are mostly caused by contested property rights and/or management rules, or by resource competition and uneven decision-making power. By contrast, although relatively few cases mention social cohesion and trust in existing leaders (27 and 29 cases, respectively), most of these cases report the existence of these variables in the described fisheries (23 and 21 cases, respectively). In this regard, users often share a long history of resource use (53 out of 56 cases) and an understanding of the social-ecological system (25 out of 27 cases).

4.4.2. Co-management attributes

Co-management initiatives usually aim to fulfil between one and four goals. Among the 70 cases reporting goals (77% of the cases reviewed), the most mentioned seek an improvement of the management process of the fishery, namely: *to increase participation in management* (29 cases), *to increase legitimacy and/or compliance with fishing rules* (19), *to define or enforce fishing rights* (19), and *to incorporate customary management norms in formal management* (18). Only one case has the explicit objective of *resolving existing conflicts in resource management*. Ecological, socio-economic and generic goals are much less reported, with 24, 8 and 8 cases, respectively (Table A.4.6 in Appendix 4 for the whole set of objectives). Given the expected adaptive nature of co-management, it is surprising that only 15 cases indicate that goals have changed over the course of the initiative while 21 have maintained the same goals (Figure 4.4).

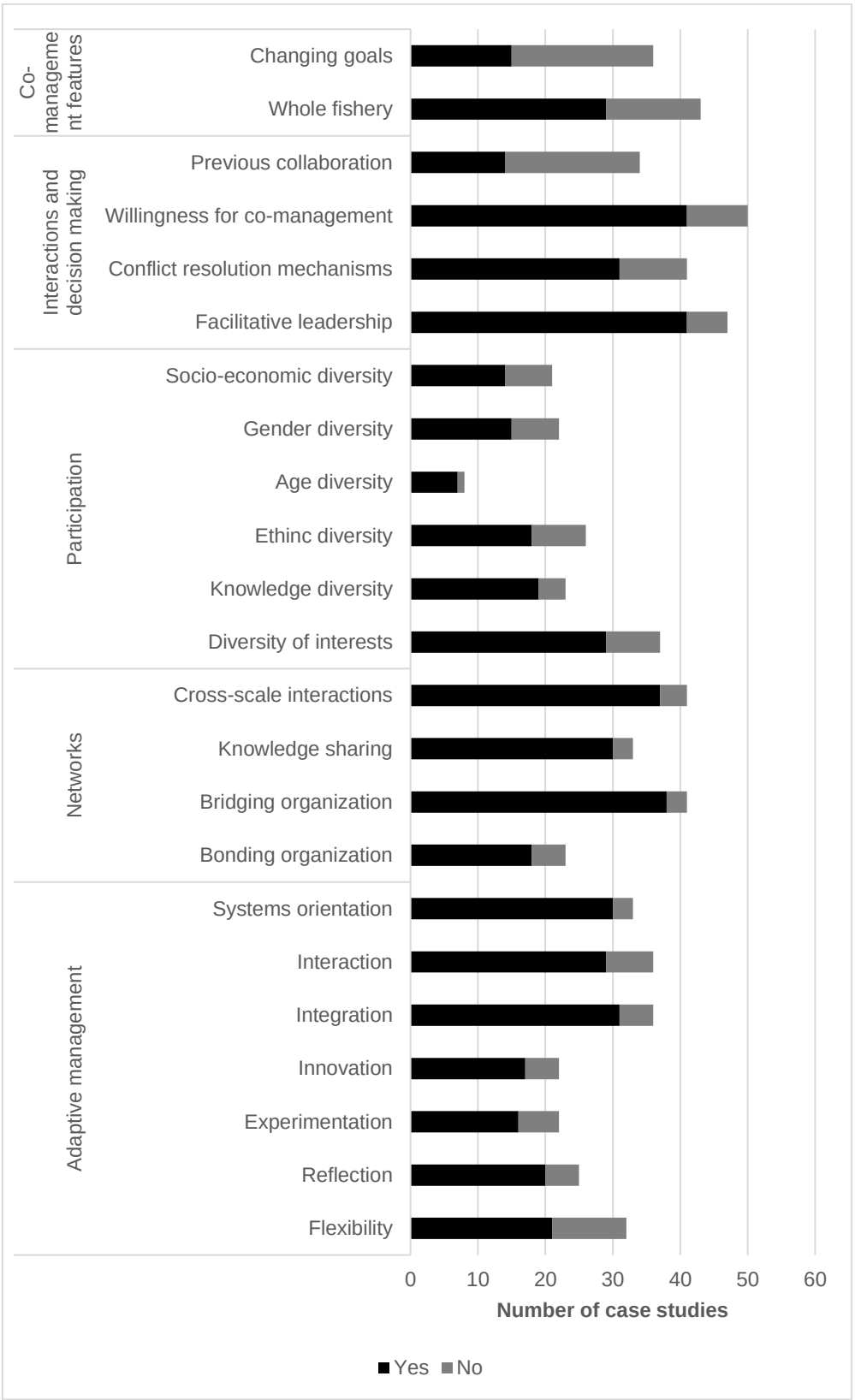

Figure 4.4 Number of cases studies reporting key co-management attributes with yes/no answers (Fig. A.4.4 in Appendix 4 for the whole set of co-management attributes).

The co-management initiatives included in this review have been established relatively recently. Out of the 79 cases reporting their years of existence (87%), 63 have existed for 20 years or less. The oldest documented initiatives are seven cases in Fiji that have been running for 58 years. Some articles document very young initiatives, such as those in St. Lucia, Brazil and the Philippines which had run for two years.

The stage of co-management is reported in 84 cases (92%): 53 state that co-management is well implemented, 22 report initiatives that are still being implemented and 9 describe partnerships that have concluded. Among the latter, five were short-term development projects, another three were not able to continue due to a lack of government's commitment and support, and one could not handle the ecological variability of the fishery, which in turn led to resource depletion after three years of co-management. Half of the co-management partnerships (46 cases) involve only users' representatives and governments, whereas the other half include third party organizations (45), such as NGOs and research centres, which provide expert knowledge (Figure 4.4).

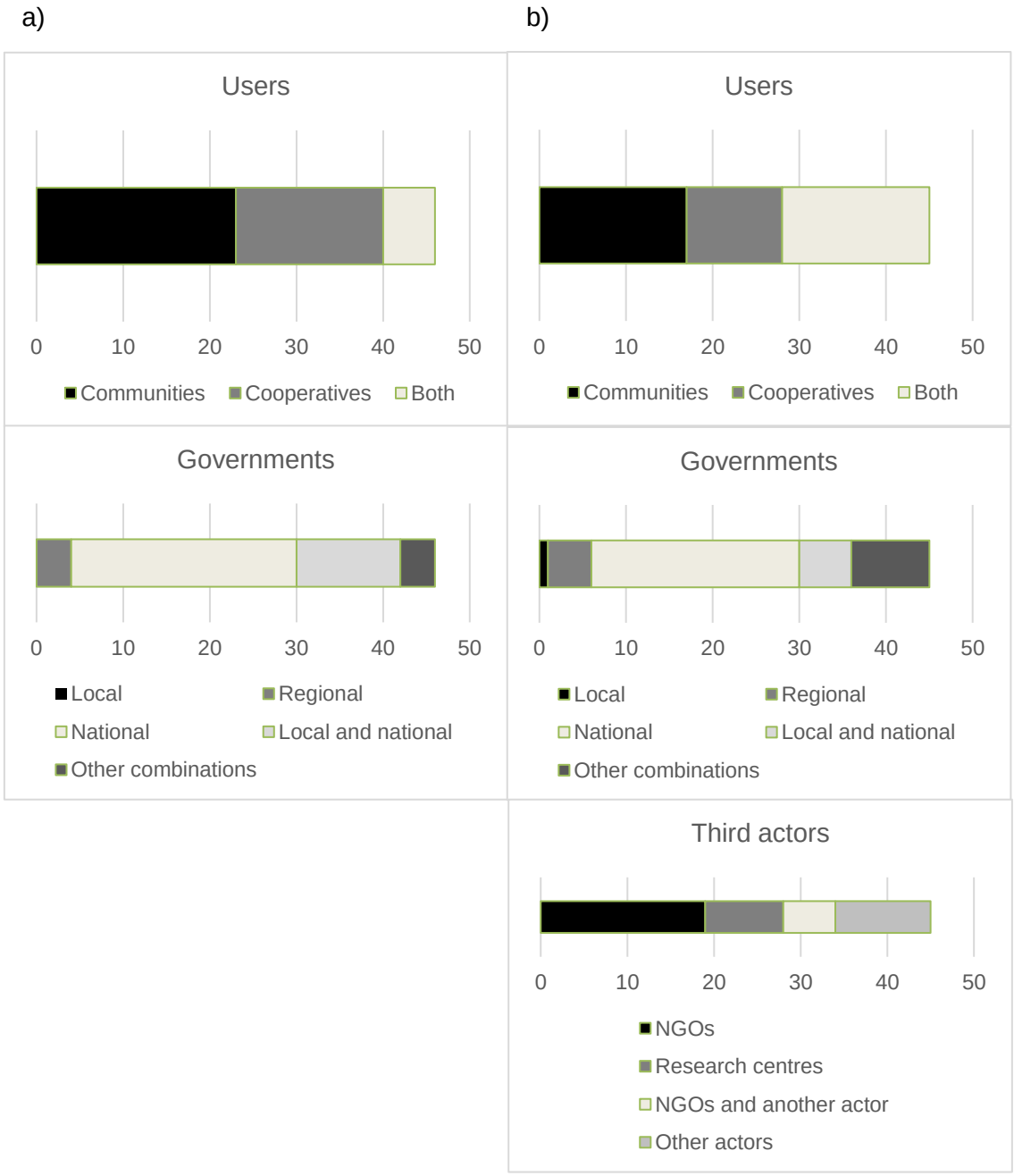

Figure 4.5 Co-management partnerships involving users and governments (a) and involving users, governments, and third actors (b). Numbers on the bottom of the bars indicate number of case studies. *Other combinations* refer to *local and regional* governments, *regional and national* governments, and *local, regional and national* governments. *NGOs and another actor* refers to *NGOs* and an *intergovernmental organization*, a *research centre* or a *company*. *Other actors* refers to *intergovernmental organizations*, *third-country governments*, *multi-stakeholder bodies at regional level*, and *companies*.

Interaction and decision-making attributes are much less reported. The *regime*, or the main actor promoting co-management, is mentioned in 66 cases (73%). Twenty-nine of these have the community as the main promoter, 25 the government, nine an NGO, two a research centre and one a private company. Forty-one cases in our dataset highlight that actors are willing to participate in co-management whereas 9 cases report a lack of incentives for local participation.

The most common power-sharing scheme is *cooperative*, which has been developed in 17 cases where government and users share, in theory at least, equal power. An *advisory* scheme is present in another 16 cases, where users have full decision-making authority and count with governments' endorsement. *Informative*, *consultative*, or *instructive* power-sharing arrangements are described in four, nine and two cases, respectively. Forty-one cases note that there is a lead actor who supports local involvement in co-management, which is considered lacking in another six cases. Finally, conflict-resolution mechanisms are documented in 31 out of 41 cases.

Although a diversity of actors is theoretically important to nurture the co-management partnership with different perspectives, experiences and knowledge systems, this is scarcely reported in our dataset. In this regard, the most documented variable in the *participation* category is the existence of a diversity of interests (37 cases, 41%), while other sources of diversity, such as knowledge, gender and age diversity are reported in only 23, 22, and eight cases, respectively. In the *networks* category, a bridging organization supporting cross-scale interactions, i.e. vertical links across the involved actors, is mentioned in 38 cases and lacking in three cases (reported by 45% of the dataset cases), whereas a bonding organization supporting cohesion among participants, i.e. horizontal links, is described in 18 cases and lacking in five cases (reported by 25% of the dataset cases). Twenty case studies explicitly affirm that government and users had collaborated before co-management was introduced, whereas in 14 cases they had not (reported by 37% of the dataset cases).

Finally, only 14 cases analysed are explicitly characterised as adaptive co-management, but interestingly 59 of the total sample (65%) describe at least one characteristic of adaptive management. These include initiatives with a *systems orientation* approach, i.e. management that recognises and accounts for human-environment complex interactions (reported in 30 out of 33 cases reflecting explicitly on this variable), *integrating* different perspectives, approaches and knowledges (31 out of 36) and facilitating deliberative *interactions* among actors (29 out of 36). Case studies applying *flexible* norms (21 out of 32) and *experimental* management actions (16 out of 22), which are also key characteristics of adaptive co-management, are less often reported.

4.4.3. Outcomes

The reviewed cases show an improvement of all outcome groups: *ecological*, *process*, *socio-economic* and *generic*. However, the number of cases reporting each outcome varies (Figure 4.6 and Figure A.4.5 in Appendix 4 for the whole set of outcome variables). Ecological outcomes improve in 29 of the 40 cases reporting such outcomes (44% of the cases). The most reported ecological outcomes are *abundance* of species (29 cases), which increases in 20 cases, decreases in five and does not change in four, and *habitat* for nesting, breeding and feeding (15 cases), that increases in 10, decreases in three and does not change in two cases.

Process outcomes are the most reported and improved outcomes. They are stated in 88 cases (97%) and have a positive impact in 72. The single most reported outcome is *participation*, mentioned in 71 cases. *Participation* improves in 67 cases, worsens in 1 and remains equal in 3. Participation increases mostly in what concerns decision-making processes, but it also increases in problem-solving forums and monitoring activities. *Social learning* improves in 41 cases, worsens in three and does not change in four. Most improvements of social learning take the form of strengthened agreement on social norms, increased knowledge of the management rules, as well as of expanded shared understanding. Other aspects of social learning, such as changing policies where unsustainable resource management routines might be rooted, questioning governing norms that might contravene co-management objectives, or improving the ecological knowledge of the fishery across all participant actors, are less reported. *Local fit*, i.e. the congruence of management norms with local knowledge, norms and conditions, increases in 39 cases, decreases in two and remains equal in six. Improvements mostly happen in the form of increased alignment of management practices with local ecological conditions, followed by improved correspondence with local knowledge and with local norms. Finally, 34 cases highlight that *compliance* has increased with co-management, four mention a decrease and 10 describe no changes.

Socio-economic outcomes are less reported and show the least positive results, only improving in 23 of the 39 cases referring to these outcomes (43% of the dataset cases). The most reported outcome is *catches* (24 cases) either at a fishery, community, cooperative or individual level. After the implementation of co-management, catches increase in 16 cases where this issue is reported, decrease in six and do not change in two. Impacts on *income* are reported in 17 cases, of which income increases in 14 and decreases in three of these.

Finally, generic outcomes are the least reported, with only 34 cases making explicit reference to any of such outcomes (37% of the dataset cases). *Adaptive capacity* is the most reported (22 cases), and it is reported to increase in 16 of these cases and to decrease in 6. *Wellbeing* (16 cases) is reported to increase in 14 of these cases and does not change in two. Finally, v*ulnerability* (7 cases) is reported to increase in 5 of these cases, to decrease in one and to remain the same in one of the cases.

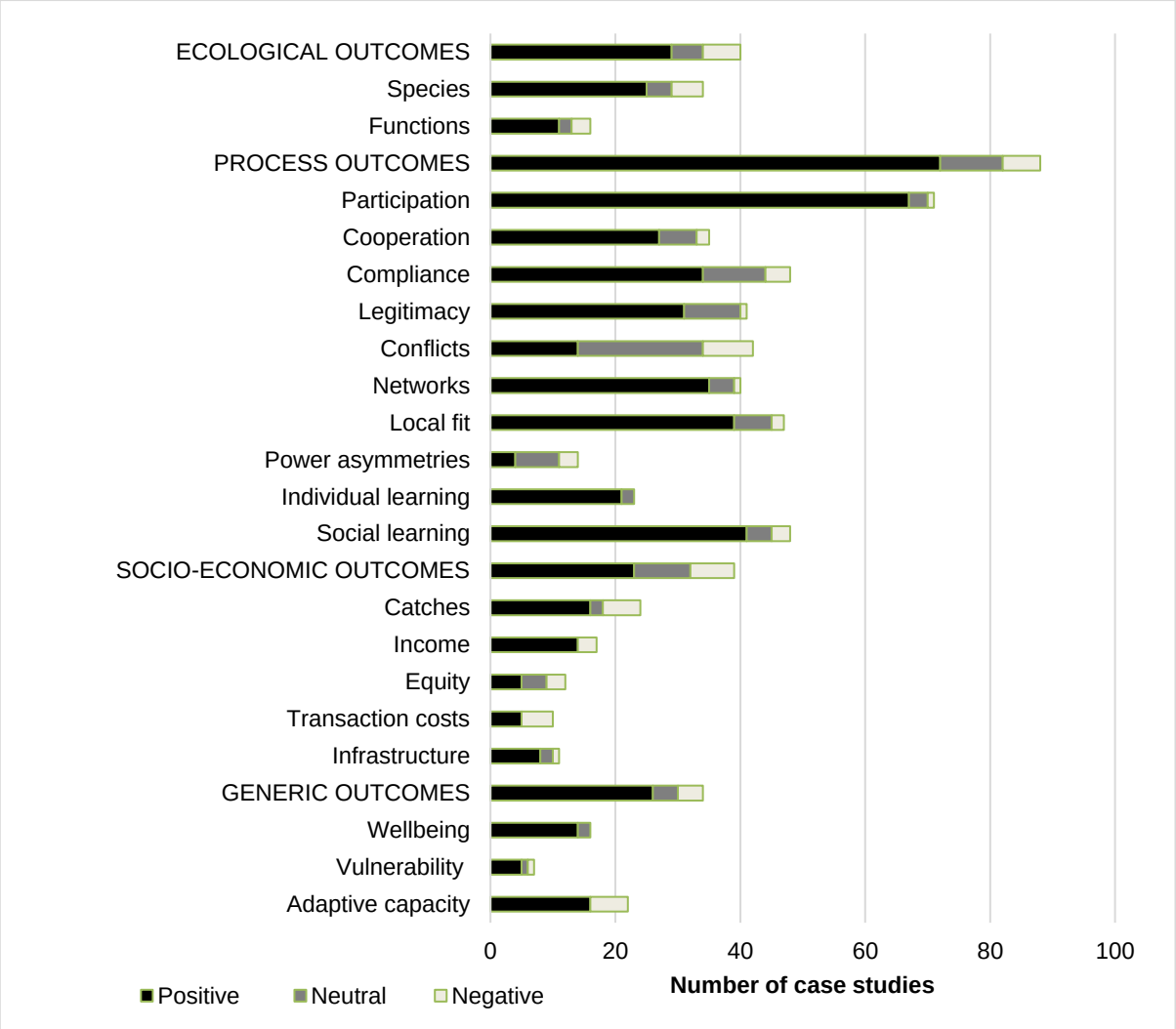

Figure 4.6 Number of case studies reporting outcome variables. Bars indicate how many of the case studies reporting a given variable do so positively, negatively, or indicate no change.

The only three outcome variables reporting more neutral and negative effects than positive are *conflicts* (42 cases), *power asymmetries* (14) and *distributional equity* (12), yet these variables show low reporting levels. Twenty dataset cases explicitly report that conflicts do not change, 14

describe a decrease of conflicts and 8 report an increase. Only 29 cases describe the actors involved in these conflicts, including grievances among users (10 cases), users and government (12 cases), users and other actors (two cases), and users, government and other actors (five cases). Existing power asymmetries are reduced in four cases of the dataset, reinforced in three of the cases and ignored by the co-management initiative in seven cases. Finally, distributional equity increases in five cases of the dataset while remains the same or worsens in four and three cases, respectively.

The level of achievement of the goals stated by each co-management initiative is not always measured in the correspondent articles (Figure 4.7). The goal *to define or enforce fishing rights* is the most commonly assessed and realised in practice: Nineteen of the cases in the dataset report this goal, with 15 cases indicating positive outcomes and one being neutral. If we exclude the goals stated in only one or two cases of our dataset (i.e. *dealing with conflict*, or *maximising equity*), the following least reported goal is *to address illegal fishing*, with only three of the dataset cases referring to it and indicating a negative result.

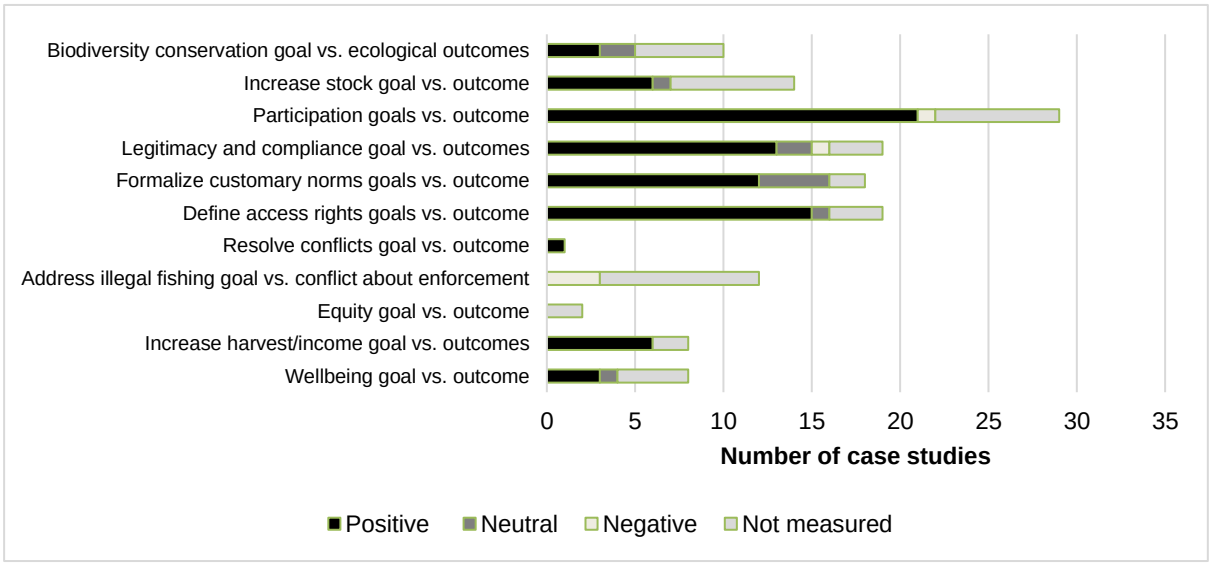

Figure 4.7 Number of case studies measuring or not outcomes related to their stated goals, with specification of whether the outcomes are positive, neutral or negative

Sixty-six cases (i.e. 73%) provide information on research design. Most of them (54 cases) are grounded on an analysis of the fishery's state compared to baseline information, which is commonly collected through users' perceptions (44) and, to a lesser extent, through expert

consultation (27). Twenty-three cases collect and contrast data between study sites and control groups and in two cases data are estimated on the basis of past records. Twenty-nine cases use secondary sources of information to complement first-hand empirical findings; these sources are scientific articles (17) and reports and newsletters (24) (Figure A.4.6 in Appendix 4 to find this data disaggregated by outcomes categories).

4.4.4. Explaining co-management outcomes

Results from both Fisher test and multinomial logistic regressions show some significant results that shed light on existing interactions between co-management context, attributes and outcomes (Table 4.1 and Tables A.4.3 and A.4.4 in Appendix 4). The most influential variable in the expected outcomes is the *diversity of interests* represented in the co-management initiative. Engaging a diversity of stakeholders in the co-management partnership is likely to result in more positive *outcomes* overall, and *process outcomes* particularly (13.50 times more likely and 8.67 times more likely respectively) than to remain constant (no change). Also, engaging actors that represent the *socio-economic diversity* of the fishery is related with increased *compliance* ($p \leq 0.05$).

Our statistical analysis also suggests that the existence of *operational rules*, such as quotas and temporal restrictions, can facilitate *social learning* ($p \leq 0.05$). Existing rules are often discussed and refined by co-management participants, resulting in e.g. increased collective knowledge of the dynamics of the fishery, more agreement on rules, more agreement on desirable behaviors towards natural resources, and other characteristics of social learning. Surprisingly, we also observe that the presence of an *intergovernmental organization* in the co-management partnership hinders the creation of multilevel *networks* ($p \leq 0.05$), and the presence of *community* representatives lowers the chances to reduce *conflict* ($p \leq 0.05$). The latter might be explained by the fact that conflicts are more likely to surface when community interests are brought to the fore through the interaction of their representatives in the co-management regime. We would suggest that unearthing all existing conflicts in co-management forums is necessary to deal with them successfully over time. The former result is less intuitive, and it may be explained by the fact that our dataset is small and only three cases report the existence of intergovernmental organizations.

The analysis also suggests that if the targeted species is *shellfish*, *socio-economic* outcomes are more likely to remain constant than to worsen (0.05 times more likely) or to improve (0.10 times more likely). The presence of *industrial fishing* in the fishery constrains *species*' size, diversity and abundance ($p \leq 0.05$), and is also likely to impinge negatively on *cooperation*, which might not

increase as a result ($p \leq 0.05$). However, if there is *artisanal fishing*, resource management *legitimacy* is more likely to improve with the establishment of co-management ($p \leq 0.05$). Our analysis also suggests that when *illegal fishing* is reported, *ecological outcomes* are more likely to improve (29.98 times more likely) than to remain constant. Taken together, these results suggest that involving *artisanal* fishers in co-management may result in more legitimate outcomes, while *industrial* fishers might have fewer incentives to cooperate for the conservation of fish stocks. Finally, when co-management includes one or more practices of *adaptive management* the *adaptive capacity* of the fishery increases ($p \leq 0.05$) and the likelihood of *conflicts* to appear or increase is reduced ($p \leq 0.1$).

Table 4.1 Multinomial logistic regressions in terms of the relative risk ratios of the association between co-management context and attributes with co-management outcomes

	Ecological outcomes			Process outcomes			Socio-economic outcomes			All outcomes		
Explanatory variables	Worsened	No change	Improved	Worsened	No change	Improved	Worsened	No change	Improved	Worsened	No change	Improved
Fishery type												
Coastal	---	---	---	---	---	---	0.75(1.13)	^	0.94(0.11)**	---	---	---
Off-shore	---	---	---	---	---	---	0.78(4298.36)	^	1111159($4.06x10^9$)	---	---	---
Coastal and off-shore	---	---	---	---	---	---	0.78(4293.86)	^	1111159($4.06x10^9$)	---	---	---
Shellfish	---	---	---	---	---	---	0.05(0.07)**	^	0.10(0.11)**	---	---	---
Recreational fishing	---	---	---	0.47(0.60)	^	0.17(0.14)**	---	---	---	---	---	---
Illegal fishing	$3.02x10^7$(5.87)	^	29.98(48.03)**	---	---	---	---	---	---	---	---	---
Stage of co-management												
Implemented	---	---	---	---	---	---	---	---	---	0.11(0.16)	^	0.24(0.26)
Terminated	---	---	---	---	---	---	---	---	---	0.25(0.375)	^	0.05(0.07)**
Diversity of interests	---	---	---	0.00(0.00)	^	13.50(14.81)**	---	---	---	0.00(0.00)	^	8.67(8.83)**

Note: Values represent relative risk ratios with associated standard deviations in parentheses. Base outcomes are highlighted as ^. Statistical significance level is given by **=p≤0.05. Non-significant results are not shown and highlighted as ---.

When co-management replaces centralized decision-making frameworks, it seems more effective in reducing conflicts and addressing power asymmetries. Co-management might also deepen power asymmetries when it replaces previous community-based systems (Table 4.2). However, given the reduced number of cases in the dataset that report on these variables, such relationships appear statistically non-significant.

Table 4.2 Contingency table between *previous institutions* and the outcomes *conflicts* and *power asymmetries*

	Conflicts			Power asymmetries		
Previous institutions	**Worsened**	**No change**	**Improved**	**Worsened**	**No change**	**Improved**
Customary	1	4	1	2	2	0
National	1	4	10	0	1	3
Both	1	2	0	0	2	0

4.5. Discussion

The results section has provided evidence on the key context and attributes of co-managed small-scale fisheries, their most relevant outcomes and the interrelationships between context, attributes and outcomes. Here we first synthesize and discuss the main findings, and we subsequently reflect on two elements that underpin our systematic review: the spatial distribution of the case studies reviewed and the potential of our review framework to advance the research frontier on the co-management of natural resources.

The most reported context variables in our dataset suggest that co-management often occurs in coastal small-scale fisheries with previous open-access conditions targeting a diversity of species, in a context of decentralized NRM, and with a supportive legislative framework that includes clear operational rules, such as quotas and closed-seasons. Most of the initiatives included in the review have been running for 10 years or less, share equal power between government and users or empower users very significantly, while half of them include third parties, usually NGOs and research centres. Communities or government often take the lead in promoting co-management, and throughout the process there is often facilitative leadership provided by a guiding individual

or organization. Although not evenly reported throughout the reviewed case studies, it seems that co-management can be a platform for knowledge generation and exchange across scales, as expected from a multi-level governance scheme (Vodden, Ommer and Schneider, 2005).

Our review also suggests that co-management can be a conduit to the sustainability of small-scale fisheries. Our analysis indicates that 76% of the reviewed cases document one or more positive outcomes, whereas 17% produce mixed results and 7% fail in achieving goals. These findings are in line with other scholarly work, which considers fisheries co-management largely successful in achieving both social and ecological objectives (Gutiérrez, Hilborn and Defeo, 2011; Cinner *et al.*, 2012). Evidence from the few cases of the dataset reporting on ecological outcomes suggests that co-management can make targeted species more abundant and improve their habitat. Combining diverse management approaches and technologies, such as gear restrictions, catch reduction, and closed areas, co-management contributes to the restoration of marine ecosystems and rebuild fisheries (Worm *et al.*, 2009). In line with co-management theory, a relevant number of the dataset cases report an improvement of stakeholders' participation in management and other process outcomes, such as increased compliance, enhanced social learning, and improved local fit. A reviewed case study, for example, describes how the participation of local users in the design of the management plan of Indonesian coastal fisheries strengthened the congruence of management norms with local ecological conditions and resulted in increased compliance and the banning of very harmful fishing techniques (Crawford *et al.*, 2004).

Other theorized, process-related outcomes of co-management, such as conflict resolution, remain poorly reported and point to mixed results. For example, Ho et al. (2016) show that the Vietnamese government implemented a co-management regime in the Tam Giang Lagoon, where the newly created fishery associations were successful in mediating and improving recurrent conflicts over resource access. This subsequently led to better ecological and social outcomes. In contrast, Nursey-Bray and Rist (2009) show how the incorporation of indigenous cultural aspirations, including traditional hunting of endangered species, into the management framework of Australia's Great Barrier Reef Marine Protected Area resulted in more rather than less conflicts between indigenous peoples, tourist operators and local residents. These two examples suggest that the potential of co-management to resolve or mitigate conflicts should not be taken for granted (Gelcich *et al.*, 2006; Béné *et al.*, 2009).

Only one of the case studies reviewed explicitly acknowledges that the *reduction of conflict* was a key goal of the initiative studied. This is somewhat surprising since co-management should, by

definition, bring together different stakeholders in joint decision-making forums and, as a result, unearth existing conflicts or facilitate new conflicts to emerge, particularly when community representatives play a more central role in fisheries' management. This could be regarded as a desirable outcome since conflicts might reflect the fact that historically marginalised management perspectives had been brought to the fore. Furthermore, conflicts can create the conditions for new knowledge and sustainable practices to emerge (Keen, Brown and Dyball, 2005; Matulis and Moyer, 2017).

However, conflicts can also destroy long-term collaboration processes, and thus should be taken up and addressed seriously (Lee, 2013). One important source of at-sea conflicts are grievances between artisanal and industrial fishers because the latter are more efficient in extracting the resource and often destroy artisanal fishing equipment (DuBois and Zografos, 2012). In this review, the most reported reason for conflict is competition among user groups and, although only 8 cases mention the presence of industrial fishers, who can have a negative impact on the fish stocks and prevent users' cooperation. These results call for the inclusion of industrial fishers, when applicable, in the co-management partnerships in order to better handle any potential conflicts, strengthen cooperation, and facilitate that user groups operate under the same governance mechanism and regulations, since artisanal fishers often follow locally established norms whereas industrial fishers operate within the context of formal government rules (DuBois and Zografos, 2012). This would hopefully facilitate the eventual achievement of improved ecological outcomes. Our statistical analysis also suggests that conflict can be prevented and diminished by strengthening users' collective action and community institutions that promote cooperation and equitable outcomes and ensure a more adaptable management system to changing conditions (Ratner *et al.*, 2017).

As for conflict, socio-economic outcomes, such as changes in *income*, *catches*, *power asymmetries* and *equity* are also rarely explored in depth in the dataset cases. And, whereas the few cases reporting *income* and *catches* mostly show an increase of these two variables, case studies reporting on *power asymmetrie*s and *equity* show rather mixed results. For instance, our review suggests that if power asymmetries within the local community are not addressed by the co-management scheme, the most powerful actors can have greater influence on co-management outcomes (Davis and Bailey, 1996; Adger, Brown and Tompkins, 2005), leading to the uneven distribution of both income and other benefits (Barnaud and Van Paasen, 2013). Whereas equity is theorized to increase with co-management (Plummer and Armitage, 2007c), previous case-based studies show both improved and worsened distribution of co-management benefits among

local fishers (Cinner *et al.*, 2012; García Lozano and Heinen, 2016). Therefore, future research needs to provide more evidence on the role of co-management in dealing with conflicts, power asymmetries and equity. Specifically, more evidence is required to test if co-management is more effective in reducing conflicts and addressing power asymmetries when it devolves management rights to local users after the failure of centralized management approaches, or when it replaces traditional systems of resource use and management (Armitage, Berkes and Doubleday, 2007b; Berkes, 2010a; Russell and Dobson, 2011).

The scarce reporting on outcomes other than specific *process* outcomes can be explained by the fact that most initiatives reviewed are short-lived, recently implemented or in the implementation phase, which probably made it difficult for researchers to observe significant changes in ecological conditions and fishers' wellbeing aspects that require longer periods to crystallise (Yang and Pomeroy, 2017). Paying more attention to ecological, socio-economic and more generic outcomes, including the status of fisheries' species, changes in income and catches, and users' material, knowledge and political conditions seems paramount. Ideally, these analyses should draw on panel and longitudinal data collected through multi- or inter-disciplinary research.

The results of our systematic review additionally hint at the importance that social diversity in co-management plays in determining co-management outcomes. The statistical analysis suggests that the presence of artisanal fishers and the absence of industrial fishers, as well as the existence of clear operational rules, are the context conditions that support the most successful co-management initiatives. These findings complement, rather than contradict, the other enabling context conditions identified by previous studies which enhance co-management success, including local leadership, social cohesion, governance capacity, quotas and protected areas (Gutiérrez, Hilborn and Defeo, 2011; Selig *et al.*, 2017).

Our review also indicates that partnerships involving all stakeholders and accounting for their socio-economic diversity seem more able to enhance compliance with agreed rules and achieve better management outcomes than those partnerships involving only local leaders. This is consistent with the view that ensuring representativeness, and sharing both power and benefits translates in more sustainable outcomes (Jentoft, 2007; Pascual *et al.*, 2014). A key challenge for co-management theorists and practitioners is developing co-management initiatives involving multiple actors with diverging values, interests and goals, in order to implement more legitimate management arrangements whilst effectively dealing with potential conflict (Ratner, Oh and Pomeroy, 2012). In this regard, our review suggests that partnerships implementing adaptive

management practices, such as a flexible co-management structure that can quickly respond to signals of environmental change (e.g. McCay et al., 2014) or experimenting with new management tools to replace previous failed management systems (e.g. Crawford et al., 2010), are better able to prevent conflicts and to increase the adaptive capacity of the fishery.

As for other systematic reviews conducted to evaluate emerging environmental policy frameworks (Plummer *et al.*, 2012; Wamukota, Cinner and McClanahan, 2012), our results should be taken with caution. Our dataset is limited in scope, with case studies selected only from international and English-written peer-reviewed scientific articles. If we had reviewed scientific research published in multiple languages, as well as grey literature published by research programs or the co-management initiatives themselves, we would have probably come up with a much larger and complete dataset of case studies worldwide. Such dataset would have in turn enabled us to test for some multivariable cause-and-effect relationships that we were not able to perform in this article due to the high number of unreported variables.

Our data selection bias also probably explains the gaps observed in the distribution of case studies, with a surprising lack of studies in western and southern Africa, many Central and South American countries, and large parts of Asia, e.g., China and Russia, which might have nonetheless been reported in non-English written academic journals. The rather patchy distribution of the reviewed cases probably obeys to funding, research and policy developments. In Eastern Asia, co-management research seems to respond to a need to evaluate development projects promoted by international donors. For example, two cases in the Philippines (Baticados and Agbayani, 2000; Kuperan *et al.*, 2008) were developed under the International Collaborative Project on Fisheries Co-management, funded by the Danish International Development Agency, and the case in Laos (Baird and Flaherty, 2005) fell into the Environmental Protection and Community Development in Siphandone Wetland Project, funded by the European Union. In North America, interest in co-management research stems, primarily, from an interest in understanding fisheries management involving First Nations groups: six of the nine cases located in Canada and the USA involve indigenous fishing groups. Seemingly, in Africa, most studies focus on eastern countries' initiatives, with the research being led or organized by USA and UK researchers and funding programs. In turn, the relatively higher density of case studies in Chile and Brazil might be explained by the research interest that arose in response to the Chilean 'management areas for the exploitation of benthic resources' and the Brazilian 'fishing agreements' programs, which respectively promoted co-management in fisheries.

In spite of these methodological caveats, we think that the review results and its underlying analytical framework have considerable value. By innovatively combining insights from existing frameworks for the analysis of social-ecological systems (Ostrom, 2007, 2009; Mcginnis and Ostrom, 2014) and adaptive resource management (Plummer, Baird, Armitage, *et al.*, 2017), we have provided a rather comprehensive map of all relevant variables for the study of co-management approaches, which can be further complemented with some additional variables from emerging literature. Selig and others (2017), for example, have found that variables like the human development index and lower coastal population density can significantly influence the ecological effectiveness of resource management initiatives. This "analytical map" can be used to conduct future reviews, but also to guide fieldwork research in well-established or new co-management initiatives.

4.6. Conclusions

Small-scale fisheries co-management is a research field of growing interest. This systematic review demonstrates that co-management initiatives are more likely to develop in coastal and multispecies fisheries with an enabling legal and institutional framework, and that co-management is usually a way to clarify property rights. Co-management benefits from involving a diversity of actors, and it faces the challenge to do so while strengthening cooperation, dealing with conflict and achieving ecological outcomes, particularly when community representatives and industrial fishers are involved. This review shows that adaptive management can contribute to prevent conflict and increase the adaptive capacity of small-scale fisheries. The review confirms that co-management can result in more solid management institutions, as well as in positive ecological and social outcomes, including increased fish abundance and catches, the participation of different actors in resource management, and in an increased adaptive capacity of the fishery. However, the review also reveals that empirical research on co-managed small-scale fisheries has to date paid insufficient attention to the social-ecological context underpinning co-management initiatives, as well as the latter's attributes. Additionally, research has been characterised by an uneven systematic recording of the outcomes of co-management, with more attention being paid to process outcomes.

We expect that the framework we have developed to conduct this review can guide future research. The use of a multi-variable and multi-dimensional framework to organise the review has allowed us to identify at least three key research domains that require further attention. First,

there is a need to investigate the extent to which co-management is effective in resolving existing grievances or buffering against potential new conflicts and in balancing power asymmetries and the distribution of resource management benefits; second, it is critical that future studies shed light on whether the performance of co-management initiatives is sensitive to the nature of the pre-existing management system; and, third, it is important to examine in which ways the involvement of third party actors in co-management affects the type of outcomes and their distribution and sustainability over time. In doing so, future research needs to target case studies where co-management has been implemented for at least 10 years and carefully examine both social and ecological goals. If we expand the evidence base in these three key areas, we will be able to better understand the ways in which co-managed small-scale fisheries benefit both fish species and fisherfolk, now and in the future, in a context of global climate change and increasing pressures on coastal ecosystems.

5. Investigating equity in the co-managed small-scale fishery of the LEBR

"Not all fishers are an absolute disaster in South Pacific."

5.1. Abstract

Most fisheries worldwide are overexploited or at their maximum sustainable yield. By widening the scope and depth of participation in decision-making, co-management has proven successful in improving the ecological status of fisheries, as well as their underlying governance system. However, little is known about how equitable co-management actually is, i.e. how well it recognizes and embraces all relevant actors' identity and interests, how participatory decision-making procedures are, and to what extent it results in fairly distributed outcomes. To address this gap, we investigate the emergence and evolution of a co-management scheme in the Mexican fishery of *La Encrucijada* Biosphere Reserve. Informed by interviews, focus groups and participant observation, we examine the design of the co-management scheme, its outcomes to date, the process leading to the realisation of such outcomes and their distribution across involved actors, paying specific attention to the performance of two cooperatives involved. Results show that recognition of different actors' views and knowledge was key for more plural access to decision-making at the fishery level. However, the analysis of the two involved cooperatives reflect that co-management failed in achieving a fair distribution of benefits. Taken together, these findings underscore the importance of recognition as a central pillar of justice in co-management and the centrality of power-sharing mechanisms in multi-party co-management partnerships. Specifically, we advocate for a careful consideration of existing power asymmetries at the local level to guarantee an equitable distribution of co-management outcomes.

Keywords: coastal fishery, co-management, equity, fishing cooperatives, Mexico, outcomes, Tropical Pacific

5.2. Introduction

Thirty percent of world fisheries are overexploited and 60% are exploited at their maximum sustainable yield (Díaz *et al.*, 2019). Governance failures in fisheries have prompted the transition from 'hard', i.e. international and national laws, to 'soft' management approaches, such as voluntary guidelines and codes of conduct, market incentives and collaborative management between fishers and government (Allison, 2001). 'Soft' management instruments show potential to improve the sustainability of fisheries if carefully adapted and implemented to each cultural and institutional context (Willmann, Cochrane and Emerson, 2009; Jentoft, 2014; Song *et al.*, 2019).

The central tenet of co-management is, in theory, an even involvement of a diversity of stakeholders in decision-making, and the integration of stakeholders' interests and knowledge systems in ways that can lead to social learning and shared understandings and actions (Plummer and Fitzgibbon, 2004). In this regard, by sharing decision-making between governments at different administrative levels, fishers, and other public or private actors, co-management often combines traditional self-governance systems with government regulations (Carlsson and Berkes, 2005; Kolding, Béné and Bavinck, 2014). Although it may benefit from a recognition in national legislation (Gutiérrez, Hilborn and Defeo, 2011; d'Armengol *et al.*, 2018), co-management can also happen informally without a legal framework (Pinkerton, 1989; Plummer and FitzGibbon, 2004). Overall, co-management arrangements are continuously evolving through deliberation, negotiation and problem solving (Carlsson and Berkes, 2005) and may need to run a certain time to yield observable outcomes (Yang and Pomeroy, 2017).

Collaborative management, or co-management, has proven a successful strategy in restoring marine ecosystems and rebuilding fisheries (Worm *et al.*, 2009). Co-management has had a great impact in fishery systems as a way to give a voice to users, who should in principle abide by resource management rules and avoid overexploitation (Ostrom, 1990). Several studies have demonstrated that co-management can enhance the ecological conditions of the fishery and improve fisherfolk's wellbeing. For instance, in small-scale fisheries, co-management has resulted in increased fish biomass and fishers' income, influence over the decision-making process and resource control (Evans, Cherrett and Pemsl, 2011; Cinner *et al.*, 2012; Whitehouse and Fowler, 2018). A systematic review of 91 co-managed small-scale fisheries from around the world has also shown that co-management enhances the habitats of aquatic species, it increases fish catches,

induces social learning among participants and supports the fishery's adaptive capacity (d'Armengol *et al.*, 2018).

Among the many claimed benefits of co-management, two of particular significance are the expectation that it will promote equity in participation and in the distribution of costs and benefits. This is argued to be achievable by more effectively involving those with a vested interest in the resource and management to participate in decision-making (Plummer and Armitage, 2007c). However, studies addressing equity-related outcomes and implications of co-management are still scarce and lack attention to the plurality of forms of equity discussed in the conservation literature (Quimby and Levine, 2018). Existing meta-analyses present inconclusive evidence regarding equity issues and cannot confirm that co-management improves benefit distribution (d'Armengol *et al.*, 2018). Whereas co-management programs in the Philippines seem to provide fairer access to decision-making and benefits (Yang and Pomeroy, 2017), coral-reef fisheries co-management cases reveal that wealthier users perceived more benefits from co-management than their poorer peers (Cinner *et al.*, 2012). Moreover, Adger et al. (2005) suggest that emerging cross-scale interactions often hide uneven power relationships and costs and reinforce existing inequalities. For example, incorporating customary practices into the statutory institutional framework through co-management may carry unequal access to participation and shares in outcomes rooted in the local social structures (Davis and Bailey, 1996).

Most research highlighted above acknowledges that equity, understood as a fair treatment or due reward, varies according to different situations and cultures (McDermott, Mahanty and Schreckenberg, 2013). Early attempts to analyse equity in conservation interventions equalled it to benefit distribution, i.e. distributional equity (e.g. McDermott and Schreckenberg, 2009), and access to decision-making, i.e. procedural equity or fair participation (e.g. Mahanty et al., 2006). *Distribution* refers to the allocation of costs, benefits, burdens and rights whereas *procedure* relates to the degree of involvement and inclusiveness in rulemaking and decisions (Pascual et al. 2014). Recently, scholars have added *recognition*, which denotes the respect for knowledge systems, values, social norms and the rights of all stakeholders in the design and implementation of management actions (Pascual *et al.*, 2014; Martin *et al.*, 2016).

In this article, we employ an equity lens to assess the performance of the co-managed small-scale fishery of *La Encrucijada* Biosphere Reserve (LEBR), in the state of Chiapas, Mexico. In 2008, the management board of LEBR partnered with eight local fishing cooperatives and other governmental agencies, research centres and NGOs, to establish a co-management regime for the

local fishery. We examine the development of co-management and the perceived outcomes to analyse how fair the design and implementation of the co-management scheme is and how equitable its outcomes are at both fishery and cooperative levels. In doing so, we zoom into two cooperatives that were equally engaged with co-management but achieved different outcomes, according to the LEBR management board. Our findings provide novel evidence on the centrality of recognition, as a normative pillar that guides inclusive participatory decision-making in co-management regimes. We also demonstrate that pre-existing conditions of inequity and uneven power relations among fishers can restrict the realization of ecological outcomes and preclude a fair distribution of socio-economic outcomes.

5.3. Case study and methods

5.3.1. *La Encrucijada* Biosphere Reserve

The LEBR covers 144,868 ha of land and water bodies, including a mangrove estuarine system, which encompasses two large lagoon systems, 17 main rivers and a network of estuaries and smaller lagoons (Figure 5.1). The reserve was originally a coastal protected area established by the Mexican government in 1995 to protect the mangroves, associated swamps and coastal ecosystems and patches of tropical forests, as well as iconic and threatened species such as jaguars (*Panthera onca*), American crocodile (*Crocodylus acutus*), Geoffroy's spider monkey (*Ateles geoffroyi vellerosus*), the endemic 'pejelagarto' (*Atractosteus tropicus*) and more than three hundred species of birds (Instituto Nacional de Ecología, 1999; The MAB Programme, 2011). In 1996, the protected area was declared a Wetland of International Importance by the Ramsar Convention and, in 2006, it formally became a biosphere reserve under UNESCO's Man and Biosphere programme, managed by a local office of Mexico's National Commission of Natural Protected Areas (hereafter CONANP).

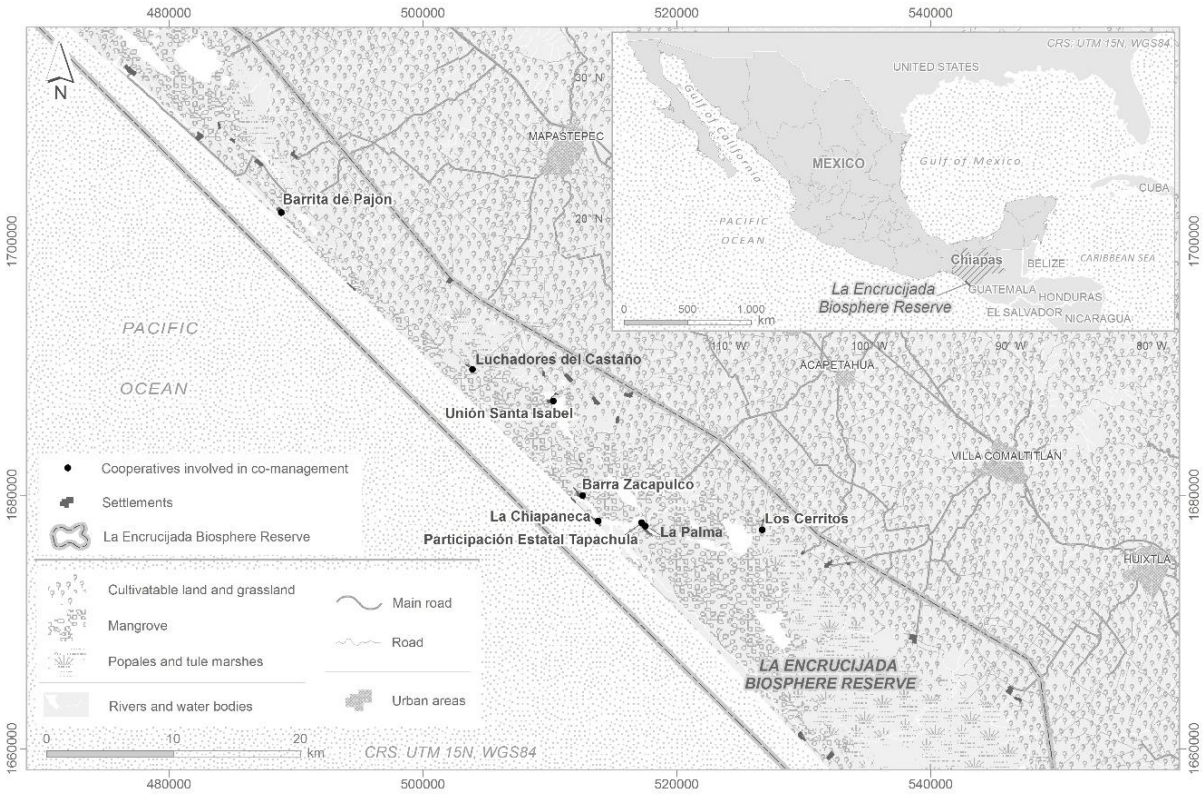

Figure 5.1 Location of the *La Encrucijada* Biosphere Reserve and the cooperatives participating in co-management. Sources: GADM the Database of Global Administrative Areas (https://www.gadm.org/), Gobierno del Estado de Chiapas: Geoweb Chiapas 3.0 (http://map.ceieg.chiapas.gob.mx/geoweb/), Comisión Nacional de Áreas Naturales Protegidas.

Originally, from 3500 to 1650 BC, the reserve area and its surroundings was home of a Mayan-Quichean society devoted to fishing, agriculture, pottery and trade. In the late 15th century, the Aztecs occupied the region to establish military fronts and get tropical products, including the valued cocoa. The Castilian troops reached the area in 1524 AC to consolidate new agricultural exploitations such as nopal cactus' cochineal, cotton, sugar, and leather. More recently, in the 19th century, immigrants from Japan, China and Germany introduced the coffee plant. In the 20th century, a trainline along the coast was built and together with the Pan-American highway facilitated the arrival of new migrants from other Mexican states and neighbouring countries and the settlement of the first *ejidos*. As such, the original indigenous populations were replaced by a new mestizo society (Instituto Nacional de Ecología, 1999; Romero-Berny and Guichard-Romero, 2015).

Nowadays, the reserve partially covers six municipalities and encompasses a population of about 27,000 inhabitants, who are spread among 82 communities and *ejidos*, of which 31 are fishing communities organized in 16 fishing cooperatives (Instituto Nacional de Ecología, 1999; director of LEBR, personal communication). The fishing cooperatives are distributed along the two main lagoon systems of the protected area, i.e. *Chantuto-Panzacola* and *Carretas-Pereyra* which, in turn, define the two core areas of the LEBR, i.e. *La Encrucijada* and *Palmarcito*, respectively. The fishing cooperatives in the area were established following the General Law of Cooperatives of 1938, which was enacted to promote the equitable distribution of fisheries' economic benefits (Espinoza-Tenorio *et al.*, 2011). A few years later, the Fishery Law of 1947 regulated artisanal fisheries by establishing contract concessions, restrictions during reproductive seasons and fishing-gear controls (Espinoza-Tenorio *et al.*, 2011). This Law also granted the fishing cooperatives' exclusive access to the most important fish stocks at a Mexican scale, such as shrimp, abalone and lobster (Ibarra, Reid and Thorpe, 2000). The Fishery Law of 1986 removed these exclusive prerogatives and allowed private fishing companies to access and appropriate fishing resources (Espinoza-Tenorio *et al.*, 2011).

In the early 1940s, fishers in the study region mostly used hooks and agave-made fishing lines for fish and cotton-stringed cast nets for crustaceans (Rodriguez-Perafan *et al.*, 2013). From the 1950s onwards, nylon nets and lines replaced previous, less resistant organic materials (Figure 5.3 shows cast net fishers in La Palma fishing waters). Shrimp corrals, a collective gear that closes a lagoon and helps catch all fish and shrimp circulating, were increasingly used by those cooperatives that had a lagoon in their fishing concession. Cooperatives without suitable lagoons, including *La Palma*, started using individual and illegal stow nets from the 1960s onwards (Rodriguez-Perafan *et al.*, 2013).

Figure 5.2 Cast net fishers

Through the 20th century, hand-driven cayucos were increasingly complemented with outboard motors thanks to governmental support. The generalized use of outboard motors allowed fishers to start selling fresh shrimp instead of dried shrimp, which lasted more but was less profitable (Ortiz, 1984). The Hydraulic Plan of the coast of Chiapas (1979-1991) enabled the construction of roads that made access to the cooperatives easier and opened new markets. However, it also changed the hydrology of many rivers and estuaries through drains and walls, which resulted in coastal erosion and siltation of lagoons (Rodriguez-Perafan *et al.*, 2013). Consequently, fish communities suffered an increased fishing pressure and reduced habitats.

Following the 1994's Law of Cooperative Societies, fishing cooperatives were allocated exclusive territorial fishing rights. The definition of territorial fishing rights through concessions evoked strong disputes related to the portioning of the fishing areas (Rodriguez-Perafan *et al.*, 2013). Since then, fishing cooperatives often have fishing agreements with neighbouring cooperatives for sharing bordering fishing waters (Rodriguez-Perafan *et al.*, 2013).

The establishment of the Biosphere Reserve in 1995 was not well accepted by fishers who saw some of their activities, such as the use of mangrove's wood, and the harvest of protected species

such as crocodiles and turtles, prohibited by the reserve management plan (Sommers González, 2007). However, the use of most fishery resources was not altered (Sommers González, 2007) because the management plan referred to the national fishing normative to regulate the fishing waters of the fishing cooperatives (Instituto Nacional de Ecología, 1999). Such a fishing normative did not establish any specific regulation for the fisheries of LEBR until the enactment of the 2017 National Fisheries Chart.

Nowadays, each fishing cooperative has its own norms and sanctions for the management of their fishing waters, which are decided by all members through the cooperative's assembly (See an image of a cooperative assembly in Figure 5.3). Any fisher living in the community or communities covered by the cooperative can potentially become a member, but in practice membership has been circumscribed to adult men. Only in certain occasions women are accepted if they are replacing their husbands, for example, when the latter die or migrate. Every two or three years, the members elect a new administrative board that has the duty to monitor compliance with cooperative norms, represent the cooperative, and market the harvest, which is sold to local intermediaries.

Figure 5.3 Assembly of *La Palma* fishing cooperative

The LEBR co-management scheme has its origins in 2008, when an European NGO that trades organic products, showed interest in exporting fish to European markets if fishing practices accorded with the guidelines of the FAO's Code of Conduct of Responsible Fisheries. Three cooperatives, *La Palma*, *Los Cerritos* and *Luchadores del Castaño* (hereafter *Luchadores*), were supported by CONANP and a local NGO to improve the fishing practices and achieve organic certification. This initiative, which started as a commercialization strategy, turned in 2009 into an initiative to strengthen local institutions for achieving a more sustainable fishery. More fishing cooperatives showed interest in being part of the new co-management process and until 2013 five more cooperatives became involved, *Barra Zacapulco*, *Barrita de Pajón*, *La Chiapaneca*, *Participación Estatal Tapachula* and *Unión Santa Isabel*. Although initially only cooperatives with fishing concessions to fish in the estuarine system were involved, the last cooperatives to join the process, *La Chiapaneca* and *Participación Estatal Tapachula*, had permits to fish in open waters. The involved fishing cooperatives had between 13 and 154 members and represented a total of 762 fishers, mostly men. All but one, i.e. *Barrita de Pajón*, of the involved cooperatives were distributed along the *Chantuto-Panzacola* lagoon system.

5.3.2. Research design

The co-management scheme in LEBR provides an interesting case study to shed light on the equity dimensions of co-management given the high marginalization rates in the region (de la Vega Estrada, Romo Viramontes and González Barrera, 2011) and the opportunity for co-management to enhance local livelihoods. The analysis of the overall co-management regime through an equity lens, with respect to both process and outcomes, is performed at two geographical levels: fishery and community. By the fishery level we refer to the organizations represented in the co-management committees and the fishing waters managed by the eight cooperatives involved. By the community level, we refer to the members of a cooperative and their fishing waters. The analysis at the community level is based on a comparative analysis of two fishing cooperatives to investigate how differentiated local contexts influence distributional equity, given the same institutional design at the fishery level, and thus the same recognition and procedural context at the level of the co-management initiative.

We chose two of the pioneering cooperatives in co-management. *La Palma,* established in 1941, is the oldest cooperative in the LEBR and has one of the highest in number of members, 126. In contrast, *Luchadores*, established in 1995, is one of the youngest and smallest cooperatives, with

33 members (See the facilities of the *Luchadores* cooperative in Figure 5.4). Whereas all the members of *La Palma* cooperative live in the community with the same name, most members of *Luchadores* live in the community of *El Castaño*, and a few of them live in nearby communities. The major part of the income in *Luchadores* comes from participation in the shrimp corral, a collective gear with a net that is casted every two weeks and that ensures similar catches for all fishers. In *La Palma*, wealthier fishers own more expensive and profitable individual gears, stow and trammel nets, creating a system that seems to perpetuate great income differences among fishers.

Figure 5.4 Dock and other facilities of the *Luchadores del Castaño* cooperative

5.3.3. Data collection and analysis

Prior to conducting fieldwork, the lead author obtained informed consent from participants and presented the research aims and plans to the officers of the LEBR management board (i.e., CONANP), the current NGO involved in co-management, and the leaders of the eight fishing cooperatives. She conducted 75 open-ended semi-structured interviews during two non-consecutive fieldwork periods held between September 2014 and September 2015 (Table 5.1). She used two different ways to select interviewees: on the one hand, she randomly selected those

fishers who appeared in the cooperative facilities to sell their harvest after fishing and, on the other, she targeted key informants through a snowball sampling process, including current and past cooperative leaders and female fishers.

Table 5.1 Number of interviews

Actors involved in co-management	Interviews (number)
Fishing cooperatives	**48**
La Palma	25
Luchadores del Castaño	14
Barra Zacapulco	2
Barrita de Pajón	1
La Chiapaneca	2
Los Cerritos	2
Participación Estatal Tapachula	1
Unión Santa Isabel	1
Government	**15**
CONANP	5
CONAPESCA	4
INAPESCA	2
Municipality of *Acapetahua*	1
Municipality of *Mapastepec*	1
SEPESCA	2
NGOs	**5**
ACMT	2
CASFA	1
Pronatura Sur	1
Ser Integral Chiapas	1
Research centres	**7**
ECOSUR	3
UNICACH	4
Total	**75**

Interviewees were encouraged to describe: 1) perceived drivers of change of *La Encrucijada* fishery; 2) the evolution and activities of co-management, including perceptions of recognition and fair procedures; and 3) perceived outcomes of co-management, including perceptions of fair distribution. Fishers were additionally asked to provide information about: 4) their fishing activities; 5) the functioning of the cooperative; 6) compliance with the rules; and 7) existing conflicts in the management of the fishery and the overall co-management regime. The information obtained through these interviews was triangulated with focus groups and participant observation activities in the two communities.

The lead author also joined the daily activities in the LEBR office and attended meetings of the two main co-management committees at the fishery level, i.e. the technical-scientific and the inter-cooperative committee. She also travelled regularly to the fishing communities of *La Palma* and *El Castaño* and spent more than two weeks in each where she joined the daily lives of the fishing families. She also attended an assembly of the *La Palma* cooperative and a weekly meeting of the *Luchadores* cooperative, and she also participated in a collaborative monitoring trip led by the current NGO involved in co-management with fishers of *Participación Estatal Tapachula* cooperative, and a fishing trip with a fishing family of *El Castaño* community.

Additionally, the lead author organized three focus groups in the LEBR. The first was aimed at getting insights on the main events that had shaped the evolution of the co-management process until then and to jointly develop an analysis of actors' engagement and participation in the process through a sociogram exercise. This focus group involved three officers of the LEBR management board who were at the time or had been involved in the co-management initiative, and three NGO officers. The other two focus groups were conducted in the two studied cooperatives and they were both aimed at describing the main events that people as important for understanding the history of the fishing cooperative and discussing the influence of government regulations, including the co-management initiative, on their fishing activities. In *Luchadores*, participation was unfortunately limited to two management board's members and another member. In *La Palma*, four leaders and two fishers participated in the first part of the focus group and two leaders and one fisher stayed until the end of the second part. All interviews and focus groups were conducted in Spanish and recorded with consent.

Data analysis involved the transcription of the interviews and the focus groups conversations and, subsequently, a content analysis based on pre-defined categories and subcategories from two analytical frameworks. These categories included, on the one hand, coding responses according

to their relevance or reference to the three broad pillars of equity identified in the introduction, namely recognition, fair procedure, and equitable distribution (Pascual *et al.*, 2014; Zafra-Calvo *et al.*, 2017). On the other hand, we also coded the responses according to their reference to either the early design of the co-management initiative or its actual implementation at the time of fieldwork, and three broad dimensions of co-management outcomes (as in d'Armengol et al., 2018): process outcomes, which encompass local fit, i.e. congruence of norms with local conditions, compliance with rules, and conflict considerations; ecological outcomes, mostly related to fish abundance; and socio-economic outcomes, focused on income and infrastructure.

5.4. Results

5.4.1. Equity in institutional design

This section presents a historical description of the evolution of the co-management initiative through an equity lens. As mentioned earlier, a few stakeholders (i.e., three cooperatives, CONANP and a local NGO) started the co-management initiative with a common interest in achieving organic certification for selling fishery products to broader markets. Specific motivations to engage in co-management included fishers' aim to reverse the observed decline of fish populations and achieve better revenue from their fishing activity, the CONANP officers' interest in pursuing conservation goals while ameliorating the impacts of fishers' livelihoods through working collaboratively with them, and the local NGO's intention to promote rural development and intermediate between fishers and markets.

CONANP mobilized resources from international donors through the local NGO to organize a series of workshops from 2009 to 2011. These workshops were attended by eight fishing cooperatives, government agencies (e.g., CONANP, CONAPESCA, SEPESCA, and the local councils of *Acapetahua* and *Mapastepec*), a local (first) NGO, a national (new) NGO, and research centres (ECOSUR, UNICACH, and UNACH) to share the knowledge available about the fishery, including information about the fish species and habitats, the fishing activity and the applicable national and cooperative norms, discuss the problems facing the fishery, and propose solutions. A main output from the workshops were jointly agreed 20 inter-cooperative norms (Table 5.2), that adapted national legislation on fisheries and conservation to the conditions and needs of the fishery, establishing the basis of a more sustainable fishery.

Table 5.2 The 20 inter-cooperative norms

1. Each fishing cooperative must have a capacity-building program;
2. Demarcate fishing areas;
3. Use the same fishing times;
4. Do not build refuges;
5. Care for product quality;
6. Respect mesh size for each species;
7. Respect closed seasons and no-take areas;
8. Create a control committee for compliance of these norms;
9. Agreements must be taken under public notary guarantee;
10. Do commercialization at a system instead of at fishing cooperative level;
11. Respect flora and fauna;
12. Do not pollute the system;
13. Release bycatch as soon as possible;
14. Only those who own a fishing permit shall fish;
15. Use authorized fishing gears;
16. All fishing cooperatives must fish in their concession areas, unless an agreement between cooperatives exist;
17. Standardise the prices in the whole system;
18. Define fish sizes that apply to the whole system;
19. Establish closed seasons for all the species;
20. Get involved in activities for improving the environment and environmental education.

During workshops, the emphasis on marketing of the first NGO contrasted with the conservation approach of the LEBR management team. As a result, in 2012, CONANP allied with another NGO to get more funding and the former abandoned the process. Co-management continued with more emphasis on institutional building, promoting cooperative norms to regulate the fishing activity and monitoring. In 2013, CONANP created two co-management committees at the fishery level that were facilitated by the new NGO: the inter-cooperative committee and the technical-scientific committee. The inter-cooperative committee met three or four times a year, brought together the leaders of the eight involved fishing cooperatives and aimed at coordinating actions and agreeing on shared norms. This committee counted on the advice of the technical-scientific committee, in which participants evaluated the results of co-management and made proposals to improve them. The technical-scientific committee met twice a year and was composed of the leaders of the inter-

cooperative committee (i.e. fishers), CONAPESCA, INAPESCA and research centres (i.e., ECOSUR and UNICACH) as permanent members, but also accepted occasional participants such as other fishers' representatives, government organizations, researchers and NGOs.

By opening up a space for discussion and deliberation between fishers and other stakeholders, both the workshops and the consultative technical-scientific committee established the basis for self-recognition. In the committee, participants discussed the sustainability of the fishery and government officers and researchers advised fishers based on the results of co-management. This collaborative atmosphere contrasted with previous historical fisher's attitudes of confrontation and protest towards national and regional government authorities (e.g., CONAPESCA, SEPESCA) and the paternalist attitude that these authorities showed fishers. Interviewees from government agencies, NGOs and researchers acknowledged they now had more trust in the fishers' capacity to act as fishery stewards. As the CONANP's delegate in Chiapas described, the co-management process facilitated understanding between fishers and the fishery authority, encouraged a process of the former's self-esteem. Moreover, and for the first time since the LEBR was established, CONANP became a key actor of fisheries management in the protected area, mainstreaming the conservation goal into the fishery management agenda:

> "[The co-management process] has been useful to show CONAPESCA that not all fishers are an absolute disaster in South Pacific, to show SEPESCA and other authorities related with production that there are other ways of doing things that allow people to make it better. And that the conservation approaches are not an obstacle for production." (G06, CONANP's political delegate in Chiapas).

Also, CONAPESCA and SEPESCA, that hold formal authority over the fishery, recognised CONANP's role and its contribution to the improvement of the fishery management. Seemingly, fishers increasingly accepted CONANP as an ally on fishery issues, changing the bad perception they had since the declaration of the biosphere reserve. This is exemplified by a leader of *La Palma* who recognizes and welcomes the higher involvement of CONANP in fishery management and its economic support:

> "Now we have a better relationship with CONANP because at least they now also monitor the no-take areas and the harvest (…). Based on that, they send us projects, temporary jobs. They help us with these temporary jobs. (…) Five years ago, they did nothing of this." (P02, leader of *La Palma* cooperative).

In terms of procedure, a number of actors could participate in fishery management and coordinate their respective actions through the co-management committees. Among all actors, CONANP, with the support of a new NGO, could gain local support for conservation-orientated norms through intervening in the assemblies of the fishing cooperatives, organizing social events in the communities, rewarding economic support, and joining with CONAPESCA to establish new restrictive norms as mandatory for the renewal of fishing concessions. However, such growing influence of CONANP in local decision-making created division among some co-management participants, both at the fishery and community level. For example, some interviewees from research centres and other governmental bodies blamed CONANP for 'controlling too much the decision-making process', while others, such as the following testimony from INAPESCA, considered that fishers needed a government authority promoting coordinated local decision-making:

> "They [fishers] need to make decisions globally, in a joint, coordinated way (…). This needs to be done by a government organization because the fishers alone will not do it. This organization has to be CONANP, I would like to do it myself, but I would have more troubles than CONANP, because they are there, on a daily basis, and I cannot." (G04, delegate of INAPESCA in Oaxaca and Chiapas).

Similarly, at community level, a leader of the fishing cooperative *Luchadores* also recognized the relevant role of CONANP in regulating the fishing activity but reported that fishers from other involved cooperatives did not agree with some conservation measures such as no-take areas because they felt these were an imposition that deterred them from fishing:

> I heard fishers from other cooperatives saying, (…) '[CONANP officers] are doing things badly, they imposed the no-take areas where we fishers cannot fish anymore because it belongs exclusively to the biosphere reserve'. This is a mistake because it is not like this, they said clearly to us 'the no-take area is for you, no fishing, no blockage, when the stock goes out, you can fish it'. But it does not belong to CONANP or anyone else but the fishers" (C01, leader of *Luchadores del Castaño*).

Local decision-making mechanisms, through the fishers' assemblies, did not change. However, women and young fishers achieved higher opportunities to participate. CONANP dedicated increasing resources to those cooperatives who involved females in their decision-making processes, and trained groups of young fishers in leadership skills to be more confident and

intervene in discussions during the assemblies. As a result, *La Palma* and *Luchadores* accepted two new female members each and *Luchadores* incorporated two young fishers into the cooperative's board. The recognition and procedural dimensions of the co-management initiative are summarized in Table 5.3.

Table 5.3 Recognition and participation equity dimensions of the co-management scheme at fishery and community levels

	Fishery level	Cooperatives	
		La Palma	***Luchadores del Castaño***
Recognition	Fishers and government authorities changed their historical relationship from fishers' protest and authorities' paternalism towards mutual trust and collaboration. Participants mostly recognized CONANP's authority on fishery issues. CONANP promoted the enrolment of female fishers in the cooperatives and more active participation of young fishers within them.		
Participation	The leaders of the eight fishing cooperatives strengthened collaboration and promoted fishery-level norms through the inter-cooperative committee, facilitated by CONANP and ACMT. The leaders of the inter-cooperative committee, CONAPESCA, INAPESCA, research centres and other invited participants, participated in local decision making in the technical-scientific committee, facilitated by CONANP and ACMT.	Two female fishers gained access to local decision-making through their enrolment to the fishing cooperative.	Two female fishers gained access to local decision-making through their enrolment to the fishing cooperative. Two young fishers became leaders of the cooperative.

5.4.2. Equity in outcomes

This section turns now to explore the outcomes of the co-management fishery to date, looking at procedural, ecological and socio-economic outcomes, and using the lens of equity where applicable. The first of these outcomes, as highlighted earlier, concerns the fit of co-management norms with the practices and ecological conditions of the local fishery. In this regard, we can say that the studied initiative has been successful in translating the new collaborative institutional arrangements highlighted in the previous section into the voluntary development of no-take areas and some additional regulations by either all or some cooperatives, respectively, mostly by adapting national legislation to the local ecological conditions of the fishery and even establishing more restrictive regulation (see a sign of a no-take area in Figure 5.5).

Figure 5.5 Sign of a no-take area

For example, the *Luchadores* cooperative established a closed season for blackthroat cichlid (*Astatheros macracanthus*) and three spot cichlid (*Amphilophus trimaculatum*) and a new regulation of their fishing zones that promoted a widespread use of more selective fishing gear, prioritizing hooks that could be used in all fishing areas, moderating the use of cast nets, and restricting trammel nets to a few and little accessible waters. In turn, *La Palma* established a temporary no-take area to protect white snook (*Centropomus viridis*) (See Figure 5.6). Such new voluntary regulations were strictly established following fishers' ecological knowledge because, as interviewees of INAPESCA and UNICACH reported, there was insufficient scientific knowledge about the behaviours of these species in LEBR to advice fishers on the best periods and fishing waters to stablish closed seasons and no-take areas. As such, these new norms were more coherent with local ecological conditions than the two official closed seasons that affected the inner waters of LEBR to protect flathead grey mullet (*Mugil cephaus*) and white mullet (*Mugil curema*) which, according to interviewees, did not coincide with the spawning periods of these species in LEBR and, in turn, were not endangered locally.

Figure 5.6 Sign of the temporary no-take area in *La Palma*

Regarding compliance, CONANP and the new NGO established monitoring patrols with fishers to achieve four aims: controlling fishers' compliance towards local and national norms; assessing the performance of no-take areas; tracking the evolution of catches; and measuring the catch per unit of effort in each fishing cooperative. In 2015 (when fieldwork was conducted), these monitoring activities lacked accuracy to test for any significant improvement of the ecological status of the fishery, no-take areas performance or changes in catch per unit of effort. However, a CONAPESCA officer interviewed acknowledged that collaborative surveillance had been effective in involving fishers to voluntarily improve their fishing practices and compliance. Similarly, the NGO representative reported that displaying the results of monitoring to each cooperative's assembly was useful to incentivize fishers to comply. Both in *La Palma* and *Luchadores*, interviewees recognized that after their involvement in co-management, fishers caught fewer juveniles thanks to the use of bigger mesh sizes and the release of by-catch. In *Luchadores*, interviewees reported that fishers renounced to use illegal gear and fishing techniques, such as the use of artificial shelters for attracting and catching fish.

The establishment of mechanisms to resolve emerging conflicts among fishing cooperatives often related to disputes about the use of each cooperative's fishing waters were successful. However, in this case, fishery-level negotiation mechanisms did not prove useful to resolve existing conflicts at the cooperative level. For example, in *La Palma*, despite fishers being more aware of the perils of using the most effective fishing gear, the 33 owners of stow nets did not relinquish to this illegal gear. Interviewed fishers who did not own stow nets revealed that they had demanded a restriction of its use in several assemblies of the fishing cooperative. However, the owners of stow nets prevented any regulation in this sense. A member of *La Palma* cooperative describes the discussions in the cooperative fishing assemblies:

> "There are many discussions [among cooperative members]. I do not think they will remove stow nets, but they can be moderated: 15 stow nets every other week. (…) This way they would kill fewer small fish and shrimp could reach the sea to spawn. (…) During the assemblies, the cooperative leaders have accepted a moderation of use, but after one hour nobody accepts." (P37, member of *La Palma* cooperative)

Our data generally shows that interviewees perceived positive ecological and socio-economic outcomes from co-management, who nonetheless held contrasting perceptions about the recovery of fish populations both at fishery and cooperative levels. At the fishery level, the NGO officer overseeing collaborative monitoring perceived an increase of shrimp (*Litopenaeus* sp.) but a decrease of snook (*Centropomus* sp.) and three spot cichlids (*Amphilophus trimaculatum*). A scientist from UNICACH warned that such observations should be assessed over the long term, due to the natural interannual variability of fish populations, and regretted the lack of scientific monitoring. At the cooperative level, fishers' views were even more diverse. In *Luchadores*, most fishers had observed a recovery of commercial fish. For example, one interviewee mentioned an increase of abundance and size of white snook (*Centropomus viridis*) over the past three years, while another argued that he had observed a significant number of juveniles of blackthroat cichlid (*Astatheros macracanthus*) and three spot cichlids (*Amphilophus trimaculatum*) which had dramatically decreased over the previous years. In contrast, eight fishers in *La Palma* reported a decrease of fish populations, while only four members witnessed an increase and two did not see any change.

Interviewees of both cooperatives also had contrasting views about the effects of co-management on their income from the fishing activity: although most acknowledged a recent increase in the commercial price of fish, only in *Luchadores* did fishers generally agree that their economic situation had improved in recent years. In contrast, most fishers in *La Palma* had not observed any changes in fishing revenue. Finally, regarding other economic and infrastructure outcomes, CONANP employed fishers temporarily to perform conservation tasks of the fishing areas, including signposting of no take areas and reforestation of mangroves. The fishing cooperatives also received infrastructure to manage the harvest, e.g. ice makers, cool chambers, and filleting tables (see Table 5.4 for a summary of ecological and socio-economic outcomes).

Table 5.4 Distributional equity in outcomes

Outcomes	Fishery level	Cooperatives	
		La Palma	*Luchadores del Castaño*
Process	Compliance towards national and local norms increased.	The new local norms were more suited to local ecological and social conditions.	The new local norms were more suited to local ecological and social conditions.
	Conflicts among fishing cooperatives were addressed in the inter-cooperative committee.	Although compliance levels increased, some fishers kept using the illegal gear stow net.	The fishers of *Luchadores* were generally acknowledged by co-management participants to be the fishers that complied the most.
		Existing local conflicts were not resolved.	
Ecological	There are no reliable sources of information to assess any changes in fish populations.	Predominant perception of a continued decrease of fish populations.	Predominant perception of a recovery of certain commercial fish populations.
Socio-economic		Mixed observations about the impact of co-management on fishers' income from the fishery activity.	Mixed observations about the impact of co-management on fishers' income from the fishery activity.
		Economic subsidies, temporary jobs and fishing infrastructure.	Economic subsidies, temporary jobs and fishing infrastructure.

5.5. Discussion

The results suggest two important features of the co-management initiative, which have implications for understanding the mechanisms through which co-management develops and results (or not) in an equitable resource management strategy. First, the important role of recognition as a basis for collaboration among previously hostile actors; second, the mechanisms through which participation became more plural enhanced knowledge integration and experimentation but failed in incorporating the voices of the most marginalized fishers. In what follows, we further discuss these two main issues.

Co-management workshops, and their evolution into more stable committees, were effective spaces for establishing the conditions for mutual recognition among actors during the early years of the co-management initiative. This was especially important for those actors who already had decision-making power at the national and local levels, i.e. government agencies and fishing cooperatives, who found a new formal forum to hear and understand each other demands, incorporate each other's knowledge and respect each other's authority on fisheries issues. Recognition, an often-neglected aspect in the analysis of equity in co-management literature, and in conservation initiatives in general (Martin *et al.*, 2016), became the fundamental pillar upon which co-management in LEBR was constructed, including a more participatory scheme with observed outcomes.

Such spaces of collaboration also allowed other stakeholders to participate and influence decisions at the local level. Workshops were useful to bring together a high diversity of actors and established a solid ground for those most committed actors to participate in co-management committees. The contribution of the different actors facilitated by CONANP further encouraged the integration of different kinds of knowledge and resulted in experimental actions and reflection over results. In this sense, the access of multiple actors established the path towards a form of adaptive co-management.

Despite improvements in recognition and procedural equity at the fishery level, co-management was not successful in achieving a fair distribution of benefits at the cooperative level. This could be explained, in the first place, because co-management did not target the most poor and marginalized. McDermott and Schreckenberg (2009) found that this was key for achieving equity in community forestry. Involving local fishers more actively in co-management, especially those

most marginalized, should put the question of equitable benefit distribution central in the co-management agenda. By paying consideration to power relationships within fishing cooperatives, co-management would minimize any possibilities to entrench an empowered and economically advantaged fisher elite (Davis and Bailey, 1996).

Local fishers' involvement in co-management was restricted to their participation in the cooperatives' assemblies. Consequently, the voice of the most marginalized fishers could not be heard in the fishery-level co-management committees. This could have affected the unequal distribution of benefits between fishing cooperatives, as the differences between *La Palma* and *Luchadores* reflect. In *La Palma*, since only richer fishers could afford the most expensive fishing gears, this could also probably explain why fishers had contrasting views about the recovery of fish populations. Whitehouse and Fowler (2018) found that those co-management initiatives that involved the community from the start and established groups of participants to guide the implementation of co-management were more successful in addressing social equity. Also, d'Armengol et al. (2018) found that the capacity of co-management initiatives to involve participants representing a diversity of interests and socio-economic levels were key conditions to achieve the highest level of co-management outcomes and improve users' compliance. The LEBR co-management scheme should find ways to include local fishers, not only the leaders, more actively in the future implementation of co-management to improve local fair distribution of co-management benefits, including the restoration of fish populations and increase of catches, and achieve higher levels of compliance, especially in *La Palma*, where socio-economic differences among fishers are more pronounced than in *Luchadores*.

5.6. Conclusions

The research around co-management has so far paid little attention to social equity issues. This article proposes a three-dimensional framework for assessing the fairness of its institutional design and distribution of benefits. Our results show that recognition among previously hostile actors was key for enabling more plural access to decision-making. However, the failure to engage the most marginalized actors prevented a fair distribution of co-management benefits between and within fishing cooperatives.

Overall, this case study shows that social equity cannot be assumed as a by-product of power-sharing in co-management (Quimby and Levine, 2018) and that further attention is needed to

assess the multiple dimensions of equity and the different scales in which these can be analysed. Policy-wise, the LEBR case shows two important lessons. First, that new co-management initiatives need to allocate sufficient time and flexibility for actors that do not usually collaborate to find ways to engage with each other. Second, that effectively involving the most marginalized local users is key for achieving a fair distribution of co-management benefits.

6. Exploring mental models in the co-managed small-scale fishery of the LEBR

"Collaboration requires integrating a diversity of perspectives."

In:

d'Armengol, L., I. Ruiz-Mallén, C. Barnaud and E. Corbera (revisions needed). Mental models of a fishery co-management system in La Encrucijada Biosphere Reserve, Mexico. *Ecology and Society*.

6.1. Abstract

The analysis of 'mental models' improves our understanding of how people perceive that a given system works. We elicited and compared mental models of the small-scale fishery co-management scheme in the biosphere reserve of *La Encrucijada*, Mexico, by interviewing stakeholders at the fishery system and community levels. In co-management, local users, governments and other actors supposedly collaborate in joint decision making. Our analysis shows that most co-management stakeholders perceive it to be a centralized scheme in which government agencies support local fishers mainly through economic incentives. It also shows that collaborative decision-making processes and negotiation mechanisms to accommodate divergent interests are insufficient. These findings suggest that government actors needed to have invested more resources and time in making the co-management regime better known, accepted and internalized by participants, particularly local fishers. In doing so, we argue, fishery co-management schemes like the one analysed in this article can minimize social conflict over the access and use of local fisheries and avoid exacerbating uneven power relations and forms of local elite capture.

Key words: Collaborative management; decision-making power; protected area; shared understanding; small-scale fishery

6.2. Introduction

Investigating stakeholders' understandings of complex social-ecological systems can improve our knowledge of how and why they identify problems, and envision solutions to deal with them (Mathevet *et al.*, 2011; Lynam and Fletcher, 2015). Collaboration requires integrating a diversity of perspectives through social learning, and can lead to improved ways to manage socio-ecological systems that accommodate these multiple perspectives (Kotschy *et al.*, 2015). Perspectives that are too divergent can prevent collaboration and prompt conflict (Gray, 2004; Pahl-Wostl, 2006). Therefore, several authors have suggested that collaborative processes for managing social-ecological systems require involved actors to hold a certain level of shared understanding of how the system works (Ansell and Gash, 2008; Berkes, 2010a). This is especially the case in protected areas, which often need to deal with competing interests and expectations, e.g. among conservationists and locals (Oldekop *et al.*, 2016).

A shared understanding is a structure of collectively created meaning that emerges in and helps coordinating activities of a group to achieve shared goals (Ansell and Gash, 2008; Mathevet *et al.*, 2011). It can be achieved by processes of social learning among participants involving communication and negotiation (Armitage, Marschke and Plummer, 2008). This requires acknowledging different understandings and identities to make new meaning in which a diversity of inputs is included (Bouwen and Taillieu, 2004).

Co-management, the sharing of power and responsibility between the government and local users (Berkes, 2009), has proven useful to improve the sustainability of social-ecological systems governance (Gutiérrez, Hilborn and Defeo, 2011). Co-management can improve the ecological conditions of natural resources and the livelihoods of its users through strengthening compliance to management rules and facilitating social learning among participants (Evans, Cherrett and Pemsl, 2011; d'Armengol *et al.*, 2018). Co-management partnerships are often enriched with multiple stakeholders, which can increase both the knowledge available and the legitimacy of the process (Pearson and Dare, 2019). However, collaboration among actors holding different views and understandings is not straightforward. Co-management scholars argue that efforts should be focused to achieve a certain level of shared understanding of the management actions to take (Ansell and Gash, 2008; Berkes, 2010a). However, pluralists claim that, when a plurality of perspectives is in place, consensus can be impossible to achieve or reached only temporarily (Leach and Fairhead, 2001) and that such an emphasis on consensus can mask different and even conflicting views (Wollenberg, Anderson and Edmunds, 2001). These authors emphasize instead

the importance of mutual understanding, i.e. respect for the different views, values, skills, methods and experiences of different actors (Leeuwis, 2000; Wollenberg, Anderson and Edmunds, 2001). Shared understandings are therefore a facilitating factor but not necessarily a pre-requisite factor for collaboration. Achieving shared understanding takes time and is usually a product of the collaborative process.

Stakeholders' understandings, and shared understandings, can be analysed through representations of individual mental models (Mathevet *et al.*, 2011). Mental models are internal cognitive representations of an external reality that people construct and use to interact with this reality (Lynam and Brown, 2012; Jones *et al.*, 2014). They are by nature subjective and therefore incomplete representations, the result of personal experiences, perceptions and understandings of the world, that people use to filter new information, reason and make decisions, and adapt to changing circumstances through learning (Jones *et al.*, 2011a).

The elicitation of mental models has gained momentum in NRM scholarship, in order to understand how a given social-ecological system works according to different people (Lynam and Brown, 2012). Researchers have also elicited mental models to improve NRM policies and practice, by revealing different perceptions of an environmental issue or problem (Horowitz *et al.*, 2018), identifying priorities of resource use and management (Stone-Jovicich *et al.*, 2011), understanding stakeholders' views of risks and benefits of collaboration for biological pest control (Salliou and Barnaud, 2017) and devising the best ways to improve users' practices (Vuillot *et al.*, 2016).

In this article, we investigate participants' understanding of a co-managed scheme in the fishery of the *La Encrucijada* Biosphere Reserve, Mexico. We analyse participants' understandings of the components of the system, how it is managed, and the roles of the main actors. Our objective is to identify what the shared understandings are and what divergences persist after six years of co-management. We interviewed four types of participants that were considered relevant at the level of the fishery system: leaders of fishing cooperatives, representatives of government agencies, representatives of NGOs, and researchers. We hypothesized that we would observe different mental models between these different types of co-management participants due to their different interests and positions. We also assumed that comparing only the main types of co-management participants at the fishery system level (e.g. leaders of fishing cooperatives) may hide the understandings of the most marginalized actors (e.g., local fishers), and overlook important divergences in understandings among participants of co-management. Therefore, we also

analysed stakeholders' understandings of co-management at community level by eliciting and comparing the mental models of the members (i.e. local fishers) of two fishing cooperatives.

Specifically, we ask: what are the shared elements and the main divergences of understanding within and among the four main types of participants in co-management and the members of two main cooperatives? We then discuss what the implications of the existence of either shared or conflicting aspects of these understandings are for the future management and sustainability of the fishery. To answer our research question, we first elicit the individual mental models of the interviewees belonging to the four types of co-management participants and the members of the two selected cooperatives. We then group the mental models by type of participants, and by fishing cooperative, to discern the shared and diverging aspects of the analysed mental models.

The selected case study, i.e. the fishery co-management program of *La Encrucijada* Biosphere Reserve (LEBR), is relevant for our purpose because it groups a diversity of actors, who had not collaborated before and that, often, had contrasting goals. The declaration of the protected area in 1996 and the management plan in 1999, without consultation with local people, produced conflicts between locals and the national government, because many of the local uses of the ecosystems were restricted (Romero-Berny and Guichard-Romero, 2015). The co-management initiative, established in 2009, was seen as an opportunity for fishers and the management office of the LEBR to collaborate in pursuit of common goals. It was also seen as a platform to attract NGOs to work with the reserve and to enhance the collaboration with research institutions, which until then had only focused on studying the ecological aspects of LEBR while overlooking fishers' interests.

6.3. Methods

6.3.1. The fishery of *La Encrucijada*

LEBR (Figure 6.1) extends over 144,868 ha along the Mexican Pacific coast, in the state of Chiapas, Mexico. It is an UNESCO's Biosphere Reserve, as well as a wetland of international importance under the Ramsar Convention. The reserve's estuarine system is home to the most productive and well-developed mangroves of the Tropical Pacific coast (Instituto Nacional de Ecología, 1999) sheltering a high biological diversity (Contreras, 2010) and encompassing the highest fish

richness of all the estuarine-lagoon systems along the Mexican Pacific (Gómez González *et al.*, 2012).

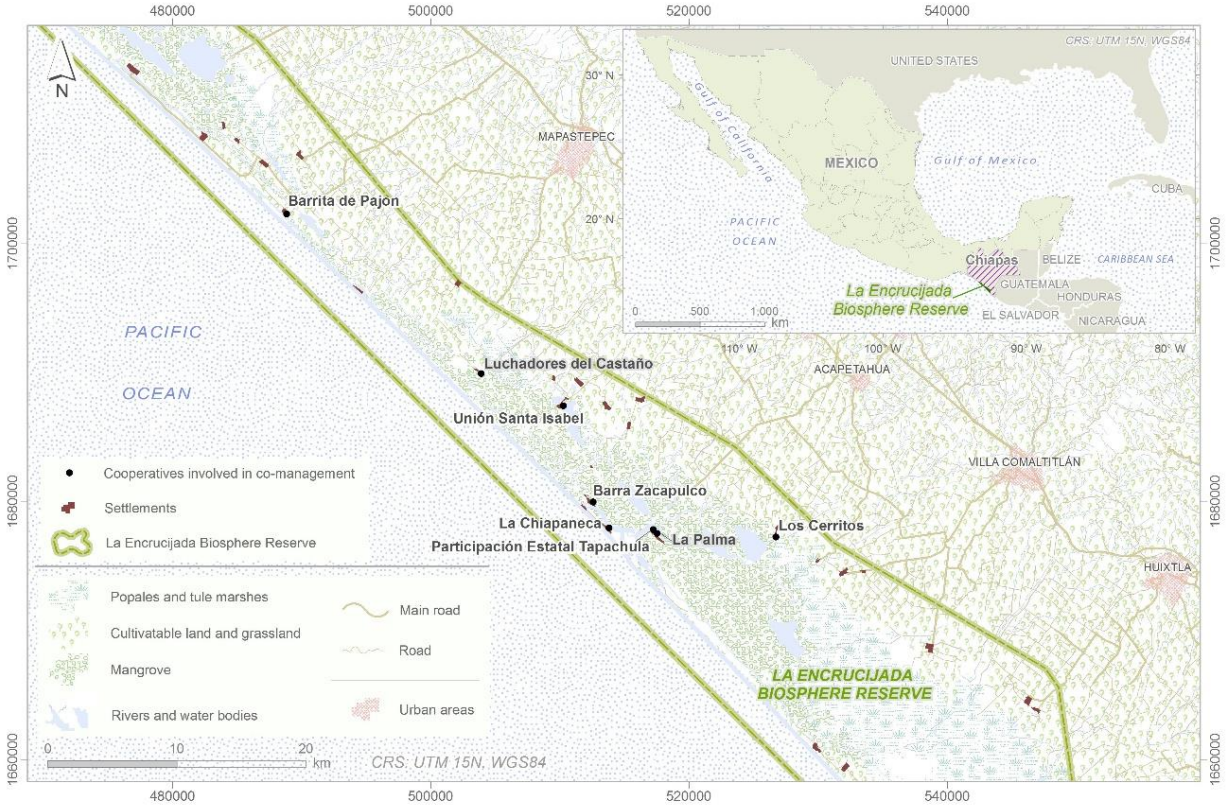

Figure 6.1 Location of the *La Encrucijada* Biosphere Reserve and the cooperatives participating in co-management. Sources: GADM the Database of Global Administrative Areas (https://www.gadm.org/), Gobierno del Estado de Chiapas: Geoweb Chiapas 3.0 (http://map.ceieg.chiapas.gob.mx/geoweb/), Comisión Nacional de Áreas Naturales Protegidas.

Eighty-two communities are located within the reserve, which represent approximately 27,000 people (Instituto Nacional de Ecología, 1999). Their main economic activities are agriculture, livestock breeding and fishing. The latter is the main livelihood source for those living in the core areas of the reserve, who fish for subsistence and commercial purposes. Educational levels among fishers are low and, on average, they have about four years of school attendance (Rodríguez Perafán, 2014).

From a total of 24 fishing cooperatives that use the resource, 18 have territory use rights through concessions in the estuarine system and six have fishing permits to fish in open waters. Those

using the estuarine system can fish up to 46 different species of fish, including crustaceans and bivalves (Rodríguez Perafán, 2014), often on fibre-made cayucos with outboard motors, and employing a variety of fishing gear, including cast nets, trammel nets, hooks, harpoons, stow nets and the collective gear shrimp corrals. Cooperatives fishing in open waters harvest more than 21 species of fishes and crustaceans (CONAPESCA, 2015) using boats and trammel nets.

In 2009, the local office of the National Commission of Natural Protected Areas (CONANP) in LEBR started a co-management scheme aimed at supporting fishers' livelihoods in response to a decline in fish stocks whilst adhering to the conservation objectives of the reserve. Four main types of participants were directly involved in the co-management scheme: fishing cooperatives that involve most fishers, government agencies, research centres, and NGOs. The system targeted eight fishing cooperatives based around one of the main lagoon systems in LEBR, i.e. *Chantuto-Panzacola*. Six of the cooperatives fished in the estuarine system and two operated in open waters. Besides CONANP, the co-management scheme also involved other government agencies with responsibility for fisheries, at the local, regional and national level, to harmonize their actions. Research centres working in the area were also invited to contribute their knowledge about the fishery. Finally, NGOs were contracted to support and facilitate co-management activities and meetings.

Representatives of the four main types of co-management participants engaged via a technical-scientific committee to discuss the performance of the co-management activities and advise the leaders of the fishing cooperatives. In turn, the leaders of the fishing cooperatives regularly met in the inter-cooperative committee with CONANP and an NGO to negotiate and establish common fishing norms. The co-management scheme also incentivized the cooperatives' fishing activities through the improvement of fish commercialization e.g. by promoting post-harvesting practices and joint marketing actions, and the organization of training courses to improve fishers' knowledge and skills. This co-management scheme was called the 'responsible fishing program', referring to the FAO's Code of conduct of responsible fishing, which claims that "the right to fish carries with it the obligation to do so in a responsible manner so as to ensure effective conservation and management of the living aquatic resources" (FAO, 1995). See a wall painting promoting the 'responsible fishing program' at the facilities of the *Unión Santa Isabel* fishing cooperative in Figure 6.2.

Figure 6.2 Wall painting at the *Unión Santa Isabel* fishing cooperative

6.3.2. Data collection

Fieldwork was conducted by the first author from April to September 2015 and comprised two phases. First, participant observation was implemented through her involvement in co-management and other fishery activities at both community and regional levels and was documented in field notebooks. Also, twelve semi-structured interviews were conducted with key informants who were more directly involved in the co-management scheme: i) government agencies, CONANP and SEPESCA; ii) fishing cooperatives, *Luchadores del Castaño* (hereafter *Luchadores*); iii) NGOs, ACMT and CASFA; and iv) research centres, ECOSUR. This first phase of fieldwork aimed at investigating the history and the outcomes of the co-management scheme to date and to identify the two most relevant fishing cooperatives for further investigation. *La Palma* and *Luchadores* cooperatives were chosen because, among the three that were first engaged in the co-management initiative, they were the two most engaged at time of fieldwork. Also, they had obtained different outcomes, as perceived by co-management participants. *Luchadores'* developed a more restrictive regulation to manage their fishing waters that resulted in recovery of certain fish populations. *La Palma*, strengthened their control over the price of fish products

towards the local intermediaries that operated in the fishery (d'Armengol, Corbera and Ruiz-Mallén, no date).

In the second phase, 31 interviews were conducted with the representatives of the organizations that were most involved in co-management and with members of the two fishing cooperatives (Table 6.1). Through the interviews we aimed to produce diagrammatic representations of individual mental models, i.e., graphs in which the nodes are concepts or objects and the links connecting nodes are relationships or associations between these concepts or objects (Dray *et al.*, 2006). The interviews with the representatives took place mostly in their workplaces and, in one case, in a cafe. The members of the cooperatives were randomly selected for interview by inviting them to be involved as they approached the cooperative facilities.

Table 6.1 Sampling strategy for the mental models' interviews

By type of co-management participant		
Type of participant	**Organizations involved**	**Interviews**
Fishing cooperatives	*Barra Zacapulco, Barrita de Pajón, La Chiapaneca, La Palma, Los Cerritos, Luchadores del Castaño, Participación Estatal Tapachula, Unión Santa Isabel*	6 (Leaders of *Barrita de Pajón, La Palma, Los Cerritos, Luchadores del Castaño, Participación Estatal Tapachula and Unión Santa Isabel*)
Government agencies	*Acapetahua* city council, CONANP, CONAPESCA, *Mapastepec* city council, SEPESCA	4 (Officers of *Acapetahua* city council, CONANP, CONAPESCA and SEPESCA)
NGOs	ACMT, CASFA, *Ser Integral Chiapas*	3 (Officers of ACMT, leaders of CASFA and *Ser Integral Chiapas*)
Research centres	ECOSUR, UNICACH	1 (Researcher of ECOSUR)
By fishing cooperative		
Fishing cooperative	**Members (i.e. fishers)**	**Interviews**
La Palma	126	8
Luchadores del Castaño	36	11

The elicitation of mental models followed an adaptation of the ARDI (actors, resources, dynamics and interactions) method for eliciting individual representations (Etienne, Toit and Pollard, 2008; Mathevet *et al.*, 2011; Vuillot *et al.*, 2016). Prior to starting the elicitation of each individual mental model (IMM), the first author explained that the purpose of the exercise was to draw a diagram of the actors, resources and activities that were related to the 'responsible fishing program', which

was the way all stakeholders referred to the co-management system. She explained that actors referred to any organization, institution, individual or group of people related to the co-management scheme, and resources referred to natural or other material goods within or mobilized throughout the system. These two concepts were not modified from the ARDI method. She then asked for activities involving actors and resources, instead of asking for dynamics or drivers of change as in the ARDI method. This modification aimed to adapt the methodology to the representation of a management system and to facilitate comprehension by less literate interviewees. Then, following the ARDI method, she asked interviewees to describe with a verb all connections among two concepts (actors, resources or activities).

To start illustrating the mental model and overcome any initial discomfort towards drawing, the first author asked each interviewee to explain, in their own words what the 'responsible fishing program' was. As the interviewee talked, the interviewer identified the actors, resources and activities from their words and wrote them down in post-its, displayed them on a whiteboard made of two DIN A4 laminated cardboard sheets, united them through arrows and labelled each arrow with a verb that described the relation between every pair of concepts united. Next, she asked the interviewee if the resulting diagram corresponded to what they had said and modified accordingly as needed. When the interviewee agreed with the representation, the interviewer encouraged them to continue drawing the mental model themselves. However, if the interviewee did not feel confident, she assisted in the drawing until all actors, resources, activities and interactions among them were represented. As many cardboard sheets as necessary were added to fit the growing diagram. See an example of a diagrammatic representation of a mental model in Figure 6.3). All mental model elicitation interviews were carried out in Spanish, recorded with permission of the interviewee, and typically lasted between 30 minutes and 1 hour and a half. Each diagram was coded and photographed for the analysis. Prior informed consent was gathered from all interviewees.

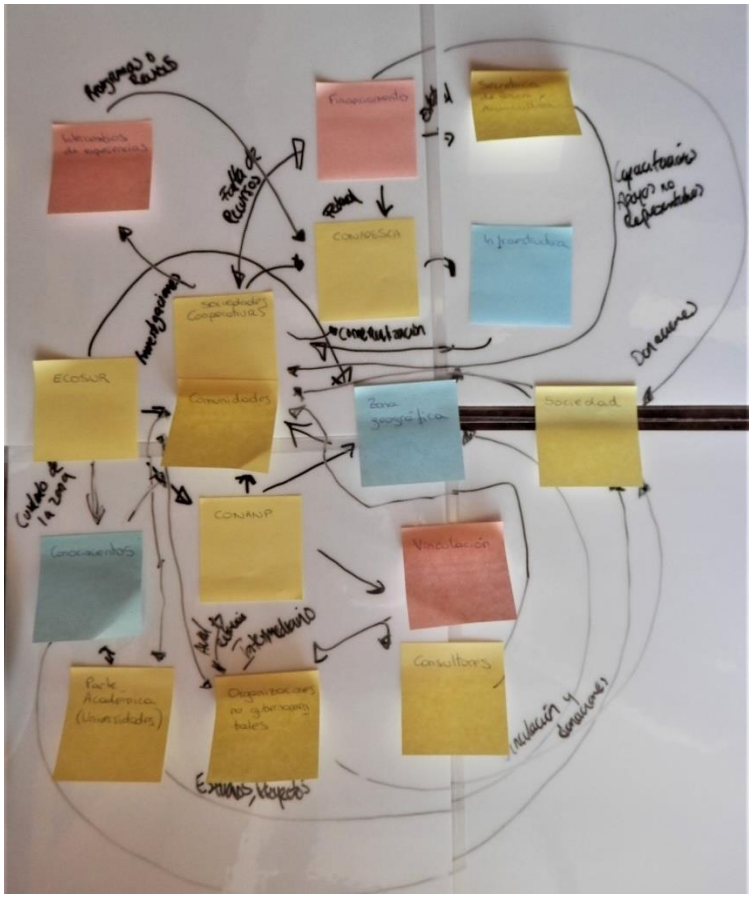

Figure 6.3 Diagrammatic representation of a mental model

6.3.3. Data analysis

Mental models were analysed at two levels. First, we developed a qualitative comparative analysis (Vuillot *et al.*, 2016) to explore differences and similarities among IMMs by comparing how actors, resources, activities and interactions were displayed in each mental model. Then, we built consensual group mental models (GMMs), which are aggregations of several IMMs representing only the most shared features. Five GMMS were built. Three of them were GMMs of the representatives of three out of the four main types of participants, i.e. fishing cooperatives, government agencies and NGOs. We did not build a GMM of the research centres, because we only could interview one of the two research centres involved. The two other GMMs were the ones of the members of the two fishing cooperatives chosen, i.e. *La Palma* and *Luchadores*. The GMMs aimed at qualitatively analysing the shared elements of understanding within and participant types and the two cooperatives.

To facilitate the analysis of the IMMs and the construction of the GMMs, we homogenized all concepts with similar meaning appearing in different IMMs (Vuillot *et al.*, 2016). For instance, *fishers*, *cooperative members* and *cooperative* were always transcribed as *fishers*, because all fishers involved in co-management are cooperative members and, locally, when people talked about the *cooperative* they referred to the *cooperative members*. *Fish*, *fish species* and *fishery resources* were always transcribed as *fish stock*. Also, when applicable, groups of concepts and relations (subgraphs) were condensed and replaced by a single concept that captured the meaning of the subgraph (Özesmi and Özesmi, 2003), for instance, *generating added value, better harvest registration, better facilities and better prices* were grouped under the term *commercialization* and *wood, wild fauna and birds* under the term *natural resources* (see Appendix 5 for the list of homogenized and aggregated concepts). When a concept was not clear, we checked the recorded interview to clarify its meaning (see individual mental models in Appendix 6).

We then created adjacency matrices (Özesmi and Özesmi, 2003; Vuillot *et al.*, 2016) for the three types of co-management participants in which all concepts of the IMMs headed the rows and columns of the matrix, and each link uniting two concepts was identified in the corresponding cell with the code/s of the IMM/s that mentioned the link. Those interactions connecting the two same concepts that were mentioned by at least 30% of the IMMs were represented in the GMMs (Vuillot *et al.*, 2016). This percentage was increased to 50% in the NGO's GMM to represent interactions mentioned in at least two of the three NGO's IMMs analysed. This consensus criterion was used to simplify the group model using a percentage of interactions that allowed for showing the important interactions without getting overwhelmed by concepts and interactions (Fairweather, 2010).

6.3.4. Limitations

We acknowledge some methodological limitations related to potential subjectivity in data collection and analysis. The assistance of the interviewer during elicitation exercises was necessary to capture mental models of less literate interviewees (e.g., fishers) that otherwise would have been omitted from the sample. To some degree, however, this may have led to a subjective interpretation of the explanations by the interviewee. To correct such a bias, the interviewer wrote down the concepts exactly as the interviewee named them and asked them to confirm that what she wrote matched their meaning. Similarly, the homogenization of similar concepts made during the data analysis could imply a degree of subjectivity, but we argue that

'imposing' a predefined set of concepts to choose from would have been more biased. The aggregation of the IMMs to build GMMs results in a simplification of the information that might hide interesting divergences among people, for example, when two IMMs of the same participant type mentioned an actor but linked it to different activities or resources. This was addressed by comparing the IMMs that contributed to each GMM and highlighting the most relevant similarities and differences. A final limitation that might have affected our results is the very different size of the samples of IMMs among the four participant types and the two cooperatives due to the different availabilities among targeted informants. Despite these limitations, we argue that our study makes a valuable contribution to the analysis of mental models in the context of a co-managed resource system.

6.4. Results

Here we describe the individual and shared understandings of interviewed participants at both system and community scales and highlight the main similarities and divergences between them.

The GMM of the interviewed leaders of the fishing cooperatives (Figure 6.4) shows CONANP and fishers united by a shared aim to preserve natural resources. CONANP is also viewed as endorsing fishers, meaning that it provides support and guidance towards a more sustainable fishing activity. The resulting GMM reflects that the fishing cooperatives' leaders do not agree on which governmental agency provides the funding, infrastructure and capacity building for co-management because their IMM show different agencies (see Coop05001, Coop014001, Coop025001 and Coop027001, Appendix 6). The GMM also highlights the role of the inter-cooperative committee as promoting a more favourable commercialization. Finally, the GMM only includes one type of activity for the fishers, which is their role in the management of established no-take areas and closed seasons. However, when looking at the IMMs of the interviewed leaders of the fishing cooperatives, the variety of roles conducted by fishers includes complying with fisheries' local and national regulations, doing surveillance, and promoting commercialization.

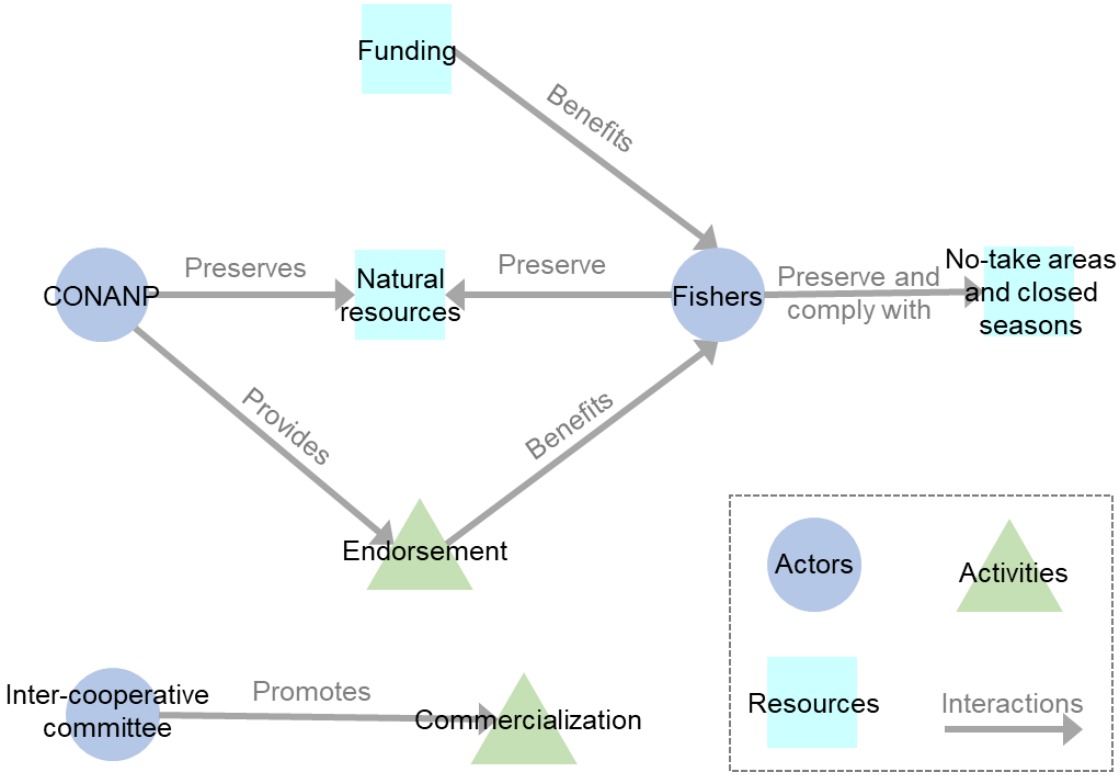

Figure 6.4 Group mental model of the leaders of fishing cooperatives

The two GMMs of members of the fishing cooperatives of *La Palma* and *Luchadores* (Figure 6.5) resonate with the GMM of the leaders of the fishing cooperatives (Figure 6.4) in that they identify two main actors: CONANP and fishers, but differ in that members do not represent the inter-cooperative committee. Both cooperatives' GMMs represent CONANP economically supporting fishers, and *Luchadores*' GMM also reflects that CONANP provides capacity building to fishers in the co-management context. Other participant types such as NGOs and research centres are not represented in the GMMs and are seldom identified in fishers' IMMs. By contrast, these two cooperatives' GMMs provide a rich picture of the activities that fishers do within the co-management scheme, which are mostly related to conservation, e.g., banning juveniles' fishing. It is also important to highlight that, while *La Palma*'s members emphasize the decision-making component of co-management, the members of *Luchadores*' represent the commercialization and conservation components.

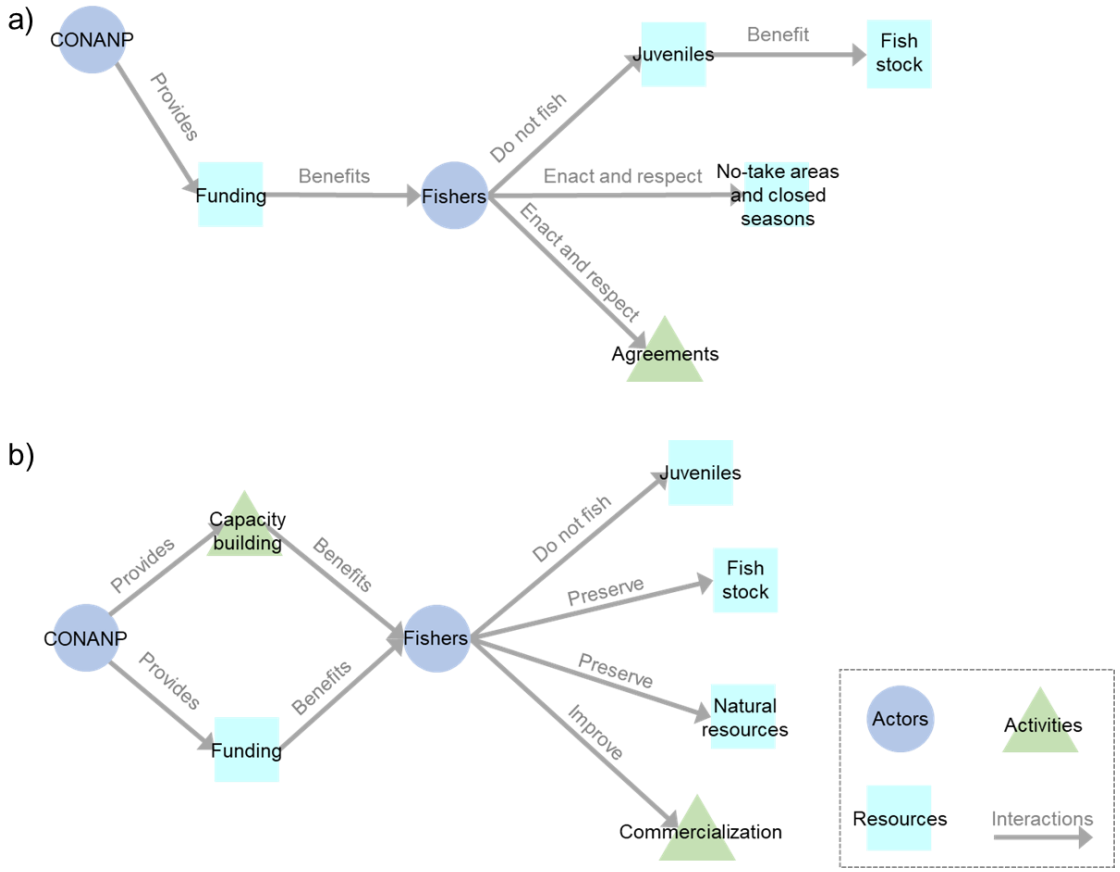

Figure 6.5 Group mental model of members of two fishing cooperatives: a) *La Palma* and b) *Luchadores del Castaño*

Figure 6.6 shows that the GMM of the representatives of government agencies includes all involved government agencies in the co-management scheme. Interviewed representatives see their role in co-management mostly as funding providers, although IMMs reveal other supportive roles such as promoting conservation, strengthening commercialization and providing capacity building. The GMM represents fishers doing 'responsible fishing practices', although it does not specify what this terminology means in practice. The GMM also recognizes the role of research centres as capacity builders but do not represents NGOs, which are shown in only one IMM (Gov00801, Appendix 6). Surprisingly, the GMM does not show any decision-making component. Only one IMM represents CONAPESCA enacting fisheries' norms (Gov027002, Appendix 6) and another represents fishers reaching agreements (Gov00801, Appendix 6).

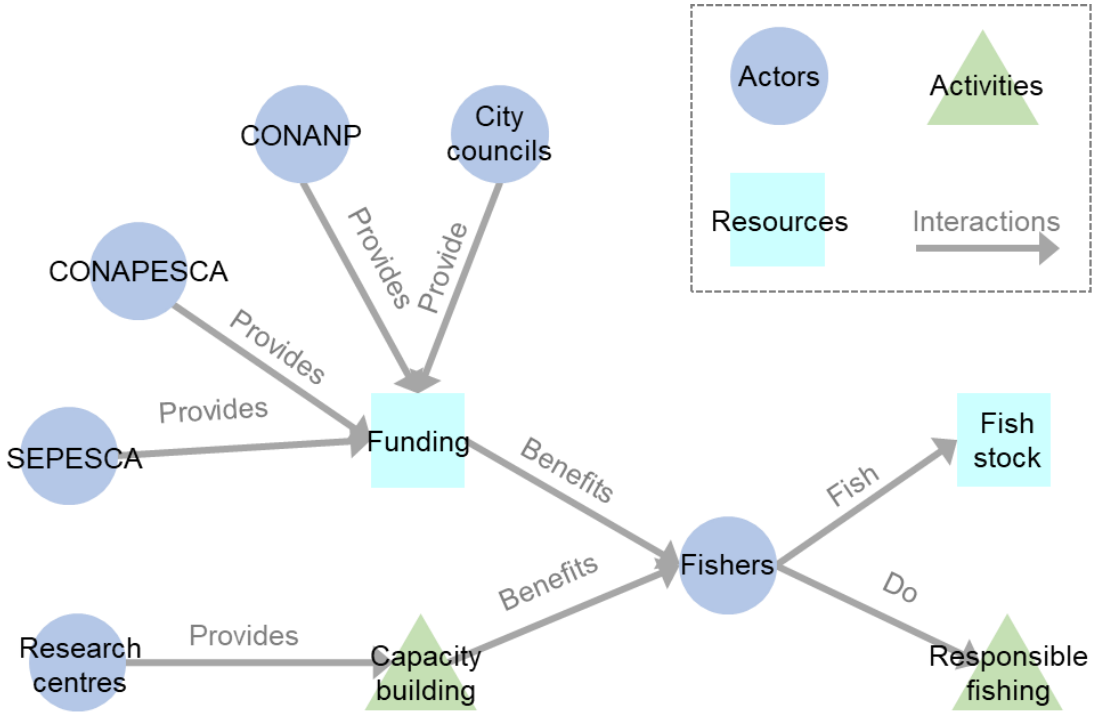

Figure 6.6 Group mental model of the representatives of the government agencies

The GMM of NGO representatives (Figure 6.7) does not represent themselves or the government agency that promoted co-management (i.e., CONANP). Fishers are represented as benefiters of co-management but are not attributed any agency. The simplicity of the GMM results from the divergence of the IMMs that comprise it. While one NGO representative (NGO028001, Appendix 6) assigns the fishers a central place, attributing them several roles related with decision-making, local knowledge generation, and promotion of alliances with government and donor agencies, another representative (NGO00701, Appendix 6) restricts fishers' roles to communicating with CONANP and promoting commercialization through the inter-cooperative committee. The third interviewed NGO representative (NGO00601, Appendix 6) does not assign any agency to fishers and is the only one to represent NGOs as funding intermediaries between governments, donor agencies and the fishers.

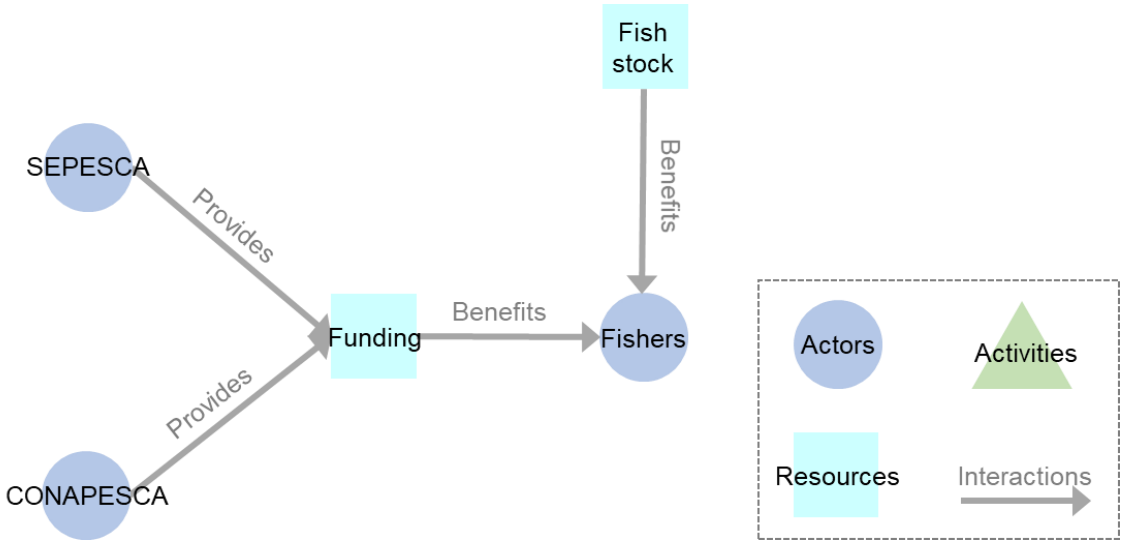

Figure 6.7 Group mental model of the representatives of NGOs

Finally, the individual mental model of the interviewed researcher (Figure 6.8) neatly differentiates three components of the co-management scheme, i.e. support to fishers, decision making and commercialization, and relates each actor with one or two of these components. This IMM identifies all participant types and almost all government agencies involved, except city councils. Interestingly, it only identifies CONANP supporting fishers by raising conservation awareness among them and endorsing them. It does not identify any economic support from any government agency or donor.

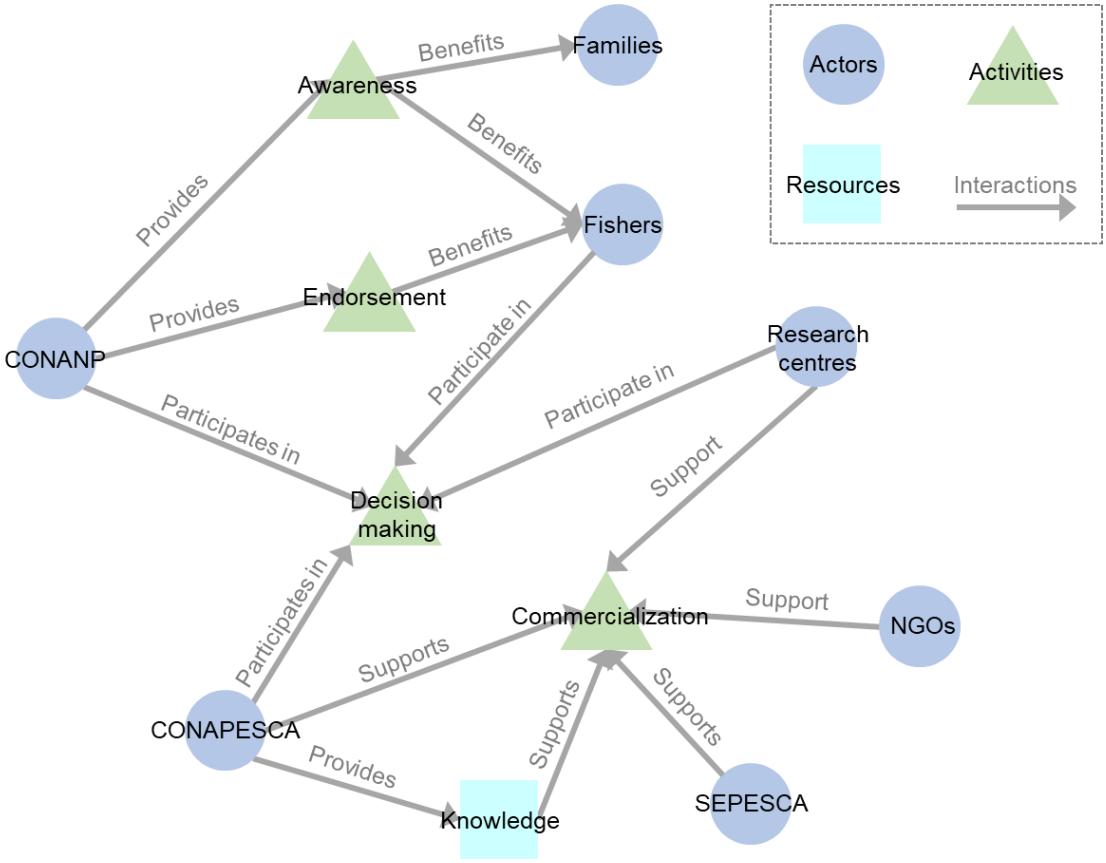

Figure 6.8 Individual mental model of the representative of a research centre

Overall, GMMs reveal an agreement among participants that co-management is a scheme in which different government agencies provide material and non-material support to fishers. CONAPESCA and SEPESCA are mostly represented as providers of financial support and CONANP is perceived as providing both funding and endorsement to fishers. According to the mental models analysed, only the representatives and members of fishing cooperatives have a clear understanding of the actions undertaken by fishers. The other GMMs reflect a lack of agreement about the activities conducted by the fishers within the co-management scheme, or a very vague understanding of their role in co-management. NGOs and research centres are rarely represented both in GMMs and IMMs.

All GMMs, except the GMM of the fishing cooperatives' leaders and *La Palma* cooperative members, lack representation of how decision-making is achieved in co-management. The few IMMs that mention one of the two co-management forums, the inter-cooperative or the technical-scientific committees, mostly relate them with commercialization. Commercialization, in turn, is broadly represented by interviewees, being shown by 14 IMMs and two GMMs.

6.5. Discussion

Mental models are incomplete representations based on personal experiences and perceptions (Jones *et al.*, 2011a). From the many components of co-management, participants internalised those that aligned better with their own actions and interests. This explains why the GMM of government agencies mostly reflects their role in supporting fishers whereas the GMMs of the members of *La Palma* and *Luchadores* cooperatives highlight the activities fishers develop in co-management. The GMMs of the members of the two cooperatives display the roles that they perceive as priorities in each cooperative: the fishers from *La Palma*, who have been more successful in commercialization of their fishery products, highlight their role in enacting local norms for conservation, whereas the fishers from *Luchadores*, who have prioritized fisheries restoration, highlight their role in enhancing commercialization. Both emphasize the roles on which they are the weakest, which might reflect a willingness to work on these aspects and improve their management.

Following the definition of co-management as an institutional arrangement in which at least users and government share decision-making power over resource management (Berkes, 2009), one would expect that the shared understanding of participants in the co-management scheme of LEBR would include local fishers, relevant government agencies involved (i.e. CONANP, CONAPESCA), and one or more components of collaborative decision-making (e.g., the inter-cooperative and the technical-scientific committees). As expected, the mental models of all four types of co-management participants reflect a partnership between fishers and government. However, the sharing of decision-making power between these two actors is overlooked by all stakeholders except from the IMM of the researcher. The representatives of the government and NGOs, as well as the members of the two fishing cooperatives, do not recognize any component of collaborative decision-making within the co-management scheme and highlight that government agencies provide support, often economic, to fishers.

The lack of collaborative decision-making components and the headlining of economic relations between fishers and government in most mental models is surprising and concerning. It is surprising because, even though CONAPESCA retains the legal authority in fisheries, the four main types of participants in co-management regularly use formal and informal mechanisms for collaborative decision-making. For instance, they all meet twice per year in the technical-scientific committee of LEBR fishery. They also participate in decision-making through informal mechanisms created within the co-management scheme such as participating in the assemblies of

the fishing cooperatives or organizing capacity-building activities. Instead of showing this reality, analysed mental models mostly reflect the centralized management arrangement that was in place before actors started collaborating. This might suggest that social learning processes among co-management participants have not yet been able to change this 'old' vision of the fishery management, perhaps because this kind of learning processes require more time and interaction (Suškevičs, Hahn and Rodela, 2019).

Since interviewed co-management actors should be aware of these participation mechanisms, because of their direct involvement, their absence in most mental models might also suggest they are not using them and, consequently, that decision-making in *La Encrucijada* fishery is not a result of negotiation between the different participants. In contrast, the representation of economic support in all GMMs reflects the shared and well-established understanding of the relation between government and fishers, framed in a historical context of state-led interventions for development and conservation, and promotion of cooperatives' productivity through subsidies and infrastructure investments (Young, 2001; García Lozano, Smith and Basurto, 2019). Such an approach based on economic incentives can result in detrimental social and ecological impacts if it is taken for granted by fishers and leads them to change their behaviour from active conservation agents to passive ones, as has been documented in the case of the payments for ecosystem services (Ruiz-Mallén *et al.*, 2015). Furthermore, a lack of shared understanding of the participation mechanisms can undermine the 'participatory' component of co-management or even lead to future project failures and conflicts due to a lack of accommodation of multiple views and interests (Leeuwis, 2000; Neef, 2008).

Finally, the different understandings of co-management decision-making components between the leaders and the members of the fishing cooperatives also deserve discussion. While the leaders clearly identify the inter-cooperative committee as a mechanism for the fishing cooperatives to agree on common norms, the GMMs of the members of *La Palma* and *Luchadores* do not recognize this function. This reveals the existence of different power positions at the community level that might imply the imposition of interests of leaders to the detriment of those who are more disadvantaged when negotiating co-management agreements (Wollenberg, Anderson and Edmunds, 2001). In some cases, like the one described in this paper, the design and implementation of co-management decision-making mechanisms seems to be favouring a form of elite capture at the community level (Agrawal and Gibson, 1999). To avoid this, it is necessary to acknowledge these power asymmetries and to strategically deal with them in the implementation

of the collaborative scheme, which requires both adapted methodologies and reflecting further on the ethos of the facilitators of such collaborative schemes (Barnaud and Van Paasen, 2013).

6.6. Conclusions

Our findings show that six years after the start of fishery co-management in LEBR, the old centralized management scheme remains in the consensual understandings of participants. The shared understandings, represented in the GMMs, and the comparison of IMMs also reflect important aspects of power-sharing among participants at both system and community levels. Namely, that the co-management decision-making mechanisms are not common knowledge among participant actors and that government agencies employ economic incentives to keep fishers engaged in co-management. Future conflicts may arise from an absence of negotiation mechanisms to accommodate divergent interests and positions, and in turn exacerbate existing power asymmetries at the community level by favouring forms of elite capture. Thus, the findings suggest that fishery co-management schemes, in LEBR and elsewhere, should encourage practices and mechanisms that rest in both engaging and functioning institutional arrangements, and aim to ensure that all participants, and particularly fishers, have *de facto* access to decision-making.

7. Conclusions

"We've been in bad shape ever since Columbus landed… But that's O.K. You can't go back. We must live in this modern world and do what we can to keep it livable"

(Billy Frank, Jr., chairman, Northwest Indian Fisheries, in Lee, 2013)

This dissertation set out to investigate social-ecological outcomes resulting from co-management schemes in small-scale fisheries and analyse how contextual and inherent characteristics of co-management shape such outcomes at both global and fishery scales. It has been guided by three main research questions, which have been addressed in three separate empirical chapters. Overall, the major contribution of the dissertation has been to provide analytical and empirical evidence on the co-management of small-scale fisheries and discuss what had been until today a rather unexplored research gap: their social equity implications and their ability or not to incorporate a diversity of actors' views in their institutional architecture.

The following sections summarise the main findings of the dissertation, present the theoretical and methodological contributions, outline policy implications and propose possible research avenues to advance the knowledge of small-scale co-managed fisheries.

7.1. Summary of findings

Chapter 4 of this dissertation has provided novel and robust evidence on the performance of co-management in small-scale fisheries worldwide. It set out to answer: *which are the contexts, attributes and outcomes of co-managed small-scale fisheries and how do the former affect the latter?* Based on a systematic review of 91 published case studies, chapter 4 demonstrates that co-management initiatives mostly achieve process (i.e. governance) outcomes, among which the increased participation of stakeholders and social learning stand out, as well as the development of new norms that better fit fishers' knowledge and local social-ecological conditions. Ecological outcomes are also relevant and positive in the studies reviewed, with increased abundance of species and improved habitats. Social outcomes, such as an increase of catches, are much less reported.

Chapter 4 has also shown that embracing a diversity of interests is the most important variable linked to positive outcomes. Compliance is positively related with participants representing the socio-economic diversity of the fishery whereas cooperation is negatively affected by the presence of industrial fishing. Finally, initiatives that adopt adaptive management principles preven new conflicts and strengthen the adaptive capacity of the fishery. Interestingly, the few case studies with data about previous management institutions and the effects of co-management on power asymmetries and conflicts indicate that replacing previous community-based systems is counterproductive, whereas replacing previous government-centred regimes results in improvements in both variables. Overall, the chapter shows that co-management outcomes have been generally positive worldwide but its effectiveness in resolving existing conflicts, reducing power asymmetries and distributing benefits equitably between co-management actors is more uncertain.

Chapter 5 has delved into the case study of a small-scale fishery in the LEBR of Mexico to analyse the equity dimensions of the institutional design, implementation and outcomes of co-management. The chapter was set out to answer: *How fair is the design and implementation of the co-management scheme in La Encrucijada and how equitable are its outcomes?* Grounded in 75 interviews and participant observation in the LEBR co-management initiative, the chapter identifies the main factors shaping co-management development in the fishery during the last six years and it describes participants' perceived outcomes, both at fishery and community level. Analysis of the institutional design and implementation of the co-management initiative has revealed that the recognition of all potential participants by the initiative's promoters facilitated a change of attitudes among participants, who moved from confrontation to collaboration, while establishing the basis for more participatory decision-making at the fishery level. However, the analysis at the cooperative level has shown that the initiative has so far been unable to resolve existing conflicts among fishers and has failed to facilitate effective access of the most marginalized fishers to decision-making. This, in turn, explains the incapacity of co-management to provide a fair distribution of benefits among local users. These results suggest that the co-management initiative should make additional efforts to include the most economically disadvantaged local users in the implementation of the initiative, as well as to ensure a more equitable distribution of benefits at both fishery and local levels.

Chapter 6 has also been grounded in the LEBR co-managed fishery, in order to analyse similarities and differences in understandings of the co-management scheme in LEBR. It set out to answer: *What are the shared elements and the main divergences of understandings within and among*

representatives of the four main types of stakeholders in co-management and the members of two main cooperatives? Informed by 31 diagrammatic representations of the mental models of co-management participants, the chapter has shown that participants in *La Encrucijada* share an understanding of co-management as a partnership of two main actors, i.e. government agencies and fishers, in which the former provide economic support to the latter. Most participants overlook a key aspect of co-management, i.e. the collaborative decision-making component. I have argued that the lack of understanding of negotiation mechanisms may lead to the emergence of conflicts due to a lack of accommodation of different views and interests or favour forms of elite capture at the local level. These findings suggest that the fishery co-management scheme needs to find more effective ways of engaging all participants, in order to make them (further) aware of negotiation procedures and in doing so increase the access to and legitimacy of decision-making and any resulting outcomes.

7.2. Theoretical and methodological contributions

Chapter 4 has advanced knowledge on CPR theory by providing evidence that co-management, a combination of communal and government property rights regimes, can be a solution to the sustainability of small-scale fisheries. The chapter has also demonstrated that co-managed small-scale fisheries are more likely to be successful if they embrace the diversity of interests and socio-economic status and adopt adaptive management practices. This chapter, together with previous works (e.g. Gutiérrez, Hilborn and Defeo, 2011), contributes to elucidating the 'enabling conditions for successful co-management', i.e., those contextual and inherent characteristics that help achieving positive co-management outcomes.

Chapter 5 has advanced social equity research on co-management by stressing the need to move away from the analysis of social equity only in terms of access to decision-making, i.e. procedural equity, to address also the distribution of benefits in co-management, i.e. distributional equity (e.g. Evans et al., 2011; Whitehouse and Fowler, 2018; Yang and Pomeroy, 2017). Additionally, the chapter has argued that co-management scholars need to incorporate recognition, i.e. mutual respect for the diversity of knowledge systems, values and social norms in place (Pascual *et al.*, 2014), upon which procedural and distributional equity are based. Chapter 5 has also provided evidence of co-management as an institutional approach that facilitates a more equitable access to decision-making. The LEBR case suggests that a fairer distribution of benefits will only be

achieved if co-management is capable of effectively engaging the most marginalized local users in decision-making.

Findings from the analysis of the co-management participants' mental models in chapter 6 have confirmed the assumption that stakeholders collaborating in environmental management and decision-making have a certain level of shared understanding (Berkes, 2010a). However, it has provided novel and surprising evidence on the fact that this shared understanding may reflect the 'old' centralized management scheme and omit the new collaborative decision-making mechanisms.

Methodologically, the main contribution of this dissertation has been the framework developed in chapter 4 for the analysis of co-management in small-scale fisheries. This framework follows previous efforts to adapt Ostrom's framework (Ostrom, 2007, 2009) for analysing social-ecological systems to the specificities of small-scale fisheries (Gutiérrez, Hilborn and Defeo, 2011; Cinner *et al.*, 2012; Basurto, Gelcich and Ostrom, 2013; Ernst *et al.*, 2013; Partelow, 2015) by tailoring it to *co-managed* small-scale fisheries. The framework now includes variables such as property rights, fishery type and power-sharing, and it incorporates characteristics of adaptive co-management, such as experimentation and social learning (Plummer and Armitage, 2007a; Plummer and FitzGibbon, 2007; Plummer *et al.*, 2012, 2014). I believe this framework can be useful to analyse initiatives of co-managed small-scale fisheries worldwide and pay attention to outcomes and the contextual conditions affecting their performance.

7.3. Policy implications and future research

Findings and reflections of this dissertation offer three main policy implications for the design and implementation of co-management schemes in small-scale fisheries globally, and a key learning aspect with implications to Mexico's formal policy on fisheries co-management. First, more attention needs to be placed in mainstreaming conflict-resolution mechanisms within co-management institutions, since our systematic review has shown that conflicts have been only reduced in about 30% of the reviewed initiatives worldwide. The results of the case study in Mexico confirm this finding: conflict-resolution mechanisms should be mainstreamed at the level of the co-management committees that bring together the diversity of stakeholders, in which only the representatives of fishers participate, as well as at community level, to guarantee spaces for discussion and resolution among users.

Second, this dissertation has made evident that co-management initiatives in small-scale fisheries need to establish negotiation spaces for joint decision-making and collaboration to accommodate different interests and views. As the results of the analysed case study suggest, co-management promoters need to make sure that all participants, especially those most marginalized actors such as local fishers, have access to, know and internalize these spaces. Otherwise, collaboration would not necessarily induce processes of social learning that change the understanding of the new institutional design, at least in the first years.

Third, findings of this dissertation have also drawn attention to the need of further investigations into the effects of co-management on changing existing power asymmetries and contributing to social equity, between participant stakeholders, but more critically between governments and fishers or fishing cooperatives. The systematic review has shown that only a small percentage of case studies address these outcomes and they show mixed trends. The LEBR case study has shown that distributional equity and local-level conflicts cannot be ameliorated or transformed unless the co-management initiative addresses existing power asymmetries and effectively includes most marginalized fishers in decision-making. The systematic review results also suggest that co-management is more successful in reducing power asymmetries and resolving conflicts when it replaces previous government-centred management regimes than when it replaces community-based co-management. These findings require further research that compares the effects of replacing these management regimes. Policy wise, these results suggest that before replacing community-based management for co-management, other options such as providing support to the local institutions should be considered.

Finally, the case study of LEBR demonstrates that co-management can emerge and deliver positive outcomes when there is no legal framework supporting such a management approach. As explained in the introduction, Mexico established the basis for fisheries co-management at the regional (not local) level but participatory councils have not been implemented. In this case study, CONANP' decentralization has been key in enabling co-management. However, CONAPESCA, the national government agency with authority in fisheries, is a highly centralized organization. To encourage co-management in other Mexican fisheries, not only in natural protected areas, CONAPESCA should deconcentrate management power to local CONAPESCA offices and officers. Only this way will co-management be a realistic management option for most Mexican fisheries along the two coasts of the country and inner waters.

8. References

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Appendix 1: Interview arrangement

A.1.1. Appointment template

Mi nombre es Laia, soy una estudiante española del Colegio de la Frontera Sur y la Universidad Autónoma de Barcelona. Estoy haciendo una investigación doctoral sobre la pesca y el programa de pesca responsable en La Encrucijada. Ahora estoy recogiendo información sobre la historia de la comunidad y la pesca. Sé que tú eres una persona que tienes información sobre esto. Por eso me gustaría hablar contigo cuando te vaya mejor durante un mínimo de media hora o una hora.

A.1.2. Introduction and end of the interview

Mi nombre es Laia, soy una estudiante española del Colegio de la Frontera Sur y la Universidad Autónoma de Barcelona. Estoy haciendo una investigación doctoral sobre la pesca (y el programa de pesca responsable) en La Encrucijada. Estoy entrevistando gente con información sobre la pesca con el objetivo de elaborar una tesis doctoral y de recopilar información que pueda ser útil para el manejo de la pesca en La Encrucijada y en México.

La información que me proporcione será confidencial y su nombre será apuntado sólo por mi propia referencia, utilizando un código que sólo yo conozco, aunque esta información se puede publicar si usted así lo desea.

Me gustaría grabar la conversación para no perderme nada importante de lo que me dice, pero si lo prefiere podría simplemente tomar notas.

¿Tiene alguna pregunta?

¿Me daría el consentimiento para poder grabarle?

[ENTREVISTA]

Si algunas cuestiones importantes no me han quedado suficientemente claras, resumir la información que me ha dado el entrevistado. Recordarle que esta información es para un proyecto de investigación doctoral.

Pedir información personal: edad, tiempo en el cargo/organización/programa de pesca responsable, en qué otra organización estaba anteriormente, qué ha estudiado, nombre completo, teléfono y/o e-mail.

¿Le podría hacer una segunda entrevista en unas semanas?

Le agradezco mucho el tiempo que me ha dedicado. Voy a estar en México/la comunidad hasta [fecha] y me puede contactar para cualquier duda o información que desee. Le puedo dar mi número de teléfono o correo electrónico para eso.

Apuntar: fecha, lugar de la entrevista, duración, hora,

Después de la entrevista: comprobar grabación y notas, resumir la entrevista en pocas palabras.

Hacer la transcripción no más tarde de una semana.

A.1.3. Material

1. Guía de la entrevista;
2. Bolígrafo;
3. Libreta;
4. Grabadora;
5. Cámara de fotos.

Appendix 2: Interview guides

A.2.1. Interview guide 1, addressed to representatives of organizations (but fishing cooperatives)

Pesquería de La Encrucijada

- ¿Cómo definirías la pesquería de La Encrucijada? ¿Cuáles son sus principales retos a nivel social y ecológico?

Programa de pesca responsable

- ¿Qué es el programa de pesca responsable y cuáles son sus objetivos?
- ¿Cuándo se involucró en el programa y en qué actividades ha participado?

Organización

- ¿Cuáles son la visión y misión de la organización que representa?
- ¿Cuánto hace que esta organización está involucrada en el PPR y por qué se involucró?
- ¿En qué actividades ha participado hasta ahora usted o otras personas de la organización? ¿Y con qué financiación?

Comité intercooperativo y técnico-científico

- ¿Me podría explicar qué es el comité inter-cooperativo/técnico-científico? ¿Cuándo se fundó y qué objetivos tiene?
- ¿Participa usted o su organización? ¿Qué otros participantes hay o ha habido anteriormente? ¿Cómo cubren los costos del viaje y asistencia?
- ¿Cuántas reuniones han hecho hasta el momento y qué temas se han tratado?
- ¿Qué se ha conseguido hasta el momento?

20 acuerdos inter-cooperativos

- ¿Qué son los 20 acuerdos inter-cooperativos? ¿Cómo y con qué objetivo se establecieron?
- ¿Cómo se aprobaron en cada cooperativa? ¿Se están cumpliendo? ¿Por qué?

Áreas de reserva pesquera

- ¿Qué son las áreas de reserva pesquera y qué objetivos tienen?

- ¿En qué cooperativas se han establecido y cómo se han elegido? ¿Se han mantenido estables o se han cambiado? ¿Por qué? ¿Se están respetando por los pescadores?

Monitoreo colaborativo

- ¿Cuándo se empezó a hacer monitoreo y con qué objetivos? ¿Quién participa y en qué consiste? ¿Y cómo se cubren los costos del viaje y asistencia?
- ¿Qué han observado hasta el momento? (¿qué datos han conseguido?)
- ¿Cómo hacían el monitoreo las cooperativas antes del PPR?

Resultados

- ¿Qué ha conseguido el Programa de pesca responsable hasta el momento? ¿Y qué le falta conseguir?

Datos personales

Nombre, cargo, e-mail de contacto, formación

A.2.2. Interview guide 2, addressed to fishers

Actividad pesquera

- ¿A qué edad empezó a pescar? ¿Continúa pescando? (¿Cuándo lo dejó?)
- ¿Le acompañan normalmente a pescar? ¿Quién? ¿Es suya la embarcación que usa o a quién pertenece? ¿Tiene motor la embarcación? ¿De cuántos caballos?
- ¿Qué peces pesca más? ¿Con qué arte de pesca?
- ¿Qué meses del año pesca regularmente? ¿Cuántos días pesca a la semana y cuántas horas más o menos al día?
- ¿Quién regula qué meses, días y horas pesca y en qué zonas? ¿Se decide en la cooperativa? ¿Pesca otros meses, días, horas y zonas fuera de estos? ¿Hay alguna zona donde nunca o a veces no pesque? ¿Cómo lo decide? ¿Hay algún pescado que nunca o a veces no pesque? ¿Cómo lo decide?
- ¿Qué cantidad pesca diariamente en temporada alta? ¿Y en temporada baja? ¿A qué precio vende el kilo de las especies que pesca? ¿Lo vende a través de la cooperativa? ¿Y de otra persona? ¿Quién?
- En caso de que haga actividades de procesado del pescado y/o camarón, ¿con qué peces de escama o camarón trabaja principalmente? ¿Qué proceso hace a cada uno (secado, limpiado, salado)?
- ¿Hace otra actividad diferente de la pesca? ¿Cuál? ¿Desde cuándo?
- ¿Cuántas veces por semana su familia come pescado que ha pescado o procesado algún miembro de la familia? ¿Y cuántas veces por semana su familia come pescado que ha comprado? ¿A quién suele comprarlo?

Cooperativa

- ¿Cuáles son los principales retos que afronta su cooperativa?
- ¿Están siempre de acuerdo en todo, los miembros de la cooperativa? ¿En qué cosas discrepan, por ejemplo? ¿Por qué cree que no todo el mundo piensa igual en estos temas que comenta? ¿Cómo llegan a un acuerdo? Y por ejemplo, si un pescador comete alguna acción que el resto de pescadores sabe que está mal, ¿qué hacen? ¿Me puede poner un ejemplo? ¿Qué consecuencias tiene ese pescador?
- Cuándo hay un problema con otra cooperativa ¿Cómo lo resuelven? ¿Me puede poner un ejemplo?
- Y en una situación imaginaria, si de repente se encontraran que no hay peces, por ejemplo, por un huracán, azolvamiento o contaminación, ¿Cómo lo resolvería usted?

¿Cómo lo resolverían en su cooperativa? ¿Me podría dar un ejemplo que les haya ocurrido?

Programa de pesca responsable

- ¿Cuál son los principales objetivos del Programa de pesca responsable? ¿Qué ha conseguido hasta ahora el Programa de pesca responsable? ¿Cuáles son los principales problemas que impiden la pesca responsable?
- ¿Usted a cuántos talleres de capacitación para la pesca ha asistido? ¿Qué aprendió?
- ¿Qué organizaciones/individuos están involucrados en el Programa de la pesca responsable? ¿Con cuál de ellos tiene mayor relación?

Resultados

ASPECTOS ECOLÓGICOS

- ¿Cómo están las poblaciones de camarón y escama ahora? ¿Mejor o peor que hace 6 años? ¿Por qué?
- ¿Y las tallas pescadas de los peces? ¿la variedad de peces ha variado y cómo?
- ¿Y los sitios importantes para la reproducción, cría, alimentación y refugio de pescado son los mismos o han variado? ¿cómo?
- ¿Cree que las aguas están más contaminadas? ¿Y el azolvamiento ha aumentado?

ASPECTOS MATERIALES

- ¿Y se pesca más o menos que antes? ¿Por qué? ¿Se gana más con la pesca? ¿O por otras actividades?
- ¿Qué organizaciones les ayudan a obtener mayores ganancias? (por ej., de la comercialización)

ASPECTOS SOCIALES

- ¿Participa más o menos en la cooperativa desde hace 6 años? ¿Cómo y cuándo? ¿Por qué participa cada vez más o cada vez menos? ¿Y en el programa de pesca responsable?
- ¿Con qué organizaciones se relaciona más ahora que antes? ¿Cómo les apoyan estas organizaciones?

APRENDIZAJE

- ¿Qué es lo que ha aprendido con el Programa de pesca responsable (por ejemplo, normas que regulan la pesca más adecuadas a las condiciones ambientales/sociales, que tienen en cuenta conocimiento pescadores, o sobre biología y ecología del pescado, o de

técnicas de pesca, más sustentables, o para procesar el pescado, o para conservarlo)? ¿Qué aprendizajes le han servido más? ¿Por qué?

Datos personales

- ¿Cuántas personas viven en su casa? ¿Situación civil? (soltero/a, casado/a, en convivencia, padre/madre, soltero/a, viudo/a)
- ¿Edad? ¿Sexo? ¿Qué ha estudiado?
- ¿Ha recibido ayudas económicas o materiales usted u otro miembro de la familia? ¿Me puede explicar qué tipo de ayuda era? ¿Recibe la ayuda una vez al año o más a menudo? ¿Qué cantidad de dinero recibe o ha recibido? ¿O qué material ha recibido? ¿Quién se lo ha dado?

Appendix 3: Focus groups

A.3.1. Focus groups with fishers

A.3.1.1. Guide

Objetivos

1. Conocer la historia de la cooperativa (incluyendo la iniciativa de co-manejo);
2. Identificar organizaciones y grupos civiles involucrados y relación entre ellos;

Reclutamiento

El reclutamiento va a ser en las instalaciones de la cooperativa. El grupo lo van a conformar 3 o 4 directivos de la cooperativa y 2 o 3 pescadores mayores de su confianza. Más que tener una muestra representativa, se quiere conseguir un grupo de personas que se tengan confianza y buena relación y una visión similar del manejo para no crear conflictos y conseguir este clima de diálogo y confianza. Asimismo, se intentará que los participantes tengan suficiente edad como para saber de la historia de la cooperativa.

Material

1. Grabadora;
2. Cámara de fotos;
3. Papeles de colores pequeños y grandes;
4. Rotuladores de colores;
5. Papel grande que sirva de pizarra;
6. Cinta adhesiva que se pegue y despegue fácilmente, tipo cinta de enmascar;
7. Carpetas de plástico;
8. Refrigerio.

Guía de facilitación

1. Mi intervención será la de preguntar y facilitar la discusión. No voy a tomar notas más pero sí voy a escribir en los papeles cuando no se lo requiera a uno de los pescadores;

2. Introducir cada tema y luego minimizar los comentarios más allá de aclaraciones. No dirigir sino dejar que los participantes analicen el tema desde todos los puntos de vista que quieran;

3. Si surgen tensiones, mantenerme neutral y tranquila. Si dos participantes se contradicen, intervenir para validar los dos puntos de vista y hacer avanzar la discusión con otros temas;

4. Encontrar un buen balance entre generar confianza y formalidad, para que me tomen seriamente, pero sin intimidar, y vigilando que no se desvíen de mi objetivo.

Introducción al grupo focal

1. Les voy a pedir que me dediquen dos horas de su tiempo para hacer dos dinámicas entre todos.

2. La primera es para conocer la historia de la cooperativa, y la segunda es para saber los diferentes actores importantes para el manejo de la pesca en LEBR y, en concreto, en *La Palma*.

3. Quiero poder escucharles a todos, porque cada uno tiene una visión personal que enriquece a la visión colectiva. Y no hay respuestas buenas ni malas.

4. Con su permiso voy a grabar la conversación para no tener que estar tomando notas y también quizás tomo alguna foto si no les molesta.

Ejercicio 1. Historia de la cooperativa

Me gustaría que me contaran los eventos más importantes que han pasado en la historia de la cooperativa. Vamos a dibujar una línea horizontal en un papel grande, que va desde la fecha de creación de la cooperativa (1941) hasta ahora.

1. En esta línea dibujaremos las cosas más importantes que han tenido un impacto en la cooperativa.

2. Cada uno puede decir un evento y yo lo voy a poner en la gráfica.

3. Vamos a ir comentado cada evento entre todos. ¿Qué pasó? ¿Cómo afectó a la comunidad? ¿Cómo afectó a la cooperativa o a la pesca?

4. ¿Qué más eventos han pasado que sean importantes? ¿Por qué? ¿Cómo han influido?

Ejercicio 2. Sociograma

Ahora vamos a representar los diferentes actores que más influyen sobre la pesca: artes de pesca, períodos y horarios de pesca, vedas, especies que se pescan o no, apoyos a la pesca, etc.

1. Primero, que cada uno diga uno y lo escribo en un papelito de diferente color, según:

a. Instituciones de gobierno

b. Instituciones no gubernamentales, asociaciones civiles

c. Otros grupos o personas

2. Ahora vamos a ubicar a los actores en el eje Y según los que influyen más y menos. ¿Por qué creen que es así?

3. Por último, vamos a poner en el eje X según los que influyen de forma más de acuerdo con ustedes, o menos.

Despedida

Agradecerles todo lo que me han contado, que espero que hayan pasado un buen rato y decirles que he aprendido mucho de ellos.

Fuentes

Longhurst, R., 2010. Semi-structured interviews and focus groups, in: Clifford, N., French, S., Valentine, G. (Eds.), *Key Methods in Geography*. Sage, London, UK, pp. 103–115.

Newing, H., Eagle, C., Puri, R., Watson, C.W., 2011. *Conducting research in conservation: A social science perspective*. Routledge, London, UK. https://doi.org/10.4324/9780203846452

Ruiz-Mallén, I., De la Peña, A., Méndez-López, M.E., Porter-Bolland, L., 2013. Local participation in community conservation: Methodological contributions, in: Porter-Bolland, L., Ruiz-Mallén, I., Camacho-Benavides, C., McCandless, S.R. (Eds.), *Community Action for Conservation: Mexican Experiences*. Springer Science+Business Media, New York, USA, pp. 117–133. https://doi.org/10.1007/978-1-4614-7956-7_8

A.3.1.2. Resulting diagrams of the focus group in *La Palma* cooperative

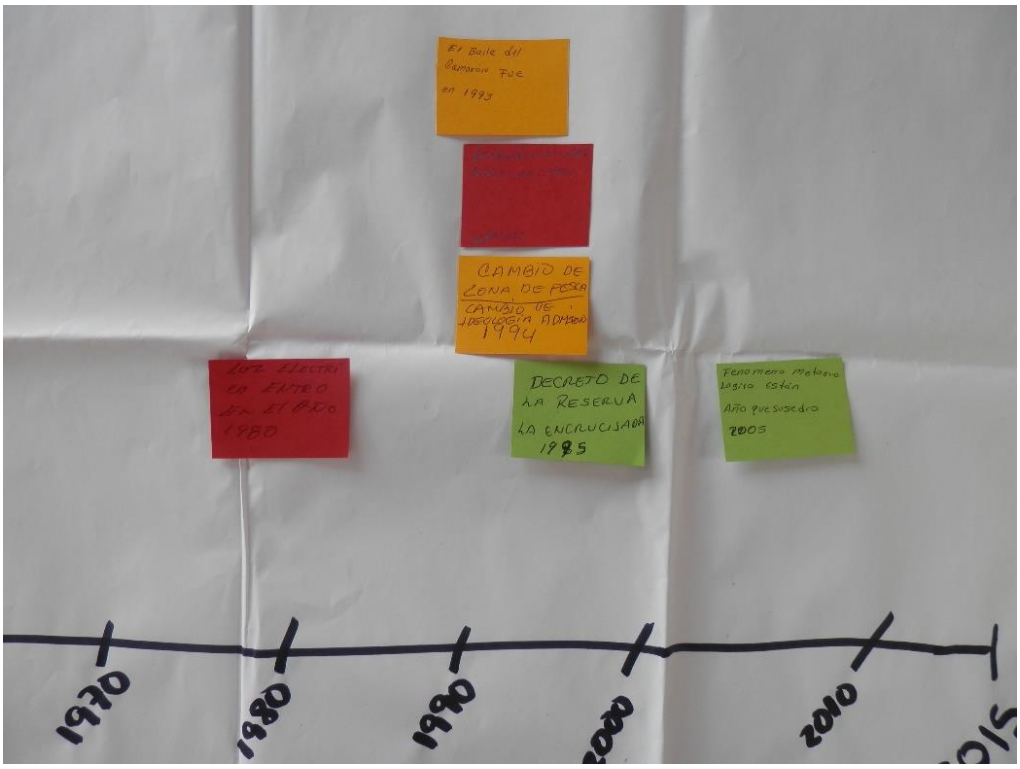

Figure A.3.1 History of *La Palma* cooperative

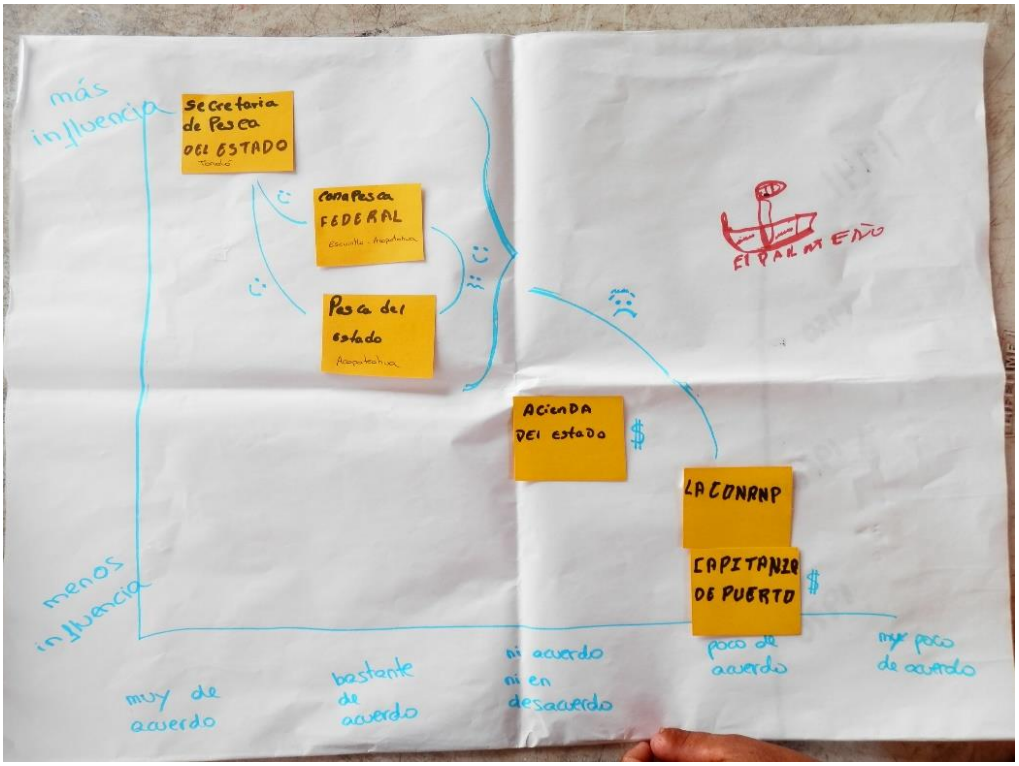

Figure A.3.2 Sociogram of organizations with responsibility on fishery management

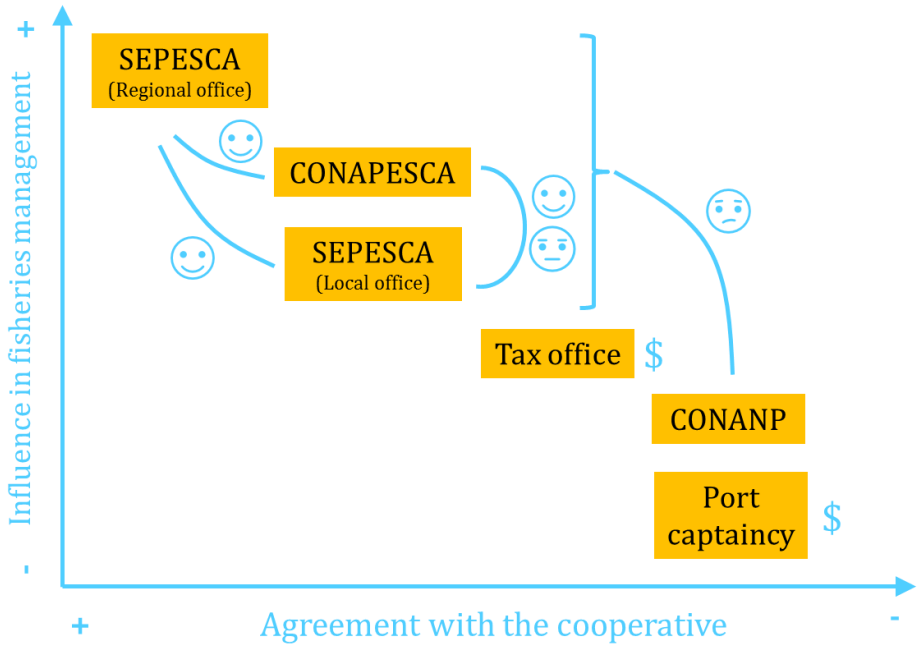

Figure A.3.3 Reproduction of the sociogram in English

A.3.1.3. Resulting diagrams of the focus group in *Luchadores del Castaño* cooperative

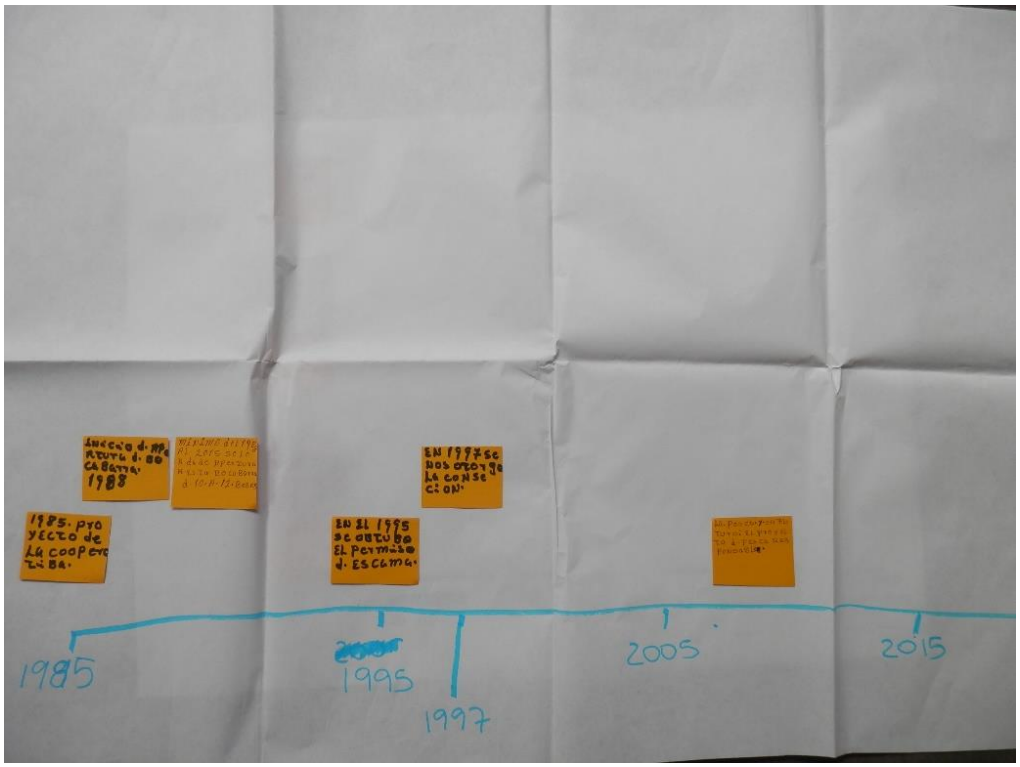

Figure A.3.4 History of *Luchadores del Castaño* cooperative

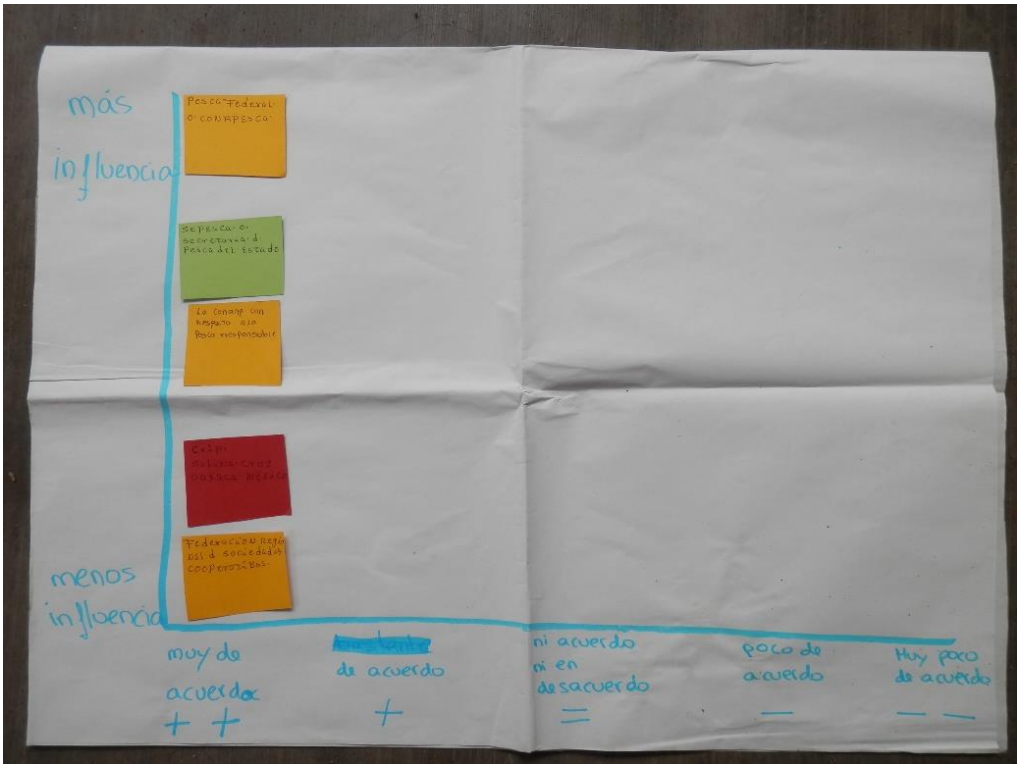

Figure A.3.5 Sociogram of organizations with responsibility on fishery management

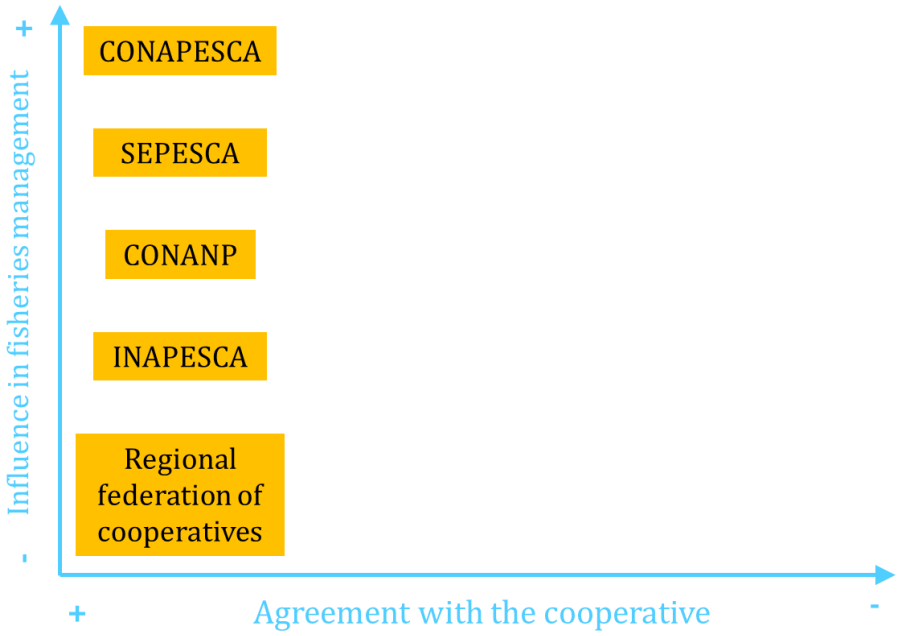

Figure A.3.6 Reproduction of the sociogram in English

A.3.2. Focus group with CONANP and ACMT officers

A.3.2.1. Guide

Objetivos

1. Conocer la historia de la iniciativa de co-manejo;
2. Identificar relación con otras comunidades;
3. Identificar organizaciones y grupos civiles involucrados y relación entre ellos;

Reclutamiento

El reclutamiento va a ser en las oficinas de la Dirección de la Reserva, a partir del técnico responsable del Programa de pesca responsable, preguntar personas que están o han estado relacionadas con el programa. Más que tener una muestra representativa, se quiere conseguir un grupo de personas que se tengan confianza y buena relación y una visión similar del manejo para no crear conflictos y conseguir este clima de diálogo y confianza.

Material

1. Grabadora;
2. Cámara de fotos;
3. Papeles de colores pequeños y grandes;
4. Rotuladores de colores;
5. Papel grande que sirva de pizarra;
6. Cinta adhesiva que se pegue y despegue fácilmente, tipo cinta de enmascar;
7. Carpetas de plástico;
8. Refrigerio (preguntaré a los técnicos de Pronatura que trabajan con ellos que será mejor ofrecerles).

Guía de facilitación

1. Mi intervención será la de preguntar y facilitar la discusión. No voy a tomar notas más pero sí voy a escribir en los papeles cuando no se lo requiera a uno de los pescadores;

2. Introducir cada tema y luego minimizar los comentarios más allá de aclaraciones. No dirigir sino dejar que los participantes analicen el tema desde todos los puntos de vista que quieran;

3. Si surgen tensiones, mantenerme neutral y tranquila. Si dos participantes se contradicen, intervenir para validar los dos puntos de vista y hacer avanzar la discusión con otros temas;

4. Encontrar un buen balance entre generar confianza y formalidad, para que me tomen seriamente, pero sin intimidar, y vigilando que no se desvíen de mi objetivo.

Introducción al grupo focal

1. Les voy a pedir que me dediquen dos horas de su tiempo para hacer dos dinámicas entre todos.

2. La primera es para conocer la historia del trabajo de la REBIEN con pescadores, sobre todo con el Programa de Pesca Responsable, y la segunda es para saber los diferentes actores importantes para el manejo de la pesca en La Encrucijada.

3. Quiero poder escucharles a todos, porque cada uno tiene una visión personal que enriquece a la visión colectiva. Y no hay respuestas buenas ni malas.

4. Con su permiso voy a grabar la conversación para no tener que estar tomando notas y también quizás tomo alguna foto si no les molesta.

Ejercicio 1. Historia del manejo de la pesca en La Encrucijada

Me gustaría que me contaran los eventos más importantes que han pasado en relación al manejo de la pesca en La Encrucijada. Vamos a dibujar una línea horizontal en un papel grande, que va desde la fecha de creación de la Reserva de la Biosfera (1995).

1. En esta línea dibujaremos las cosas más importantes que han tenido un impacto en el manejo de la pesca.

2. Para empezar, les reparto estos papelitos donde pueden escribir, con pocas palabras, el evento que consideran más importante.

3. Vamos a ver, que cada uno explique el suyo, qué ha escrito. ¿Por qué es el más importante? ¿Cómo ha influido al manejo de la pesca?

4. Si hay alguno repetido, empezamos colocando este. Y continuamos colocando otro.

5. ¿Consideran que estos eventos explican la historia del co-manejo? ¿Por qué? ¿Cómo han influido?

6. ¿Qué más eventos han pasado que sean importantes? ¿Por qué? ¿Cómo han influido?

7. Si hay tiempo: ¿qué eventos van a pasar en el futuro para alcanzar los objetivos?

Ejercicio 2. Sociograma

Ahora vamos a representar los diferentes actores que más influyen a la decisión de los pescadores en relación a la pesca: artes de pesca, períodos y horarios de pesca, vedas, especies que se pescan o no, etc.

1. Primero, que cada uno diga uno y lo escribo en un papelito de diferente color, según:

a. Instituciones de gobierno

b. Instituciones no gubernamentales, asociaciones civiles

c. Otros grupos o personas

2. Ahora vamos a ubicar a los actores en el eje Y según los que influyen más y menos. ¿Por qué creen que es así?

3. Por último, vamos a poner en el eje X según los que influyen de forma más formal (leyes, reglamentos) o de forma más informal (acuerdos verbales….).

Despedida

Agradecerles todo lo que me han contado, que espero que hayan pasado un buen rato y decirles que he aprendido mucho de ellos.

Fuentes

Longhurst, R., 2010. Semi-structured interviews and focus groups, in: Clifford, N., French, S., Valentine, G. (Eds.), *Key Methods in Geography*. Sage, London, UK, pp. 103–115.

Newing, H., Eagle, C., Puri, R., Watson, C.W., 2011. *Conducting research in conservation: A social science perspective*. Routledge, London, UK. https://doi.org/10.4324/9780203846452

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A.3.2.2. Resulting diagrams of the focus group

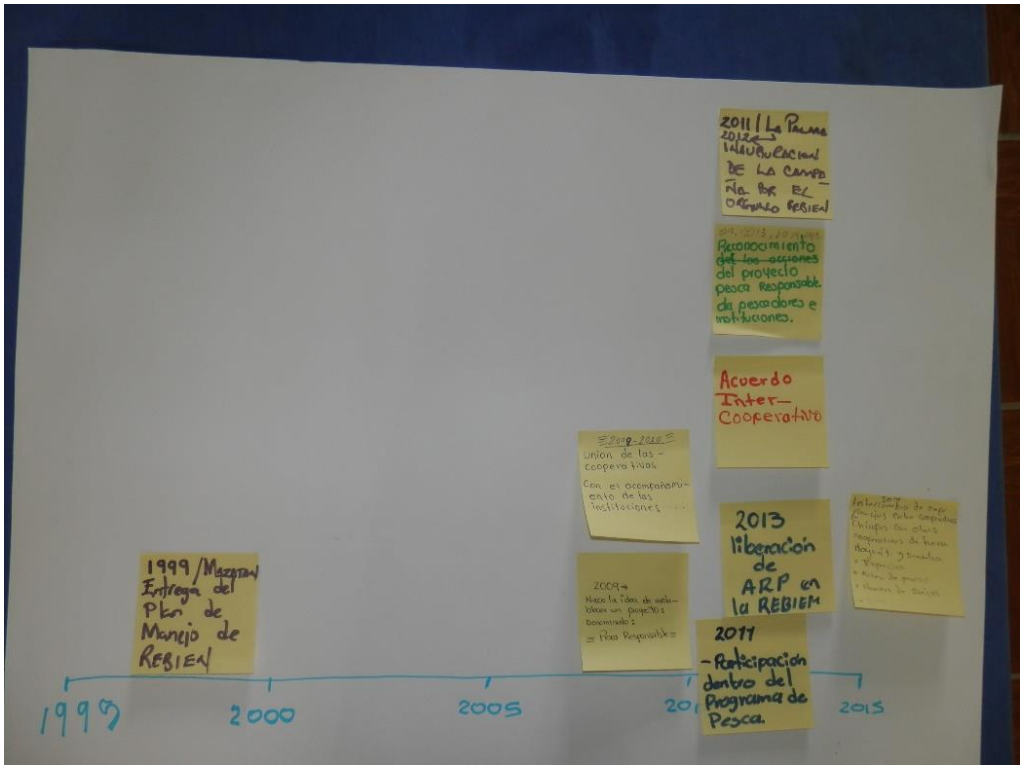

Figure A.3.9 History of fishery management in LEBR

Figure A.3.10 Sociogram of organizations involved in co-management

Appendix 4: Supplementary material of chapter 4

Table A.4.1 Variables of the analytical framework

	Variable	Definition	Answer
BASIC INFORMATION			
Geographical information	World region	World region	Africa, Central America and the Caribbean, North America, South America, Central Asia, Occidental Asia, Oriental Asia, Europe, Oceania
	Country	Country where the fishery is located	Name of the country
	Country region	Country region/s where the fishery is located	Name of the country region/s
Case study information	Community	Name of the studied community/ies	Name of the community/ies
	Cooperative	Name of the studied cooperative/s or fishing union/s	Name of the cooperative/s
	Fishery	Name of the studied fishery	Name of the fishery
	Main species	Name of the main harvested species	Name of the species
CONTEXT			
Resource system			
Ecosystem	Fishery type	Location of the fishery. Inland (lake, river, beel), coastal (open water, bays, estuaries, coastal lagoons), or off-shore (Gutiérrez, Hilborn and Defeo, 2011)	Inland, coastal, off-shore, inland and coastal, coastal and off-shore, n/a
Clarity of system boundaries	Clarity of system boundaries	Biophysical characteristics make it feasible for actors to determine where the resource system starts and ends (Basurto, Gelcich and Ostrom, 2013)	No, yes, n/a
Size of the system	Area	Area of the fishery (Plummer *et al.*, 2014)	Ha, n/a

Productivity of the system	Productivity	Total production of main harvested species per year in the fishery	Kg/year, n/a
Predictability of system dynamics	Predictability of system dynamics	Actors are able to forecast or identify patterns in environmentally driven variability on recruitment (Basurto, Gelcich and Ostrom, 2013)	No, yes, n/a
Infrastructure	Storage capacity	Capacity to hold the resource units captive in or out its natural habitats assuring a later harvest (Basurto, Gelcich and Ostrom, 2013)	No, yes, n/a
	Fishing cooperatives	Presence of fishing cooperatives or unions	No, yes, n/a
Resource unit			
Species	Resource type	Multi-species or single-species (Gutiérrez, Hilborn and Defeo, 2011)	Single, multispecies, n/a
	Diversity	Number of harvested species	Number, n/a
	Mobility outside the fishery	Main harvested species spends periods outside the small-scale fishery in any stage of its life	No, yes, n/a
	Species group	Species group	Finfish, shellfish, marine mammals, algae, reptiles, n/a
Overharvesting	Overharvesting	Harvesting rate of the main harvested specie exceeds replacement rate	No, yes, n/a
Scale	Fishing at other scales	The population of the main harvested species is harvested by any harvester at other fishing grounds (outside the boundaries of the studied small-scale fishery)	No, yes, n/a
Economic value	Economic value	The main harvested specie has an economic value	No, yes, n/a
	Price	If yes, what is the economic value? (farm gate price)	US$/kg, n/a
	Market	Market accessible for fishers. If several, consider the upper level.	Local, regional, national, international, n/a
Spatial distribution	Spatial heterogeneity	Heterogeneous allocation patterns of resource units (adapted from Basurto et al., 2013)	No, yes, n/a
Governance system			
Government support to co-management	Co-management in law	Co-management is supported by laws and/or decrees (Gutiérrez, Hilborn and Defeo, 2011)	No, yes, n/a
	Decentralization	Decentralization of authority, decision-making power and responsibility from state agencies to regional or local entities previous to co-management	No, yes, n/a

	Kind of decentralization	If yes, what kind of decentralization? (Pomeroy and Berkes, 1997) Deconcentration: From national departments and agencies to regional and field offices of the national government; Delegation: Local officials get some power but the central government retains the right to overturn local decisions and take these power back; Devolution: some functions are transferred to local governments; Privatization: Certain government functions are transferred to non-governmental organizations, voluntary organizations, community associations and private enterprises.	Deconcentration, delegation, devolution, privatization, n/a
Previous institutions, including informal	Previous institutions	Institutional framework in place before co-management	None, customary institutions (including community-based management), national or regional formal institutions, both (legal pluralism), n/a
	Previous property rights	Property rights in place before co-management	Open access, fish-based rights, territory-based rights, unspecified property rights, n/a
Formal rules (government's rules) overarching the co-management regime	Post property rights	Property rights in place during co-management	Open access, fish-based rights, territory-based rights, unspecified property rights, both, n/a
	Operational rules	Existence of size restrictions, catch quotas, fishery closures, temporal restrictions, species restrictions	No, yes, n/a
	Monitoring	The resource is monitored by the state	No, yes, n/a
	Long-term management policy	Existence of long-term management plans and/or management institutions (Gutiérrez, Hilborn and Defeo, 2011)	No, yes, n/a
	Protected areas	Formal no-take areas, marine reserves and/or protected areas (Gutiérrez, Hilborn and Defeo, 2011; Thiel, Adamseged and Baake, 2015)	No, yes, n/a
	Restocking programs	Low-cost stock enhancement activities such as extensive culture, natural restocking or transplanting (Gutiérrez, Hilborn and Defeo, 2011)	No, yes, n/a
	Subsidies	Existence of governmental subsidies to fishers	No, yes, n/a

	Subsidies linked to co-management	If yes, the subsides are given for involvement in co-management	No, yes, n/a
Sanctions	Sanctions	There are sanctions established for actors who violate operational rules (Ernst *et al.*, 2013)	No, yes, n/a
	Graduated sanctions	If yes, the sanctions are coherent with its seriousness and the times the offense has been committed (Cinner *et al.*, 2012; Basurto, Gelcich and Ostrom, 2013; MacNeil and Cinner, 2013; Thiel, Adamseged and Baake, 2015)	No, yes, n/a
Users			
Group size	Group size	Qualitative perception of the size of the user group by the author	Small, medium, big, n/a
	Number of user groups	Number of user groups involved	Number, n/a
	Number of users	Number of fishers that make a landing during the fishing season or, in absence of the prior, the number of fishers with fishing permit	Number, n/a
Dependence on the resource	Primary livelihood	The resource is a primary source of monetary income to sustain fishers' livelihoods (Basurto, Gelcich and Ostrom, 2013; MacNeil and Cinner, 2013)	No, yes, n/a
	Occupational diversity	Most (>50%) of the fishers have another source of income in the family (Cinner *et al.*, 2012; MacNeil and Cinner, 2013)	No, yes, n/a
Leadership	Leadership	Trust in leader. Existence of actors who have skills (useful to organize collective action, educated and well-connected) and are followed by their peers (Gutiérrez, Hilborn and Defeo, 2011; Basurto, Gelcich and Ostrom, 2013; Ernst *et al.*, 2013; MacNeil and Cinner, 2013; Thiel, Adamseged and Baake, 2015)	No, yes, n/a
In-user group cohesion	Social cohesion	Trust in user group. High level of trust in other user group members (>70% of group members trust in other group members) (Gutiérrez, Hilborn and Defeo, 2011; Cinner *et al.*, 2012; Basurto, Gelcich and Ostrom, 2013; MacNeil and Cinner, 2013)	No, yes, n/a
Conflict	Conflict among users	There is conflict documented	No, yes, n/a
	Motivation for conflict	If yes, the motivation is due to unfair allocation of property rights	No, yes
		If yes, the motivation is due to unfair access to market	No, yes
		If yes, the motivation is due to unfair access to support from cooperatives	No, yes

		If yes, the motivation is due to unfair access to decision making	No, yes
		If yes, the motivation is due to the use of destructive fishing gears	No, yes
		If yes, the motivation is due to disagreement with rules or rule-breaking by some fishers	No, yes
		If yes, the motivation is due to competition for resources among user groups	No, yes
Knowledge of SES / mental models	Shared understanding of the social-ecological system	Existence of shared understanding of the main actors and resources of the system and its relationships	No, yes, n/a
History of use of the resource system	Long history of resource use	The resource system has been in use for over 3 generations or 60 years	No, yes, n/a
Fishing types	Fishing types	Subsistence	No, yes
		Artisanal	No, yes
		Commercial	No, yes
		Industrial	No, yes
		Recreational	No, yes
Indigenous peoples	Indigenous users	There are indigenous among the users	No, yes, n/a
	Majority of indigenous	If yes, they are a majority (>50% of users are indigenous)	No, yes, n/a
Incompliance	Illegal fishing	Existence of illegal fishing	No, yes, n/a
CO-MANAGEMENT ATTRIBUTES			
Co-management features			
Goal of co-management	Goals	To ensure biodiversity conservation goals	No, yes, n/a

		To address declining fish stock	No, yes, n/a
		To increase participation in management	No, yes, n/a
		To increase legitimacy and/or compliance of fishing rules	No, yes, n/a
		To incorporate customary management norms in formal management	No, yes, n/a
		To define or enforce fishing rights	No, yes, n/a
		To address illegal fishing	No, yes, n/a
		To resolve conflict over access to resources and market	No, yes, n/a
		To promote equitable distribution of fisheries benefits	No, yes, n/a
		To increase harvest and/or income	No, yes, n/a
		To enhance wellbeing	No, yes, n/a
	Changing goals	Goals of co-management have changed over time	No, yes, n/a
Stage of co-management	Years of co-management	Number of years since the co-management initiative started. If the article does not say the number of years but gives information of the year it started, then the number of years should be calculated using the following formula: Co-management years = Year in which the article was published – Year in which co-management started (Gutiérrez, Hilborn and Defeo, 2011).	Years, n/a
	Stage of co-management	Stage of co-management, i.e. implementation phase, implemented or terminated. Planning stages are not included (Gutiérrez, Hilborn and Defeo, 2011)	Implementation, implemented, terminated, n/a
	Success or failure	If terminated, has he co-management initiative ended with success or failure?	Failure, success, n/a
Area of influence	Whole fishery	The co-managed area covers the whole fishery	No, yes, n/a
Interactions and decision making			
Co-management regime	Regime	Main actor promoting co-management	Government, community, NGO, academia, company, n/a

Degree of power-sharing	Power sharing	Degree of power sharing between users and government? (Sen and Nielsen, 1996) Informative: Government delegates authority to make decisions to user groups, who are responsible to inform government of these decisions; Advisory: Users advise government of decisions to be taken and government endorses these decisions; Cooperative: Government and users cooperate together as equal partners in decision-making (Gutiérrez, Hilborn and Defeo, 2011); Consultative: Mechanisms exist for governments to consult with users but all decisions are taken by government (Gutiérrez, Hilborn and Defeo, 2011); Instructive: there is only minimal exchange of information between government and users.	Informative, advisory, cooperative, consultative, instructive, n/a
History	Previous collaboration	Collaboration between communities and government agencies involved in the co-management existed prior to the start of co-management	No, yes, n/a
Willingness for co-management	Willingness for co-management	High willingness and/or incentives of actors for co-management (>50% of users have willingness and/or incentives to participate) (Plummer *et al.*, 2012)	No, yes, n/a
Interests and conflicts	Conflict resolution mechanisms	Mechanisms for conflict resolution are provided (Plummer *et al.*, 2012)	No, yes, n/a
	Facilitative leadership	Presence of a guiding individual or organization	No, yes, n/a
Participation			
Participants' typology	Participants' typology	Participants involved in the co-management partnership	Communities, cooperatives, local government, regional government, national government, intergovernmental organization, third-country government, multi-stakeholder bodies (at regional level), NGOs, research centres, companies, church, unspecified
Participants' diversity	Socio-economic diversity	Other groups, not only the community elites, are involved	No, yes, n/a
	Gender diversity	Both women and men are involved	No, yes, n/a

	Age diversity	People with different age ranges are involved	No, yes, n/a
	Ethnic diversity	Indigenous people or people of more than one ethnic group are involved	No, yes, n/a
	Knowledge systems diversity	People with more than one knowledge system are involved	No, yes, n/a
	Diversity of interests	Participants represent the diversity of actors' interests (Plummer and Armitage, 2007a)	No, yes, n/a
Networks			
Social networks	Cross-scale interactions	Existence of regular information exchange between local and upper scales (Plummer and Armitage, 2007a; Plummer *et al.*, 2012)	No, yes, n/a
	Knowledge sharing	Existence of generation, use, and sharing of information and knowledge among participants (Plummer *et al.*, 2012)	No, yes, n/a
	Bridging organization	Existence of a bridging individual or organization supporting learning, trust, networks and/or linkages (Plummer *et al.*, 2012)	No, yes, n/a
	Bonding organization	Existence of an individual or organization supporting cohesion among participants	No, yes, n/a
Adaptive management			
Adaptive management (Partelow and Boda, 2015)	Adaptive co-management	The initiative is labelled as 'adaptive co-management' by the author of the article.	No, yes
	Systems orientation	The management is oriented to making connections between people and the environment as opposed to, e.g., a focus only based on endangered species (Plummer and FitzGibbon, 2007)	No, yes, n/a
	Interaction	Processes of deliberative interaction happen as opposed to only consultation (Plummer and FitzGibbon, 2007)	No, yes, n/a
	Integration	Diverse perspectives, approaches, and/or sources of information and knowledge are integrated (Plummer and Armitage, 2007a; Plummer and FitzGibbon, 2007)	No, yes, n/a
	Innovation	If yes, this integration results in innovative management actions	No, yes, n/a
	Experimentation	Reflection on knowledge acquired results in experimental management actions (Plummer and Armitage, 2007a; Plummer and FitzGibbon, 2007)	No, yes, n/a
	Reflection	Outcomes of management actions are evaluated (Plummer and Armitage, 2007a; Plummer and FitzGibbon, 2007)	No, yes, n/a
	Flexibility	Institutional adaptability, i.e., norms have changed to better respond to contextual changes	No, yes, n/a

OUTCOMES			
Ecological outcomes			
Species	Size	Change in size of species (Plummer and Armitage, 2007a)	No, positive, negative, n/a
	Abundance	Change in abundance of species (Plummer and Armitage, 2007a)	No, positive, negative, n/a
	Diversity	A change of species diversity which affects ecosystem conditions and/or fish stocks (Plummer and Armitage, 2007a; Plummer *et al.*, 2014)	No, positive, negative, n/a
Relationships and functions	Habitat	Change of habitat for nesting, breeding and/or feeding for fish (Plummer and Armitage, 2007a)	No, positive, negative, n/a
	Key ecological processes	Change of recurrence of ecological processes with an impact to the fishery (e.g. fire, floods) (Plummer and Armitage, 2007a; Plummer *et al.*, 2014)	No, positive, negative, n/a
	Pollution	Change of concentration of pollutants (Plummer and Armitage, 2007a)	No, positive, negative, n/a
Process outcomes			
Participation	Participation in management	Participation of different actors in management institutions (Plummer *et al.*, 2012)	Same, increased, decreased, n/a
	Participation in problem-solving	If yes, participation has changed in problem-solving	Same, increased, decreased, n/a
	Participation in decision making	If yes, participation has changed in decision-making	Same, increased, decreased, n/a
	Participation in monitoring	If yes, participation has changed in monitoring	Same, increased, decreased, n/a
	Users involved	If yes, participation has changed in number of users involved in co-management	Same, increased, decreased, n/a
	Women involved	If yes, participation has changed in number of women involved	Same, increased, decreased, n/a
Social assets	Cooperation	Cooperation among resource users change	Same, increased, decreased, n/a
	Compliance	Compliance to management rules change	Same, increased, decreased, n/a

	Legitimacy	Legitimacy of governing norms for users and/or norm internalization change (Plummer and Armitage, 2007a; Plummer *et al.*, 2014)	Same, increased, decreased, n/a
	Conflicts	Conflicts between participants (Plummer and Armitage, 2007a; Plummer *et al.*, 2012, 2014)	Same, increased, decreased, n/a
	Actors in conflict	Actors involved in the conflict	Users, government, other groups
	Kind of conflict	If yes, the conflict is due to discussed and unfair representation and decision-making in the advisory committee	No, yes
		If yes, the conflict is due to contrasting management rules and local institutions and knowledge	No, yes
		If yes, the conflict is due to non-compliance	No, yes
		If yes, the conflict is due to competition for resource among user groups, including fish traders	No, yes
		If yes, the conflict is due to lack of or harsh enforcement	No, yes
	Existence of networks	Formal and informal problem-solving and/or decision-making networks are created/destroyed (Plummer and FitzGibbon, 2007; Plummer *et al.*, 2012, 2014)	Same, increased, decreased, n/a
	Extended networks	Existing networks change (Plummer and FitzGibbon, 2007; Plummer *et al.*, 2012, 2014)	Same, increased, decreased, n/a
	Local knowledge	Local knowledge presence in formal management decisions	Same, increased, decreased, n/a
	Local norms	Local norms presence in formal management norms	Same, increased, decreased, n/a
	Local conditions	Congruence of norms with local conditions	Same, increased, decreased, n/a
	Power asymmetries	Power asymmetries within the user group change (Plummer *et al.*, 2012)	Same, increased, decreased, n/a
Individual learning	Skills and knowledge	Acquisition of technical skills or knowledge (Plummer *et al.*, 2014)	Same, increased, decreased, n/a
	Information	Access to information	Same, increased, decreased, n/a
	Individual knowledge on dynamics	Individual knowledge about the ecological dynamics of the fishery	Same, increased, decreased, n/a
	Individual knowledge on rules	Individual knowledge about management rules	Same, increased, decreased, n/a
Social learning - Shared understanding	Collective knowledge on dynamics	Collective knowledge about the ecological dynamics of the fishery (cognitive learning) (Plummer *et al.*, 2014)	Same, increased, decreased, n/a

	Collective knowledge on rules	Collective knowledge about management rules	Same, increased, decreased, n/a
	Shared values	Shared values (normative learning, double-loop learning) (Plummer and Armitage, 2007a; Plummer *et al.*, 2014)	Same, increased, decreased, n/a
	Shared understanding	Shared appreciation of what is coveted and why (Plummer and Armitage, 2007a; Plummer and FitzGibbon, 2007)	Same, increased, decreased, n/a
Social learning - Institutional learning	Social norms	Agreement on desirable individual actions towards the natural resource management change (single-loop learning) (Plummer and Armitage, 2007a)	Same, increased, decreased, n/a
	Policies	Policies from which routines stem change (double-loop learning) (Plummer and Armitage, 2007a)	No, yes, n/a
	Governing norms	Governing norms are questioned (triple-loop learning) (Plummer and Armitage, 2007a)	No, yes, n/a
Socio-economic outcomes			
Catches	Fishery catches	Global catches in the fishery	Same, increased, decreased, n/a
	Collective catches	Catches at community or cooperative level	Same, increased, decreased, n/a
	Individual catches	Catches at individual or household level	Same, increased, decreased, n/a
Income (Plummer *et al.*, 2012, 2014)	Fishery income	Global income in the fishery	Same, increased, decreased, n/a
	Collective income	Income from fishery-related activities at community or cooperative level	Same, increased, decreased, n/a
	Individual income	Income from fishery-related activities at individual or household level	Same, increased, decreased, n/a
Equity (Plummer *et al.*, 2012)	Resources distribution	Equity in resources distribution	Same, increased, decreased, n/a
	Income distribution	Equity in income distribution	Same, increased, decreased, n/a
Transaction costs	Transaction costs	Transaction costs of fishery management (Plummer *et al.*, 2012)	Same, increased, decreased, n/a
Fishing infrastructure	Individual fishing equipment	Fishing equipment at individual level	Same, increased, decreased, n/a
	Collective fishing equipment	Fishery-related equipment at collective level	Same, increased, decreased, n/a

	Other fishing infrastructure	Other fishery-related infrastructure at collective level	Same, increased, decreased, n/a
	Other infrastructure	Other non-fishing infrastructure acquired thanks to the co-management of the fishery	Same, increased, decreased, n/a
Generic outcomes			
Generic social outcomes	Wellbeing	Collective or individual wellbeing (Plummer *et al.*, 2012, 2014)	Same, increased, decreased, n/a
	Vulnerability	Collective or individual vulnerability to environmental stressors (including climate change) (Plummer *et al.*, 2014)	Same, increased, decreased, n/a
	Adaptive capacity	Collective or individual adaptive capacity to environmental and other stressors (Plummer and Armitage, 2007a; Plummer *et al.*, 2012, 2014)	Same, increased, decreased, n/a

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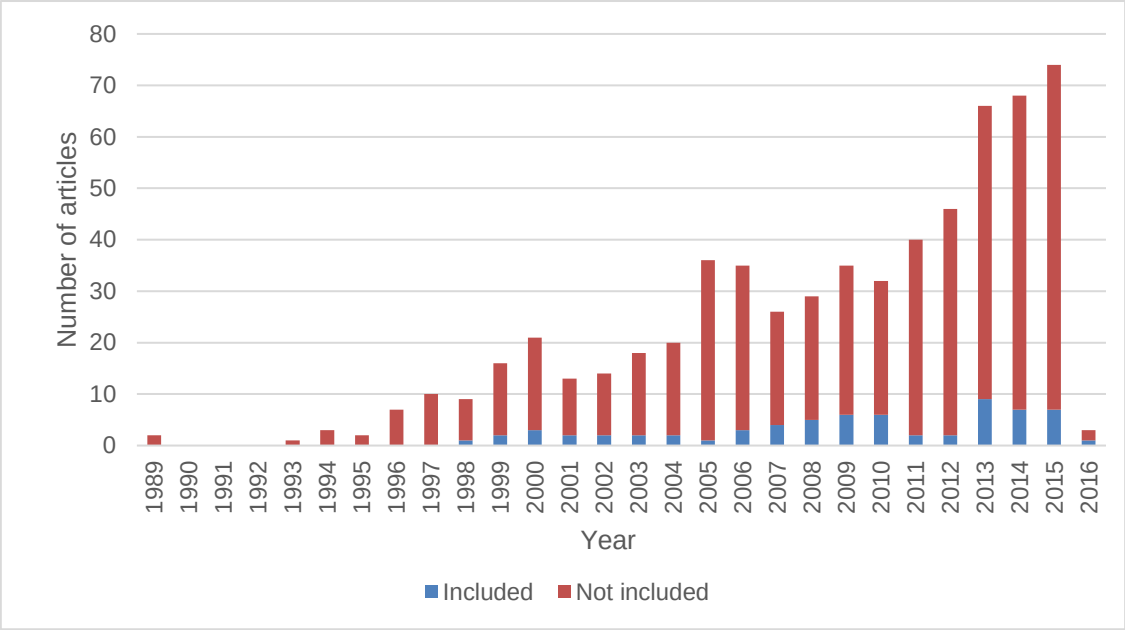

Figure A.4.1 Articles per year resulting of our search strings in Scopus and Web of Knowledge datasets

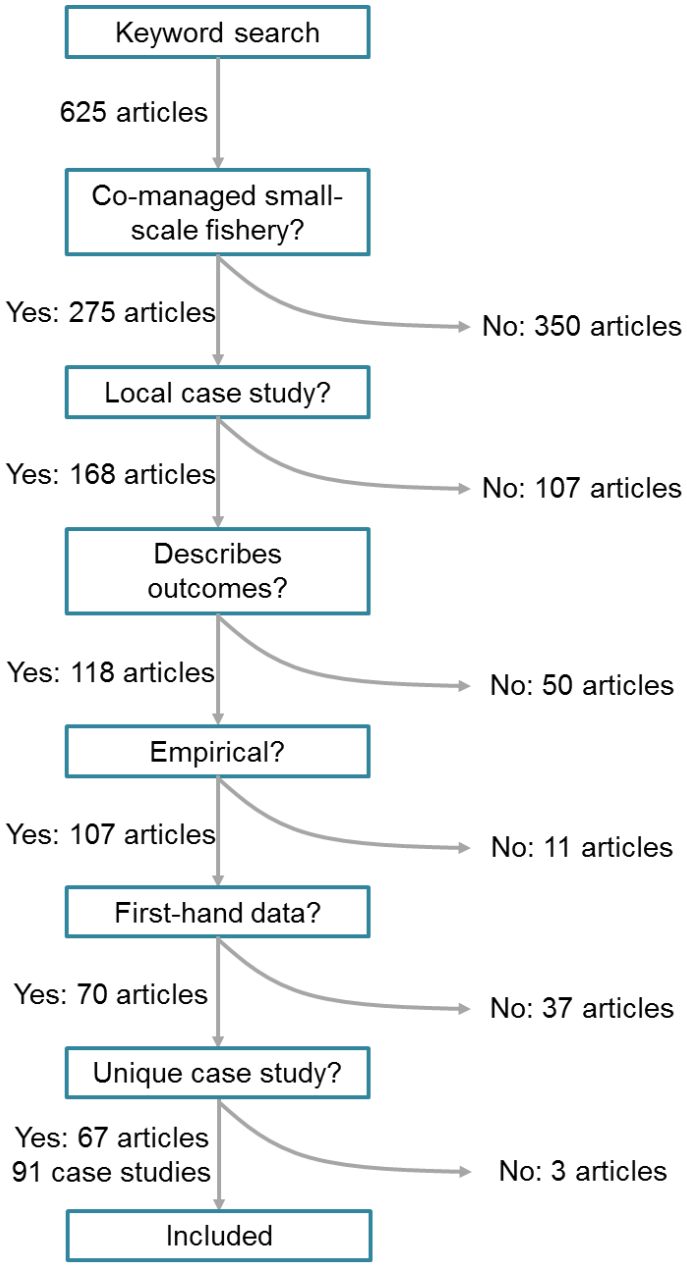

Figure A.4.2 Criteria appraisal process

Table A.4.2 List of articles included in the systematic review

Article number (among all scoped articles)	Article number (among all accepted articles)	Case study number	Authors and year	Reference
3	1	1	Aburto et al. 2014	Aburto, J.A., Stotz, W.B., Cundill, G., 2014. Social-ecological collapse: TURF governance in the context of highly variable resources in Chile. Ecol. Soc. 19, 2. doi:https://doi.org/10.5751/ES-06145-190102
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24	3	4	Baird and Flaherty 2005	Baird, I.G., Flaherty, M.S., 2005. Mekong River fish conservation zones in southern Laos: Assessing effectiveness using local ecological knowledge. Environ. Manage. 36, 439–454. doi:https://doi.org/10.1007/s00267-005-3093-7
29	4	5	Baticados and Agbayani 2000	Baticados, D.B., Agbayani, R.F., 2000. Co-management in marine fisheries in Malalison Island, central Philippines. Int. J. Sustain. Dev. World Ecol. 7, 343–355. doi:https://doi.org/10.1080/13504500009470053
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70	6	8	Castilla and Fernandez 1998	Castilla, J.C., Fernández, M., 1998. Small-scale benthic fisheries in Chile: On co-management and sustainable use of benthic invertebrates. Ecol. Appl. 8, 124–132. doi:https://doi.org/10.2307/2641370
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Table A.4.3 Fisher tests with ecological and process outcomes and variables from basic information, context and co-management attributes. Statistical significance is given by **=p≤0.05, *=p≤0.1. Some analyses were not conducted because of collinearity, two few categories, and no or insufficient observations, indicated by ^, ^^, and ^^^ respectively

	Ecological outcomes		Process outcomes									
	Species	Functions	Participation	Cooperation	Compliance	Legitimacy	Conflicts	Networks	Local fit	Power asymmetries	Individual learning	Social learning
BASIC INFORMATION												
World region	0.507	1.000	0.368	0.557	0.836	0.595	0.034**	0.253	0.677	0.406	1.000	0.402
CONTEXT												
Resource system												
Fishery type	0.421	0.758	1.000	0.427	0.173	1.000	0.751	1.000	0.185	0.186	0.545	0.626
Clarity of system boundaries	0.267	^	1.000	0.587	1.000	0.748	1.000	0.521	1.000	0.500	1.000	1.000
Predictability of system dynamics	0.222	1.000	^^	1.000	1.000	1.000	1.000	^^	1.000	0.333	1.000	1.000
Storage capacity	1.000	^^	0.214	1.000	0.643	1.000	0.100*	^^	0.345	1.000	^^	0.318
Fishing cooperatives	^^	^	1.000	0.078*	0.145	0.073*	0.132	0.386	1.000	1.000	0.111	1.000
Resource unit												
Resource type	0.648	0.206	0.427	0.761	0.674	1.000	0.419	1.000	0.236	0.727	1.000	0.499
Mobility outside the fishery	0.132	0.036**	0.444	0.427	0.266	1.000	0.406	0.294	1.000	0.143	1.000	0.353
Species group - Finfish	0.074*	0.585	1.000	0.576	0.067*	1.000	0.777	0.605	1.000	0.241	0.502	0.261
Species group - Shellfish	0.856	0.580	0.796	0.047**	0.155	1.000	0.225	0.331	1.000	0.005**	1.000	0.548
Species group - Algae	0.265	0.312	0.303	0.231	0.324	1.000	0.454	1.000	0.231	0.214	1.000	0.260

Overharvesting	0.155	^	1.000	0.682	0.448	0.642	1.000	1.000	0.354	1.000	0.468	1.000
Fishing at other scales	1.000	1.000	0.294	0.157	0.389	1.000	0.064	1.000	0.130	0.571	1.000	0.382
Economic value	^^	^	1.000	^	^	^	^	1.000	1.000	^	^	^
Market	1.000	0.700	0.013**	0.601	0.092*	0.872	0.171	0.615	0.187	0.429	0.132	0.133
Spatial heterogeneity	1.000	^^^	^^	0.464	0.133	0.464	1.000	1.000	0.107	^^	0.222	1.000
Governance system												
Co-management in law	1.000	1.000	1.000	^	1.000	1.000	0.121	1.000	1.000	^	1.000	1.000
Decentralization	0.129	0.077*	0.632	0.307	0.492	0.716	0.866	0.561	1.000	1.000	1.000	1.000
Kind of decentralization	0.347	0.661	0.623	0.808	0.725	0.603	0.327	0.050**	1.000	1.000	1.000	0.187
Previous institutions	0.137	0.545	1.000	0.157	0.031**	0.121	0.016**	0.694	0.039**	0.192	0.156	0.687
Previous property rights	0.210	0.165	0.188	0.736	0.399	0.430	0.011**	0.425	0.087*	0.907	0.386	0.945
Post property rights	0.279	0.236	0.599	0.372	0.293	0.252	0.045**	0.265	0.892	0.784	0.811	0.687
Operational rules	0.107	^	1.000	^	0.256	0.250	^	^	0.162	^	^	0.032**
Monitoring	1.000	^	0.395	0.731	0.148	0.446	0.838	0.099*	0.579	1.000	1.000	0.028**
Long term management policy	0.316	1.000	1.000	0.605	1.000	1.000	0.340	1.000	1.000	^	1.000	0.115
Protected areas	1.000	0.345	0.485	1.000	0.377	1.000	0.710	0.600	0.220	1.000	1.000	1.000
Restocking	0.697	0.375	^^	1.000	0.391	0.611	0.325	0.528	1.000	1.000	1.000	1.000
Subsidies	1.000	^	1.000	0.127	0.361	0.432	0.173	0.545	1.000	0.657	1.000	1.000
Subsidies linked to co-management	^^	^^^	^^	1.000	1.000	0.400	1.000	0.143	^^	1.000	0.444	0.400
Sanctions	1.000	^	1.000	1.000	0.231	0.250	0.644	1.000	0.684	^	0.154	0.330
Graduated sanctions	^	^	^	^	^	^	^	^	^	^	^	^
Users												
Group size	0.455	^	^^	0.235	1.000	1.000	0.143	1.000	1.000	1.000	1.000	1.000

Primary livelihood	^	^	1.000	0.474	0.524	0.465	0.623	0.193	1.000	^	1.000	0.287
Occupational diversity	0.267	^	0.333	0.565	1.000	0.604	1.000	1.000	0.660	0.333	0.473	0.515
Leadership	0.286	0.400	0.036**	0.066*	0.027**	0.083*	0.071	0.176	0.148	0.200	1.000	0.000**
Social cohesion	0.200	1.000	0.195	0.222	0.013**	0.021**	0.267	0.062*	0.200	1.000	^	0.001**
Conflict among users	0.520	0.250	0.694	0.082*	0.768	0.732	0.055	1.000	0.125	1.000	1.000	1.000
Motivation for conflict - Property rights	0.400	1.000	0.163	0.037**	0.554	0.131	0.453	1.000	1.000	1.000	1.000	0.187
Motivation for conflict - Access to market	^^	0.542	1.000	1.000	1.000	1.000	0.138	1.000	1.000	0.550	1.000	1.000
Motivation for conflict - Cooperatives' support	0.265	^	0.014**	0.057*	0.083*	0.024**	0.190	^	^	0.214	^	0.146
Motivation for conflict - Decision-making	0.081*	1.000	0.142	0.037**	0.496	0.199	0.776	1.000	0.303	1.000	1.000	0.695
Motivation for conflict - Destructive fishing	1.000	1.000	0.303	0.553	1.000	0.601	0.371	1.000	0.260	1.000	1.000	1.000
Motivation for conflict - Disagreement with rules or rule-breaking	0.064*	1.000	1.000	0.074*	0.475	1.000	0.329	0.577	0.197	0.538	1.000	1.000
Motivation for conflict - Resource competition	0.118	0.542	1.000	0.164	0.092*	1.000	0.096	0.291	0.269	0.476	1.000	0.563
Shared understanding of social-ecological system	^	1.000	^^	0.278	0.318	1.000	1.000	0.045**	0.091*	1.000	1.000	0.163
Long history of resource use	0.368	^	1.000	0.415	0.323	0.267	0.480	1.000	1.000	1.000	1.000	1.000
Fishing types - Artisanal fishing	0.579	1.000	0.675	0.246	0.118	0.038**	0.745	0.089*	0.754	1.000	0.249	0.517
Fishing types - Industrial fishing	0.059*	1.000	1.000	0.043**	0.567	1.000	0.478	1.000	0.303	0.250	1.000	1.000
Fishing types -	0.554	1.000	0.724	0.829	0.281	0.254	0.133	0.572	0.538	0.510	0.526	1.000

Subsistence fishing												
Fishing types - Commercial fishing	1.000	1.000	0.700	0.485	0.634	1.000	0.843	0.125	0.254	0.790	0.526	0.287
Fishing types - Recreational fishing	0.152	0.096*	0.046**	0.292	0.409	0.125	0.301	1.000	1.000	0.096*	1.000	0.562
Indigenous users	0.082*	0.486	1.000	1.000	0.786	1.000	0.642	0.664	1.000	1.000	1.000	0.557
Majority of indigenous users	^^	1.000	1.000	1.000	0.168	0.529	0.545	0.528	0.143	1.000	1.000	1.000
Illegal fishing	0.101	^	1.000	1.000	0.345	0.352	0.247	0.583	0.245	1.000	0.386	1.000
CO-MANAGEMENT DYNAMICS												
Co-management features												
Stage of co-management	0.004**	0.396	0.244	0.316	0.053*	0.037**	0.139	0.313	0.249	0.250	0.526	0.173
Whole fishery	0.467	0.533	1.000	0.257	0.648	1.000	0.659	0.257	0.383	1.000	0.468	1.000
Interactions and decision-making												
Regime	0.128	0.784	0.044**	0.771	0.890	0.500	0.291	0.195	0.135	0.748	1.000	0.710
Power sharing	0.718	0.400	0.059*	0.932	0.834	0.931	0.151	0.036**	0.168	0.833	0.608	0.673
Previous collaboration	0.802	1.000	^^	1.000	0.242	0.582	0.667	0.042**	0.685	1.000	1.000	0.391
Willingness for co-management	0.468	0.400	0.018**	0.031**	0.153	0.029**	0.032	0.061*	0.301	0.036**	1.000	0.003**
Conflict-resolution mechanisms	0.500	^	0.402	0.099*	0.003**	0.018**	0.054	1.000	0.056*	0.133	1.000	0.037**
Facilitative leadership	0.039**	0.048**	0.083*	0.065*	0.039**	0.053*	0.418	0.138	0.112	0.333	1.000	0.025**
Participation												
Participants' typology - Community	0.673	0.411	0.014**	0.665	1.000	1.000	0.030**	1.000	0.041**	1.000	1.000	0.392
Participants' typology - Cooperative	0.337	0.585	0.175	0.559	0.563	0.095*	0.089*	0.793	0.016**	0.388	0.040**	0.493

Participants' typology - Local government	1.000	0.132	0.724	1.000	0.799	0.196	1.000	0.785	1.000	0.790	1.000	1.000
Participants' typology - Regional government	0.386	1.000	0.373	0.736	1.000	0.561	0.033	0.504	1.000	1.000	0.478	0.539
Participants' typology - National government	0.113	0.282	1.000	1.000	1.000	0.798	0.273	1.000	0.107	1.000	1.000	1.000
Participants' typology - Intergovernmental organization	1.000	^	0.162	1.000	1.000	1.000	1.000	0.036**	1.000	^	1.000	0.128
Participants' typology - Third-country governments	^	^	1.000	0.047**	0.081*	0.093*	0.675	0.237	1.000	1.000	0.087*	1.000
Participants' typology - Multi-stakeholder bodies	0.118	^	1.000	0.229	0.292	0.244	1.000	1.000	1.000	1.000	1.000	1.000
Participants' typology - NGO	0.593	1.000	0.445	0.309	0.170	0.416	0.475	1.000	0.201	1.000	1.000	0.327
Participants' typology - Research centre	1.000	0.411	0.532	1.000	0.422	1.000	1.000	1.000	0.307	1.000	0.526	1.000
Participants' typology - Companies	^	^	0.002**	0.231	0.330	0.433	0.190	^	0.043**	0.214	^	0.063*
Participants' typology - Church	1.000	^	1.000	^	^	1.000	^	1.000	0.170	1.000	^	1.000
Socio-economic diversity	1.000	1.000	1.000	0.045**	0.023**	0.002**	0.453	0.560	0.286	0.200	0.022**	1.000
Gender diversity	0.036**	0.250	0.350	0.333	0.200	0.222	0.236	1.000	0.400	1.000	^	0.175
Age diversity	0.400	^^^	1.000	1.000	1.000	1.000	^	1.000	^^	^	^	1.000
Ethnic diversity	0.643	1.000	1.000	0.717	0.306	0.618	1.000	1.000	0.539	1.000	1.000	1.000
Knowledges diversity	0.643	1.000	1.000	0.341	0.641	0.267	1.000	1.000	^^	1.000	1.000	1.000
Diversity of interests	0.038**	0.429	0.004**	0.260	0.213	0.241	0.013**	1.000	1.000	0.036**	1.000	0.343
Networks												

Cross-scale interactions	0.123	0.583	0.136	0.028**	0.051*	0.064*	0.150	1.000	0.107	0.306	1.000	0.270
Knowledge sharing	0.417	1.000	0.071*	0.029**	0.022**	0.105	0.163	0.037**	0.036**	0.306	1.000	0.010**
Bridging organization	0.389	0.500	0.104	0.053*	0.022**	0.020**	0.500	0.036**	^^	0.333	^	0.000**
Bonding organization	0.444	1.000	0.200	0.015**	0.083*	0.037**	0.365	0.097*	^^	1.000	0.231	0.048**
Adaptive management												
Adaptive co-management	0.773	0.728	1.000	1.000	1.000	0.316	0.212	0.499	1.000	1.000	1.000	1.000
Systems orientation	0.067*	1.000	1.000	0.140	1.000	0.515	1.000	1.000	1.000	0.571	1.000	1.000
Interaction	0.596	0.643	0.355	0.041**	0.115	0.101	0.201	1.000	0.125	0.091*	1.000	0.182
Integration	0.019**	1.000	0.269	0.245	0.216	0.182	0.224	1.000	0.018**	0.571	1.000	0.085*
Innovation	0.018**	1.000	0.238	0.024**	0.117	0.296	0.374	1.000	0.286	0.400	1.000	1.000
Experimentation	0.200	1.000	0.079*	0.015**	0.106	0.467	0.156	1.000	0.128	1.000	1.000	0.464
Reflection	0.100*	1.000	0.227	0.067*	0.117	0.191	0.218	1.000	0.211	1.000	1.000	0.490
Flexibility	0.266	1.000	0.146	0.547	0.084*	0.467	0.246	1.000	0.326	0.358	1.000	0.121
Adaptive management group	1.000	1.000	0.516	0.455	0.174	0.770	0.054*	0.130	0.107	0.154	1.000	0.131

Table A.4.4 Fisher tests with socio-economic, generic and all outcomes and variables from basic information, context and co-management attributes. Statistical significance is given by **=p≤0.05, *=p≤0.1. Some analyses were not conducted because of collinearity, two few categories, and no or insufficient observations, indicated by ^, ^^, and ^^^ respectively

	Socio-economic outcomes					Generic outcomes			All outcomes (grouped)				
	Catches	Income	Equity	Transaction costs	Infrastructure	Wellbeing	Vulnerability	Adaptive capacity	Ecological	Process	Socio-economic	Generic	All outcomes
BASIC INFORMATION													
World region	0.133	0.615	0.229	0.524	0.279	0.708	0.714	0.320	0.924	0.201	0.011**	0.541	0.063*
CONTEXT													
Resource system													
Fishery type	0.330	0.484	0.068 *	0.444	0.491	0.475	1.000	0.723	0.232	0.471	0.077*	0.517	0.641
Clarity of system boundaries	1.000	^	1.000	0.464	1.000	1.000	^	1.000	0.235	0.586	1.000	1.000	0.712
Predictability of system dynamics	0.333	^^	^^^	0.333	1.000	^^^	^^^	^	0.222	1.000	0.533	^	0.673
Storage capacity	1.000	0.250	1.000	1.000	^	^^	^^	0.333	1.000	0.200	0.143	1.000	0.029**
Fishing cooperatives	^	^	^	1.000	1.000	1.000	^	^	^	1.000	1.000	1.000	1.000
Resource unit													
Resource type	1.000	1.000	0.709	1.000	0.533	1.000	1.000	1.000	0.456	0.818	0.862	1.000	0.176
Mobility outside the fishery	0.667	1.000	^	0.400	1.000	^^	^^	1.000	0.206	0.726	0.035**	0.375	0.726
Species group - Finfish	0.192	1.000	0.610	1.000	1.000	1.000	0.524	0.266	0.130	0.632	0.099*	0.569	0.468
Species group - Shellfish	1.000	1.000	0.154	1.000	1.000	1.000	1.000	1.000	1.000	0.076*	0.030**	0.469	0.084*

Species group - Algae	0.036**	0.121	0.250	1.000	1.000	1.000	1.000	1.000	0.275	0.454	0.339	0.566	0.169
Overharvesting	1.000	1.000	0.333	1.000	1.000	^	^	^	0.080*	1.000	0.573	^	0.749
Harvesting at other scales	1.000	1.000	1.000	1.000	^	^	^	1.000	1.000	0.539	0.769	0.291	0.157
Economic value	^	^	^	^	^	^	^	^	^	1.000	^	^	1.000
Market	1.000	0.625	1.000	0.600	0.500	^^	^^^	0.500	0.876	0.348	1.000	1.000	0.623
Spatial heterogeneity	^^	^	^	^^	^	^	^^^	^^^	1.000	1.000	^	1.000	1.000
Governance system													
Co-management in law	0.545	^	^	^	^	^	1.000	0.385	1.000	1.000	0.337	0.280	1.000
Decentralization	1.000	1.000	1.000	1.000	0.303	1.000	^	0.267	0.101	0.528	1.000	0.169	0.070*
Kind of decentralization	0.626	1.000	0.600	1.000	1.000	0.091*	0.200	1.000	0.220	0.323	0.318	0.601	0.616
Previous institutions	0.382	0.505	0.258	0.714	0.667	1.000	0.400	0.755	0.235	0.155	0.054*	0.043**	0.253
Previous property rights	0.707	1.000	0.834	0.190	1.000	0.571	0.733	1.000	0.166	0.691	0.214	0.417	0.293
Post property rights	1.000	1.000	0.922	1.000	1.000	1.000	1.000	0.319	0.116	0.050**	0.824	0.274	0.291
Operational rules	^	^	^	^	^	^	^	^	0.088*	1.000	^	^	1.000
Monitoring	1.000	0.133	0.229	0.464	1.000	0.167	0.200	0.154	1.000	0.799	1.000	0.041**	0.814
Long term management policy	1.000	0.111	0.500	0.444	1.000	0.091*	0.400	1.000	0.543	0.747	0.784	0.284	0.248
Protected areas	1.000	1.000	0.714	1.000	1.000	1.000	^	^	1.000	1.000	0.269	1.000	0.589
Restocking	0.706	1.000	1.000	1.000	1.000	1.000	^	0.167	1.000	0.506	0.321	1.000	1.000
Subsidies	0.405	1.000	^	1.000	0.643	1.000	1.000	^^	0.667	0.983	1.000	1.000	0.731
Subsidies linked to co-management	1.000	1.000	1.000	^	1.000	^	^^^	^^^	^	0.400	1.000	1.000	0.400
Sanctions	^	^	^	^	^	^	^	^	1.000	1.000	^	^	0.419

Graduated sanctions	^	^^^	^	^	^^^	^^	^^	^	^	^	^	^	^
Users													
Group size	1.000	1.000	1.000	^	^	1.000	^	^^	0.423	1.000	1.000	1.000	1.000
Primary livelihood	^	0.396	0.250	1.000	1.000	0.077*	0.250	^	^	0.315	1.000	0.250	0.421
Occupational diversity	1.000	0.500	1.000	1.000	1.000	0.286	^^^	1.000	0.236	1.000	0.470	0.167	1.000
Leadership	1.000	1.000	1.000	0.400	1.000	1.000	1.000	0.143	0.067*	0.003**	0.133	0.236	0.005**
Social cohesion	0.500	^	1.000	1.000	^	^	1.000	0.167	0.045**	0.005**	0.100	0.110	0.013**
Conflict among users	0.608	1.000	1.000	0.464	0.444	1.000	1.000	1.000	0.554	0.077*	0.512	1.000	0.077*
Motivation for conflict - Property rights	0.199	0.541	0.545	0.444	^	1.000	^	0.541	1.000	0.116	1.000	0.431	0.324
Motivation for conflict - Access to market	0.333	^	^	^	^	^	1.000	0.481	0.479	1.000	0.179	0.421	0.056*
Motivation for conflict - Cooperatives' support	0.333	^	0.250	^	^	^	^	^	0.275	0.068*	0.179	^	0.066*
Motivation for conflict - Decision-making	0.102	1.000	0.697	1.000	^	1.000	1.000	1.000	0.350	0.192	0.173	0.764	0.394
Motivation for conflict - Destructive fishing	0.083*	1.000	1.000	1.000	1.000	1.000	^	1.000	1.000	0.712	0.751	1.000	0.730
Motivation for conflict - Disagreement with rules or rule-breaking	0.130	1.000	0.583	0.444	1.000	1.000	1.000	1.000	0.300	0.811	0.108	1.000	0.363
Motivation for conflict - Resource competition	0.217	0.331	0.250	1.000	1.000	0.242	0.286	1.000	0.178	0.361	1.000	0.678	0.829
Shared understanding of social-ecological system	^	^	^	1.000	^	^	0.400	0.222	0.571	0.009**	0.187	0.071*	0.103

Long history of resource use	1.000	1.000	1.000	1.000	1.000	^	^	^	0.174	1.000	0.400	^	1.000
Fishing types - Artisanal fishing	0.146	0.541	0.583	1.000	1.000	1.000	1.000	0.178	0.619	0.538	0.753	0.363	0.361
Fishing types - Industrial fishing	1.000	1.000	0.583	1.000	1.000	^	^	^	0.124	0.712	0.205	^	1.000
Fishing types - Subsistence fishing	0.409	0.576	1.000	1.000	0.200	1.000	1.000	0.624	0.154	0.349	1.000	1.000	0.690
Fishing types - Commercial fishing	1.000	1.000	0.758	0.524	1.000	0.125	0.143	0.655	1.000	0.248	0.433	0.511	0.108
Fishing types - Recreational fishing	0.114	1.000	0.697	0.444	1.000	1.000	^	0.532	0.034**	0.059*	0.829	1.000	0.200
Indigenous users	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.529	0.244	0.304	0.325	1.000	0.557
Majority of indigenous users	1.000	1.000	1.000	1.000	^	1.000	^	0.545	0.250	0.526	1.000	0.275	0.369
Illegal fishing	1.000	1.000	0.071 *	1.000	1.000	1.000	^	^	0.047**	1.000	0.310	1.000	0.712
CO-MANAGEMENT DYNAMICS													
Co-management features													
Stage of co-management	0.869	0.612	0.848	0.444	1.000	1.000	0.286	0.023**	0.045**	0.507	0.580	0.154	0.019**
Whole fishery	0.323	1.000	1.000	0.400	0.250	1.000	0.333	1.000	0.485	1.000	0.788	1.000	1.000
Interactions and decision-making													
Regime	0.202	0.788	0.113	0.714	0.717	1.000	1.000	0.590	0.265	0.135	0.223	0.804	0.334
Power sharing	1.000	1.000	0.543	0.333	0.750	0.429	^	1.000	0.732	0.039**	0.910	1.000	0.138
Previous collaboration	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.192	0.319	0.633	1.000	1.000
Willingness for co-management	0.400	1.000	1.000	1.000	1.000	1.000	0.400	0.143	0.101	0.008**	0.198	0.095*	0.004**

Conflict-resolution mechanisms	1.000	0.200	0.200	1.000	^^	^^	^^^	0.378	0.437	0.218	0.200	0.275	0.043**
Facilitative leadership	0.556	^	0.222	1.000	1.000	^	0.500	0.024**	0.003**	0.028**	0.086*	0.001**	0.003**
Participation													
Participants' typology - Community	1.000	0.576	1.000	1.000	1.000	1.000	1.000	1.000	0.829	0.903	0.795	1.000	0.837
Participants' typology - Cooperative	0.659	1.000	0.131	0.524	0.321	0.625	1.000	0.351	0.134	0.843	0.159	0.300	0.755
Participants' typology - Local government	1.000	1.000	1.000	1.000	0.109	1.000	1.000	0.616	0.304	0.510	0.682	0.596	1.000
Participants' typology - Regional government	1.000	0.515	0.288	1.000	0.491	1.000	1.000	1.000	0.861	0.895	0.503	0.332	1.000
Participants' typology - National government	0.113	0.541	0.545	1.000	1.000	1.000	1.000	0.178	0.122	0.628	0.435	0.199	0.850
Participants' typology - Intergovernmental organization	1.000	0.465	1.000	1.000	1.000	0.350	0.286	^	1.000	0.457	1.000	0.566	0.569
Participants' typology - Third-country governments	^	^	^	^	^	^	^	^	^	1.000	^	^	1.000
Participants' typology - Multi-stakeholder bodies	1.000	1.000	0.583	1.000	1.000	^	^	^	0.125	1.000	0.410	^	1.000
Participants' typology - NGO	0.743	0.541	0.253	1.000	1.000	0.467	1.000	1.000	0.349	1.000	0.596	0.569	0.339
Participants' typology - Research centre	0.513	1.000	1.000	0.444	0.273	1.000	^	1.000	1.000	0.284	1.000	1.000	0.872
Participants' typology - Companies	^	0.176	0.250	1.000	^	^	^	0.273	^	0.150	0.179	0.235	0.140
Participants' typology - Church	^	^	0.583	^	^	^	^	1.000	1.000	1.000	0.410	1.000	1.000

Socio-economic diversity	1.000	^	^	^	^	^	1.000	0.200	1.000	0.775	0.154	0.182	1.000
Gender diversity	0.467	^	1.000	^	^^	^	^	^	0.022**	1.000	0.679	^	1.000
Age diversity	^^	^^^	^^^	^^^	^^^	^^^	^^^	^^	0.400	1.000	1.000	^	0.250
Ethnic diversity	1.000	1.000	1.000	1.000	1.000	1.000	^	^	0.458	1.000	0.545	1.000	1.000
Knowledges diversity	1.000	1.000	1.000	1.000	1.000	1.000	^	^	0.458	0.562	0.126	1.000	0.270
Diversity of interests	0.109	1.000	1.000	^	1.000	1.000	^	^^	0.136	0.002**	0.242	1.000	0.003**
Networks													
Cross-scale interactions	0.152	^	0.500	^	1.000	^	^	^^	0.155	0.036**	0.147	^	0.067*
Knowledge sharing	0.455	^	1.000	1.000	^	^	0.500	0.182	0.493	0.001**	0.085*	0.067*	0.006**
Bridging organization	0.500	^	1.000	1.000	^	^	1.000	0.125	0.062*	0.015**	0.088*	0.133	0.024**
Bonding organization	0.226	1.000	1.000	0.467	1.000	^	0.500	0.400	0.212	0.040**	0.204	0.378	0.060*
Adaptive management													
Adaptive co-management	1.000	1.000	0.583	1.000	0.273	1.000	1.000	0.616	0.474	0.203	0.717	0.804	0.770
Systems orientation	^	^	^	^	1.000	^	^	^	0.140	1.000	1.000	^	1.000
Interaction	0.073*	^^	0.400	^	1.000	^^	^^^	^^	1.000	0.018**	1.000	^^	0.045**
Integration	0.083*	^^	0.250	^	1.000	^^	^^	1.000	0.076*	0.045**	0.275	1.000	0.060*
Innovation	0.214	^^	0.333	^	^^^	^^	^^	1.000	0.093*	0.117	1.000	1.000	0.326
Experimentation	0.029**	1.000	^	1.000	^^^	^^	^^^	0.222	0.273	0.013**	0.190	0.300	0.065*
Reflection	0.083*	1.000	1.000	1.000	1.000	1.000	^	^^	0.318	0.166	0.706	1.000	0.279
Flexibility	0.083*	1.000	0.429	^	1.000	^	^	^^	0.407	0.375	0.390	1.000	0.528
Adaptive management group	0.659	0.360	0.545	0.444	0.448	1.000	1.000	0.011**	0.750	0.021**	1.000	0.017**	0.027**

Table A.4.5 Main characteristics of the case studies included in the review

ID	Article reference	Country	Fishery	Species	Resource	Co-management		
						Years	Stage	Regime
1	Aburto et al. 2014	Chile	Coastal	One main species	Shellfish	3	Terminated with failure	Cooperative
2	Amarasinghe and De Silva 1999	Sri Lanka	Inland	Multispecies	Finfish	13	Implementation	Informative
3	Amarasinghe and De Silva 1999	Sri Lanka	Inland	Multispecies	Finfish	15	Implementation	Informative
4	Baird and Flaherty 2005	Laos	Inland	Multispecies	N/a	N/a	Implemented	Advisory
5	Baticados and Agbayani 2000	Philippines	Coastal	Multispecies	Finfish and shellfish	7	Implementation	Advisory
6	Buang et al. 2011	Malaysia	Coastal	Multispecies	Finfish and shellfish	7	Implemented	Consultative
7	Buang et al. 2011	Malaysia	Coastal	Multispecies	Finfish and shellfish	N/a	Implemented	Consultative
8	Castilla and Fernandez 1998	Chile	Coastal	Multispecies	Shellfish	9	Implemented	N/a
9	Cinner and McClanahan 2015	Kenya	Coastal	N/a	N/a	N/a	N/a	Advisory
10	Coelho Dias da Silva et al. 2010	Brazil	Coastal	Multispecies	Shellfish	10	Implemented	Cooperative
11	Cooke et al. 2000	Fiji	Coastal	Multispecies	N/a	58	Implementation	Advisory
12	Cooke et al. 2000	Fiji	Coastal	Multispecies	N/a	58	Implementation	Advisory
13	Cooke et al. 2000	Fiji	Coastal	Multispecies	N/a	58	Implementation	Advisory
14	Cooke et al. 2000	Fiji	Coastal	Multispecies	N/a	58	Implementation	Advisory
15	Cooke et al. 2000	Fiji	Coastal	Multispecies	N/a	58	Implementation	Advisory
16	Cooke et al. 2000	Fiji	Coastal	Multispecies	N/a	58	Implementation	Advisory
17	Cooke et al. 2000	Fiji	Coastal	Multispecies	N/a	58	Implementation	Advisory
18	Crawford et al. 2010	Nicaragua	Coastal	Multispecies	Shellfish	4	Implemented	Advisory

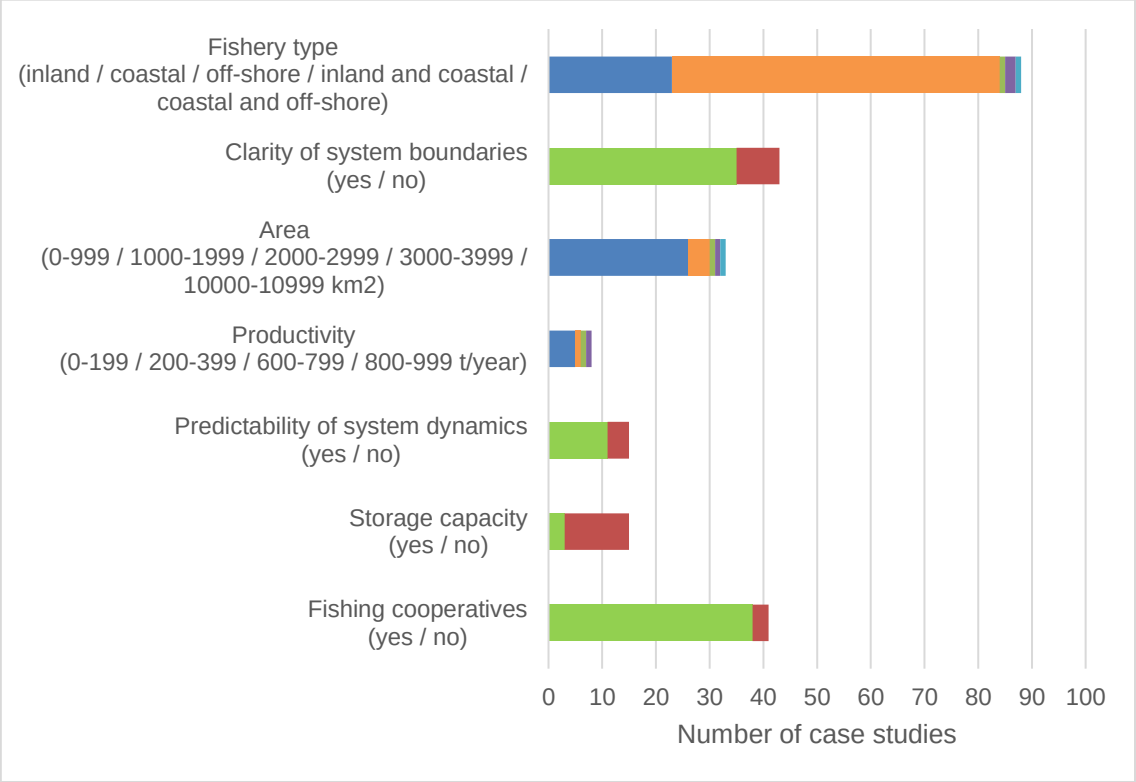
19	Crawford et al. 2004	Tanzania	Coastal	Multispecies	Shellfish	3	Implemented	N/a
20	Crawford et al. 2004	Indonesia	Coastal	N/a	N/a	3	Implemented	Consultative
21	Crosson et al. 2013	USA	Coastal	One main species	Shellfish	25	Implementation	Cooperative
22	Defeo and Castilla 2005	Mexico	Coastal	One main species	Shellfish	N/a	N/a	N/a
23	Ebbin 2012	USA	Inland and coastal	One main species	Finfish	33	Implemented	N/a
24	Ennis 2011	Canada	Coastal	One main species	Shellfish	14	Implemented	Consultative
25	Fernández-Vidal and Muño 2014	Spain	Coastal	N/a	Shellfish	7	Implemented	Instructive
26	Gelcich et al. 2006	Chile	Coastal	One main species	Algae	3	Implemented	N/a
27	Gelcich et al. 2009	Chile	Coastal	Multispecies	Finfish and algae	N/a	Implemented	N/a
28	Gelcich et al. 2008	Chile	Coastal	One main species	Shellfish	9,5	Implemented	N/a
29	Gelcich et al. 2013	Chile	Coastal	One main species	Shellfish	16	Implemented	N/a
30	Gelcich et al. 2013	Chile	Coastal	One main species	Shellfish	16	Implemented	N/a
31	Granados-Dieseldorff et al. 2013	Belize	Coastal	One main species	Finfish	13	Implemented	N/a
32	Guidetti et al. 2010	Italy	Coastal	Multispecies	Finfish and shellfish	4	Terminated with success	N/a
33	Hauck and Sowman 2001	South Africa	Coastal	N/a	Finfish	7	Implemented	Cooperative
34	Hauck and Sowman 2001	South Africa	Inland	N/a	Finfish	6	Implemented	Cooperative
35	Hauck and Sowman 2001	South Africa	N/a	N/a	Finfish	6	Terminated	Consultative
36	Hauck and Sowman 2001	South Africa	N/a	N/a	Shellfish	5	Implemented	Cooperative
37	Hicks et al. 2009	Kenya	Coastal	Multispecies	N/a	N/a	Implementation	N/a
38	Kalikoski et al. 2002	Brazil	Inland and coastal	Multispecies	Finfish and shellfish	20	Implementation	Consultative
39	Khan 2006	Canada	Coastal and off-shore	One main species	Shellfish	18	Implemented	Consultative
40	Khan et al. 2012	Bangladesh	Inland	N/a	N/a	4	Terminated	N/a
41	Ko et al. 2010	South Korea	Coastal	Multispecies	Shellfish and algae	N/a	Implementation	N/a

42	Kulatilake et al. 2010	Sri Lanka	Inland	Multispecies	Finfish	6	Implemented	N/a
43	Kulatilake et al. 2010	Sri Lanka	Inland	Multispecies	Finfish	6	Implemented	N/a
44	Kuperan et al. 2008	Philippines	Coastal	Multispecies	Finfish	20	Implemented	Cooperative
45	Kusumawati and Huang 2015	Indonesia	Coastal	Multispecies	Finfish, shellfish and marine mammals	3	Implemented	Cooperative
46	Léopold et al. 2013	Vanuatu	Coastal	Multispecies	Finfish, shellfish and marine mammals	31	Implemented	Informative
47	Léopold et al. 2013	New Caledonia	Coastal	One main species	Shellfish	5	Implemented	Cooperative
48	Levine and Richmond 2014	USA	Coastal	Multispecies	N/a	3	Terminated with failure	N/a
49	Levine and Richmond 2014	USA	Coastal	Multispecies	N/a	7,5	Implementation	N/a
50	Levine and Richmond 2014	USA	Coastal	Multispecies	N/a	8,4	Implemented	N/a
51	Maliao and Polohan 2008	Philippines	Coastal	N/a	N/a	2	Terminated with success	N/a
52	Marschke and Nong 2003	Cambodia	Coastal	N/a	N/a	4	Implemented	Advisory
53	McCay et al. 2014	Mexico	Coastal	Multispecies	Shellfish and algae	33	Implemented	N/a
54	McClanahan et al. 2006	Tanzania	Coastal	Multispecies	Finfish and shellfish	10	Implemented	N/a
55	McConney and Baldeo 2007	Grenada	Coastal	Multispecies	Finfish and shellfish	N/a	Implementation	Consultative
56	McGrath et al. 2008	Brazil	Inland	Multispecies	Finfish and turtles	10	Implemented	Cooperative
57	Njifonjou et al 2006	Côte d'Ivoire	Inland	N/a	N/a	11	Implemented	N/a
58	Nursey-Bray and Rist 2009	Australia	N/a	N/a	N/a	7	Implemented	N/a
59	Perez de Oliveira 2013	Spain	Coastal	Multispecies	Shellfish	6	Implemented	Cooperative
60	Rivera et al. 2014	Spain	Coastal	One main species	Shellfish	20	Implemented	Cooperative

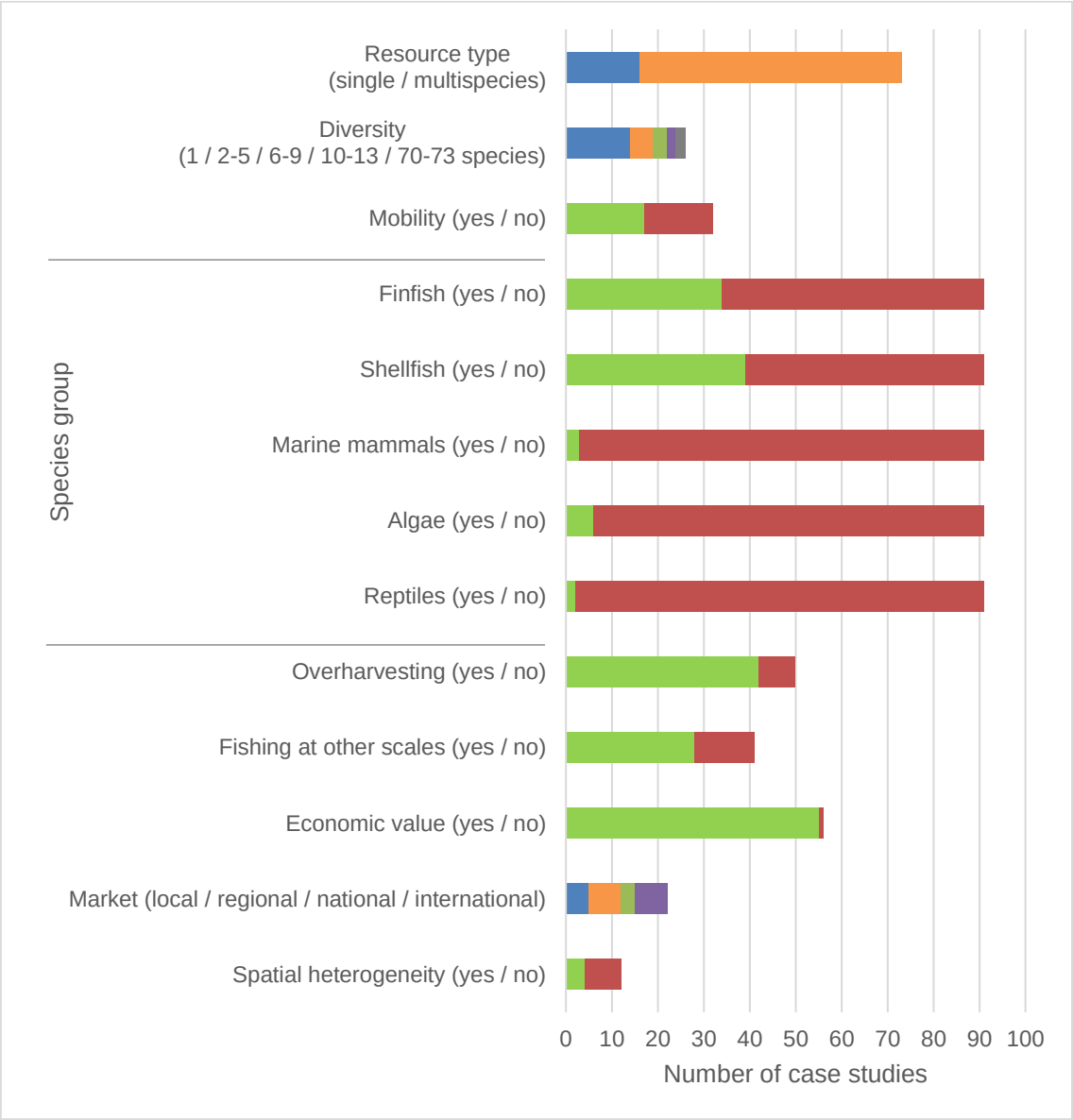
61	Russell and Dobson 2011	Malawi	Inland	N/a	N/a	N/a	Implemented	N/a
62	Sandersen and Koester 2000	St. Lucia	Coastal	Multispecies	N/a	2	Terminated with failure	Consultative
63	Sandström and Rova 2010	Sweden	Inland	N/a	N/a	N/a	Implementation	N/a
64	Sepherd et al. 2004	Ecuador	Coastal	One main species	Shellfish	4	Terminated	N/a
65	Silvano et al. 2014	Brazil	Inland	Multispecies	Finfish	2	Implementation	Cooperative
66	Sipponen and Valkeajärvi 2002	Finland	Inland	Multispecies	Finfish	5	Implemented	Cooperative
67	Sobreiro et al. 2010	Brazil	Inland	Multispecies	N/a	6	Implementation	N/a
68	Thompson et al. 2003	Bangladesh	Inland	N/a	Shellfish	6	Terminated	Cooperative
69	Thompson et al. 2003	Bangladesh	Inland	N/a	Shellfish	4	Terminated	N/a
70	Thomson and Gray 2009	India	Inland	Multispecies	Finfish and shellfish	40	Implemented	N/a
71	Tomiyama and Komatsu 2011	Japan	Coastal	One main species	Finfish	28	Implemented	Informative
72	van Mulekom 1999	Philippines	Coastal	Multispecies	N/a	10	Implemented	Advisory
73	Weeks and Jupiter 2013	Fiji	Coastal	Multispecies	N/a	9	Implemented	N/a
74	Abernethy et al. 2014	Solomon Islands	Coastal	Multispecies	N/a	10	N/a	N/a
75	Abernethy et al. 2014	Solomon Islands	Coastal	Multispecies	N/a	10	N/a	N/a
76	Abernethy et al. 2014	Solomon Islands	Coastal	Multispecies	N/a	10	N/a	N/a
77	Abernethy et al. 2014	Solomon Islands	Coastal	Multispecies	N/a	10	N/a	N/a
78	Abernethy et al. 2014	Solomon Islands	Coastal	Multispecies	N/a	10	N/a	N/a
79	Aburto et al. 2013	Chile	Off-shore	Multispecies	Finfish, shellfish and algae	9	Implemented	N/a

80	Aburto et al. 2013	Chile	Coastal	Multispecies	Finfish, shellfish and algae	23	Implemented	N/a
81	Castello et al. 2009	Brazil	Inland	Multispecies	Finfish	8	Implemented	Advisory
82	Fernandez 2007	Philippines	Inland	Multispecies	Finfish	1	Implementation	N/a
83	Kocho-Schellenberg and Berkes 2015	Canada	Coastal	One main species	Marine mammals	31	Implemented	Cooperative
84	Cohen and Steenbergen 2015	Indonesia	Coastal	Multispecies	Finfish and shellfish	N/a	Implemented	Cooperative
85	Cohen and Steenbergen 2015	Solomon Islands	Coastal	Multispecies	Finfish and shellfish	N/a	Implemented	Instructive
86	Barratt et al. 2015	Uganda	Inland	N/a	N/a	11	Implemented	N/a
87	Barratt et al. 2015	Uganda	Inland	N/a	N/a	11	Implemented	N/a
88	Al Mamun and Brook 2015	Bangladesh	Inland	Multispecies	N/a	26	Implemented	N/a
89	Vaughan and Caldwell 2015	USA	Coastal	Multispecies	Finfish and shellfish	9	Implementation	Advisory
90	Ho et al. 2016	Vietnam	Inland	Multispecies	Finfish and shellfish	4	Implementation	N/a
91	García Lozano and Heinen 2016	Costa Rica	Coastal	Multispecies	Finfish and shellfish	15	Implemented	Advisory

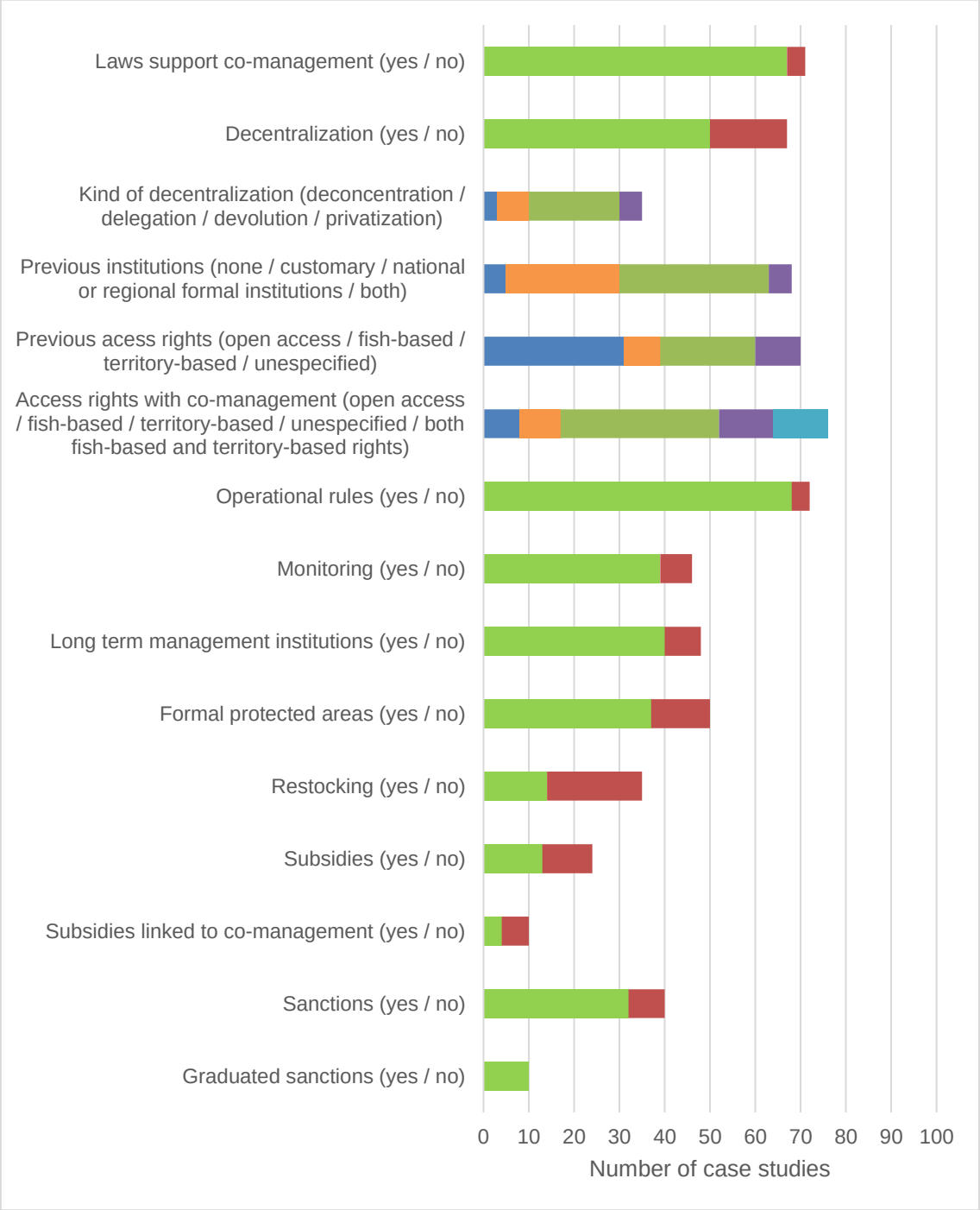
Resource system



Resource unit



Governance system



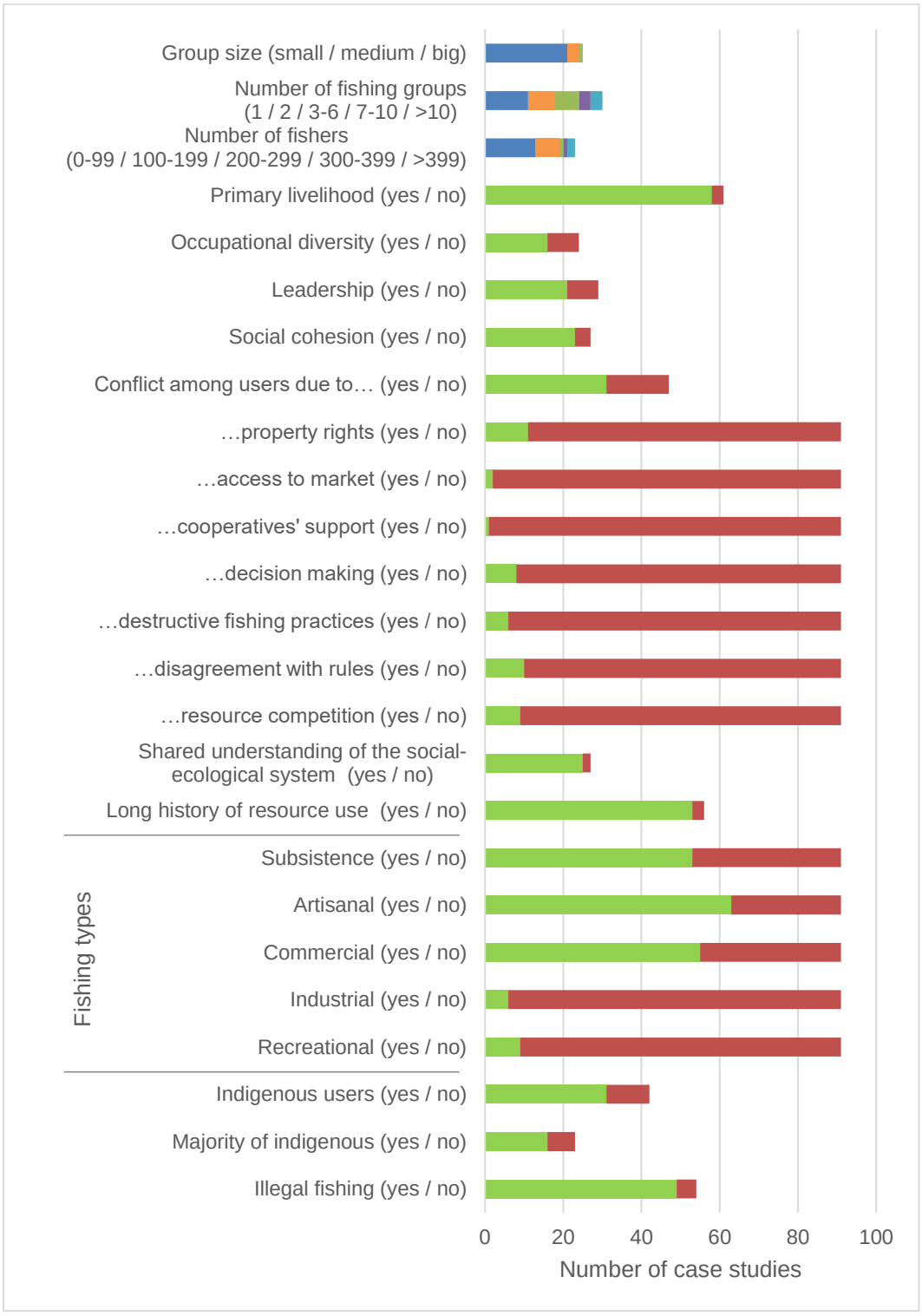
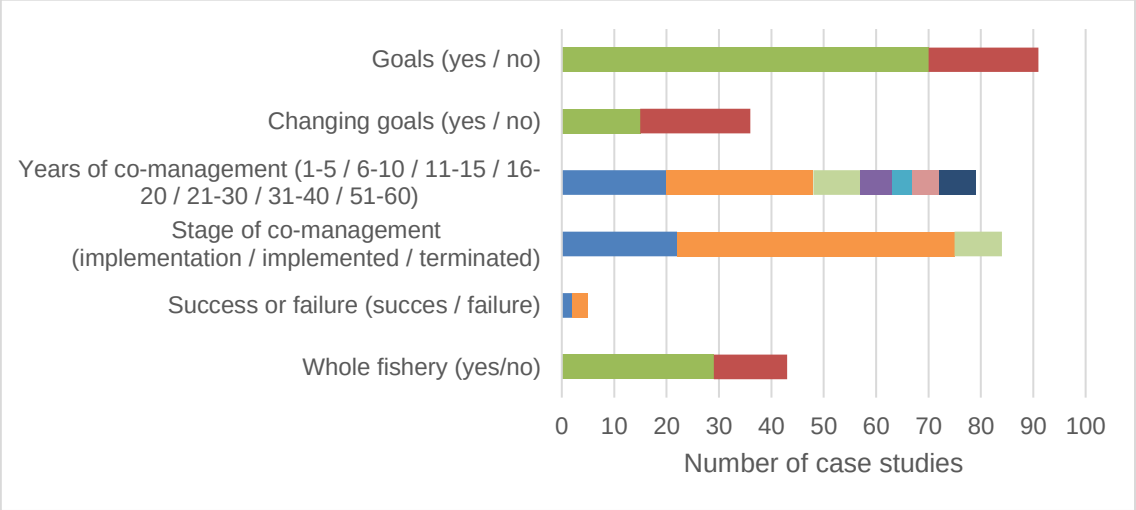


Figure A.4.3 Context variables. Responses in parenthesis. Variables with yes and no responses show green and red bars respectively. Other variables show a range of colours depending on the number of responses

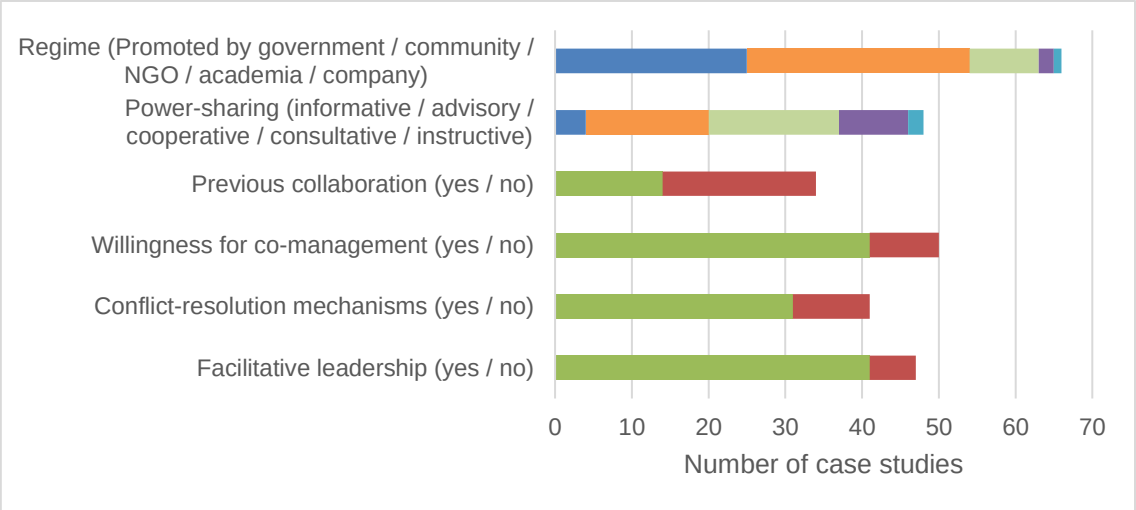
Table A.4.6 Goals of the co-managed fisheries reviewed

Main groups of goals	Goal	Case studies that report the goal (number)	Case studies that report the goal (percentage)
Ecological	To ensure biodiversity conservation goals	10	14,3%
	To address a declining fish stock	14	20,0%
Process	To increase participation in management	29	41,4%
	To increase legitimacy and/or compliance with fishing rules	19	27,1%
	To incorporate customary management norms in formal management	18	25,7%
	To define or enforce fishing rights	19	27,1%
	To address illegal fishing	13	18,6%
	To resolve conflict over access to resources and market	1	1,4%
	To promote equitable distribution of fisheries benefits	2	2,9%
Socio-economic	To increase harvest and/or income	8	11,4%
Generic	To enhance wellbeing	8	11,4%

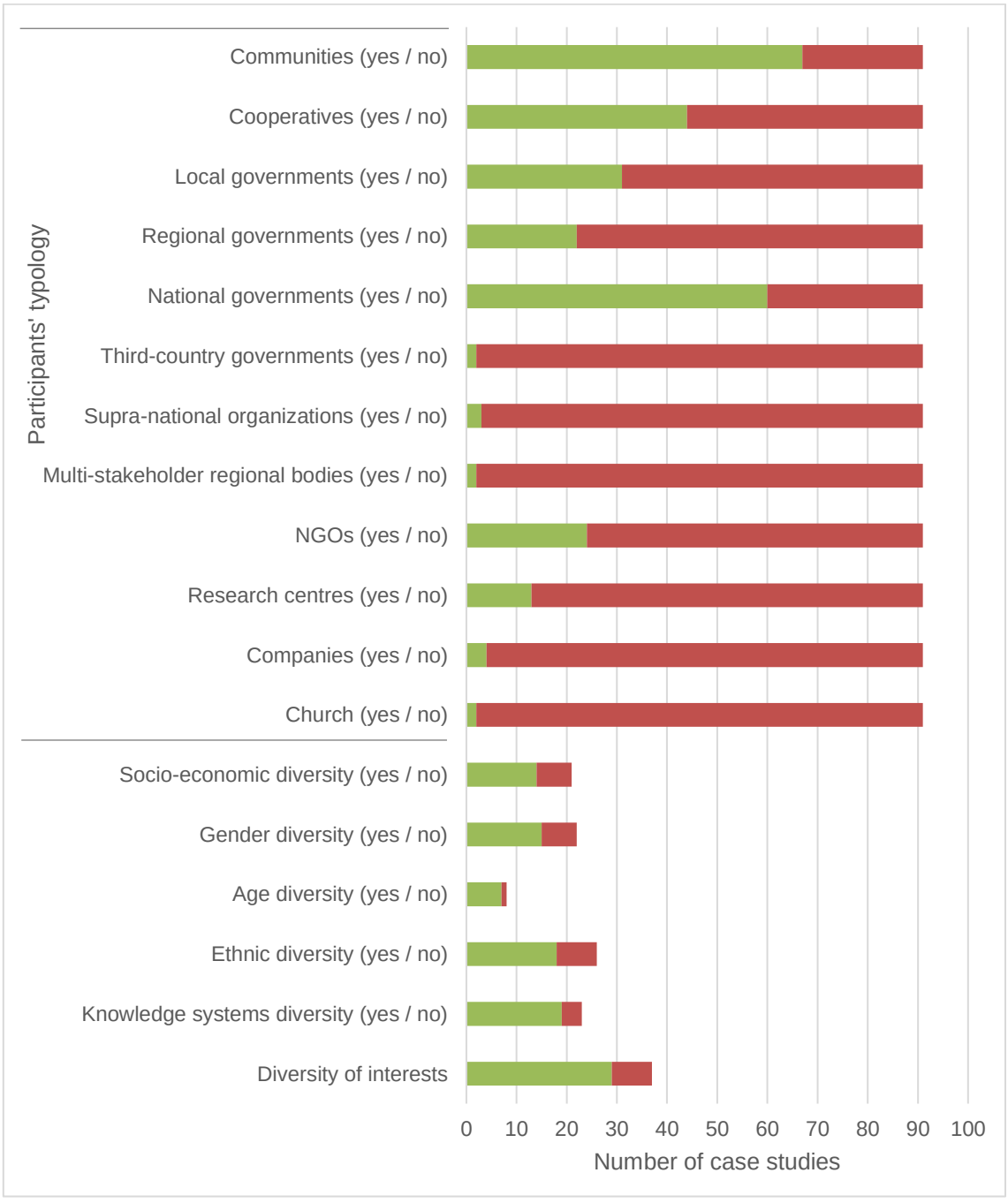
Co-management features



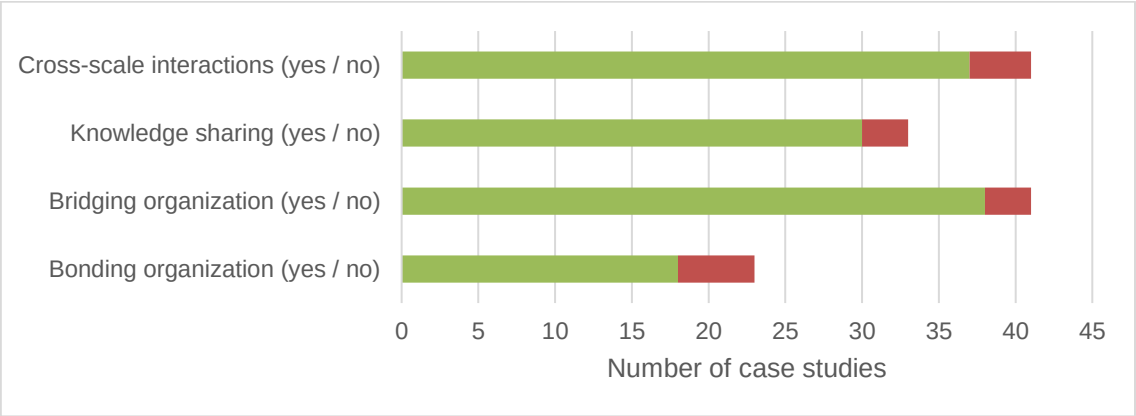
Interactions and decision making



Participation



Networks



Adaptive management

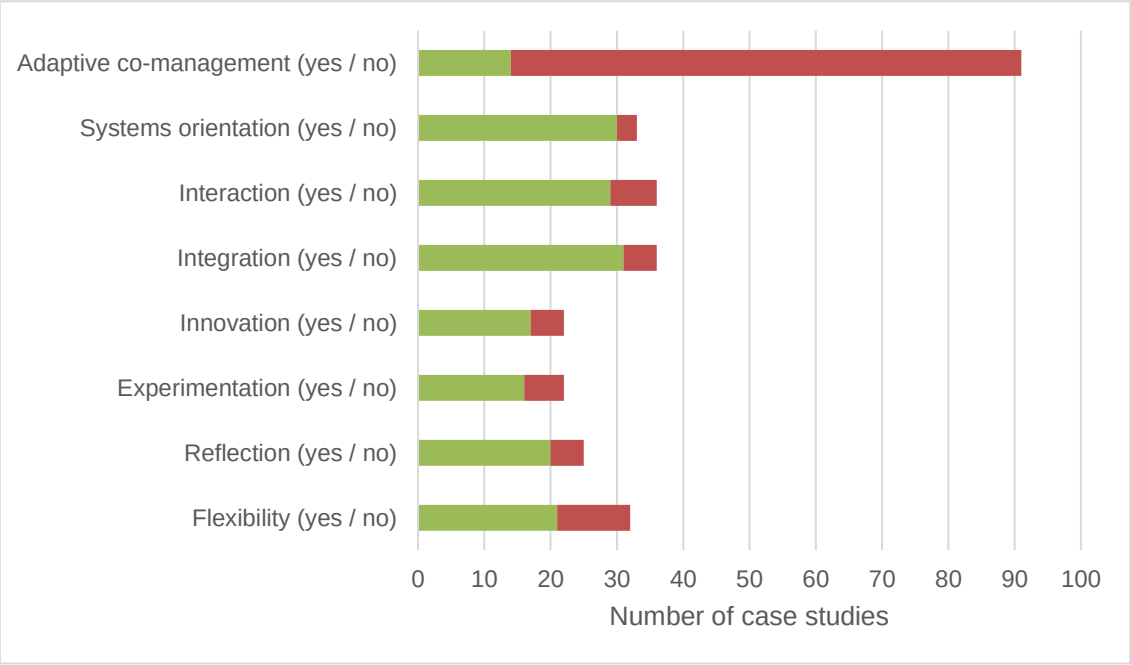


Figure A.4.4 Co-management attributes. Responses in parenthesis. Variables with yes and no responses show green and red bars respectively. Other variables show a range of colours depending on the number of responses

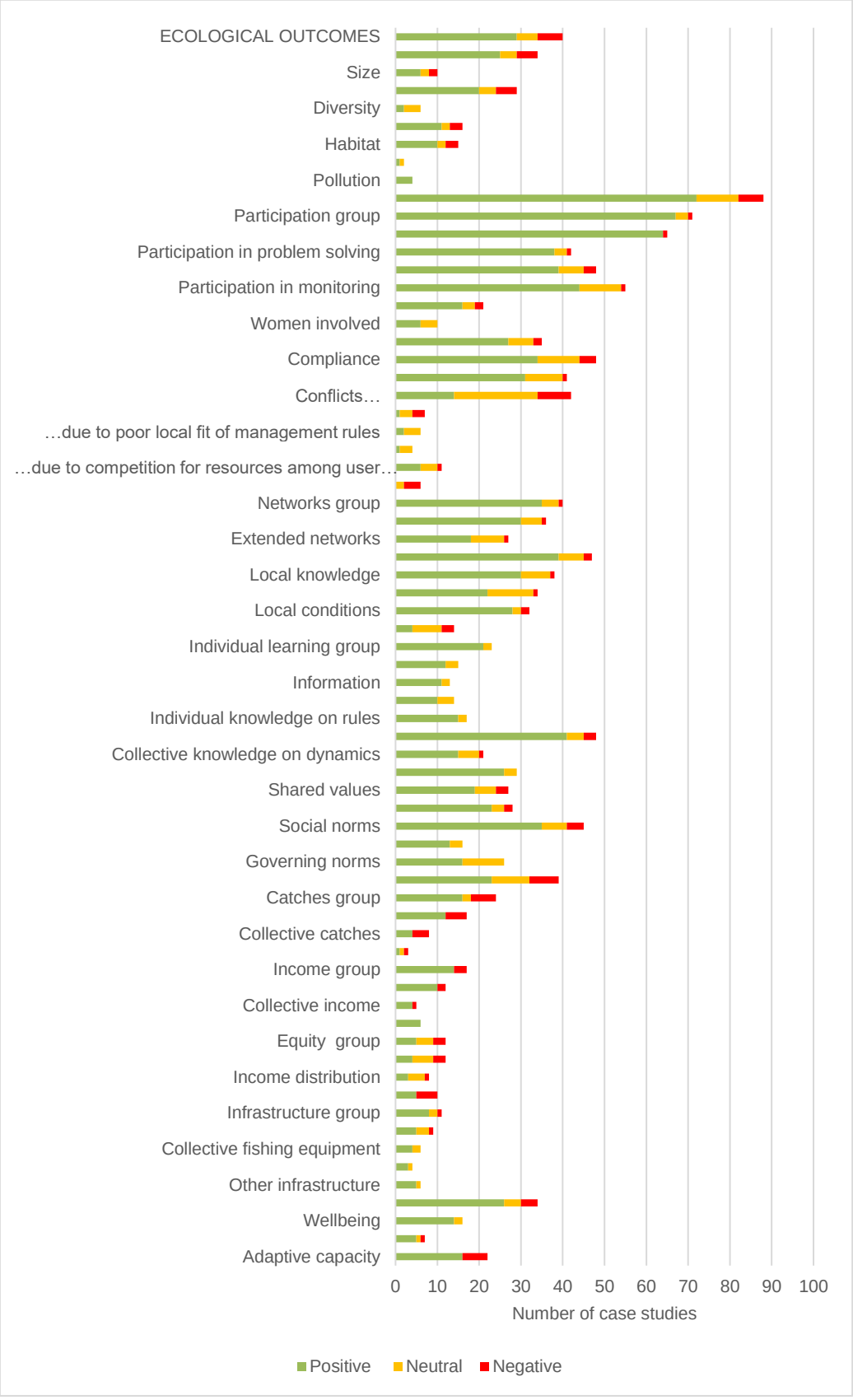


Figure A.4.5 Outcomes

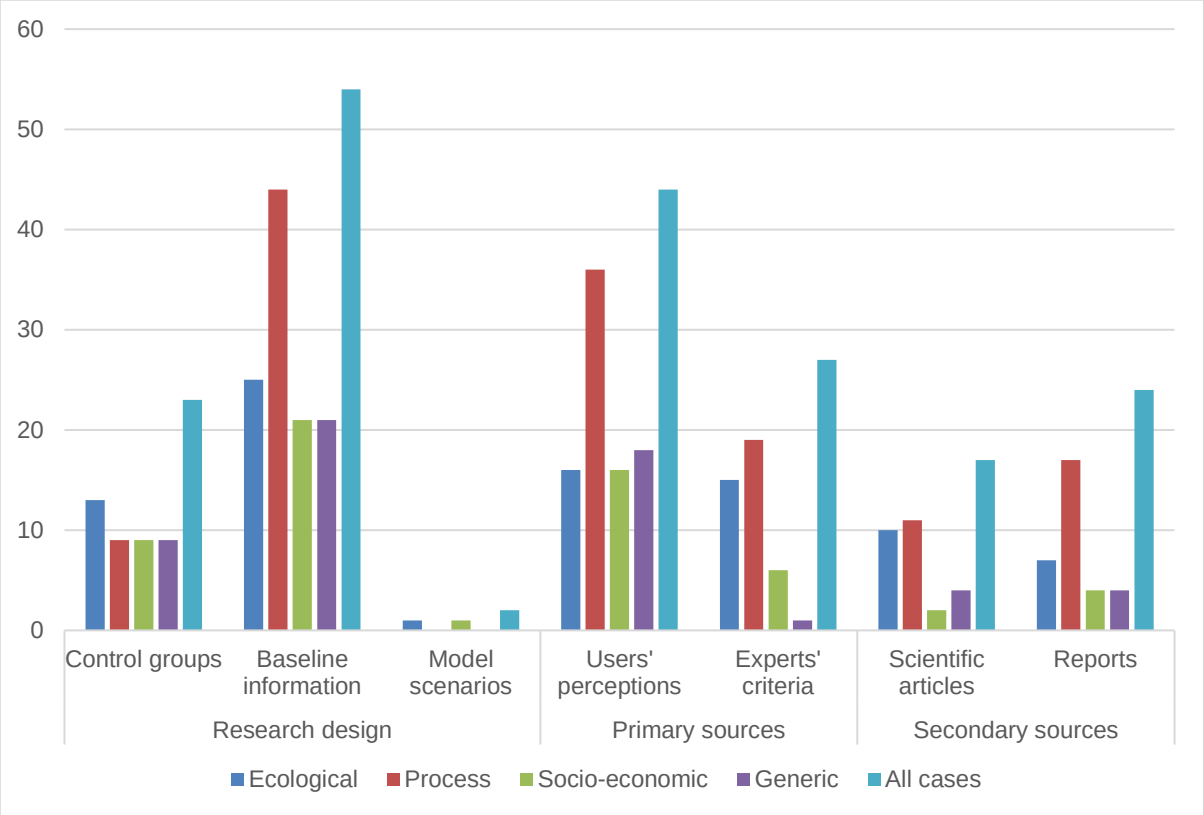


Figure A.4.6 Research design and sources of information used to assess the outcomes dimension in each case

Appendix 5: Mental models' analysis

Table A.5.1 Qualitative aggregation of actors

Final concept	Concepts in the IMMs that have been homogenized	Concepts in the IMMs that have been aggregated
Children	Children Kids School children Children or our children's children	Students + Fishers' children
City councils	City councils Local government Municipal fishery [department]	City council of *Acapetahua* + City council of *Mapastepec*
CONANP	CONANP CONANP – Reserve CONANP La Encrucijada La Encrucijada Biosphere Reserve Reserve – CONANP Reserve (Institute) SEMARNAT Those that organize (Ramón biologist)	CONANP + La Encrucijada Biosphere Reserve, Biosphere Reserve + CONANP, CONANP + Biologists, Federal government + CONANP + FANP + SEMARNAT
CONAPESCA	CONAPESCA CONAPESCA's quarters INAPESCA	CONAPESCA + INAPESCA + CRIP, CONAPESCA + SAGARPA, CRIP + CONAPESCA, Federal government + CONAPESCA + INAPESCA, INAPESCA + CONAPESCA
Cooperative leaders	Cooperative Cooperative managers Leaders	
Donors	RARE Society (for instance businessmen, institutions, banks, nature lovers) USAID	USAID + RARE
Families	Family Fishers' families Next generations	Family + Elders + Wives + Children + Schools
Federation of cooperatives	Soconusco's federation of cooperatives	
Fishers	Cooperative Cooperative men Cooperatives Cooperative society Cooperative society's members and leaders Fisher Fishermen and fisherwomen Fishers Fishers and cooperative [Cooperative] members Men Society Society (all fishers)	Cooperative + Cooperative leaders, Cooperative + Fishers Cooperative + Fishers + 6-7 cooperatives, Cooperative societies + Communities, Fishers + Adults, Fishers + Cooperatives, Fishers + Cooperatives + Dads, Fishers + Members, Open waters' fishers + Estuarine fishers, Fishing cooperatives + Fishers, Teams + Working teams + Cooperatives + Human beings,

Table A.5.1 Continued

Fishers from other cooperatives	Cooperatives Other cooperatives People from other cooperatives People from other places	
Governmental organizations	Government Other institutions Mexican state's departments	
Inter-cooperative committee	Chanpanic Responsible fishing committee	Responsible fishing committee + Facilitator
NGOs	Acción Cultural Madre Tierra Civil society organizations (ACMT) Pronatura RARE Madre Tierra	CASFA + ACMT, Madre Tierra + CASFA, Razonatura + ACMT + CASFA
Research centres	Academics ECOSUR Institutions of scientific research Scientific-technical side UNICACH	ECOSUR + Academic side (universities), UNICACH + UNACH + ECOSUR
Responsible fishing	Responsible fishing Those that come	
SEPESCA	Fishery Department Fishery and Aquaculture Department SEPESCA SEPESCA's quarters State's government	
Trade intermediaries	Coyote Trader	

Table A.5.2 Qualitative aggregation of resources

Final concept	Concepts in the IMMs that have been homogenized	Concepts in the IMMs that have been aggregated
Agreements	20 agreements Agreements Inter-cooperative agreements Internal agreements To agree	Rules + Resolution of the use of fishing gears, 20 agreements + [listing of several of the 20 agreements]
Fish stock	Fish Fish and shrimp Fish species Fishery resource Fishery resources Resource Species	Big fish + Biological resource (eggs), Fish + Crab, Future harvest + Little fish
Fish with roe	Animals with roe Fish with roe Product with roe	Flathead grey mullet with roe + Cichlids with roe
Funding	Economic resources Funds and financial resources Money Supports Temporary jobs Temporary work	Fishing infrastructure, motors + Social support for social peace during the six months of low season + Fishing gears, Resource + economy, Resources + Temporary jobs, Resources + Temporary work, Supports + Economic resources, Supports + Nets + SEPESCA's annual support + Temporary jobs + Resources, Temporary jobs + Economically
Future	Future (Living better) in future Thinking in tomorrow Tomorrow's day	
Habitat	Environment Lagoons Mangroves Nature (trees, estuaries, sea) Water	Fauna and flora + Mangrove
Harvest	Good production Permanent production Product Production	Production + Sized fishable product
Illegal gears	Forbidden gears [Shrimp] shelter	Forbidden fishing gears + Stow net
Infrastructure	Ice machine and cooperative's facilities	Money for buying motors + Nets,
Juveniles	[Catch] big fish [Catch more] fish with ideal size and weight Juvenile product Product Small fish Small species	[Catch more] fish with commercial size + [Release] small fish

Table A.5.2 Continued

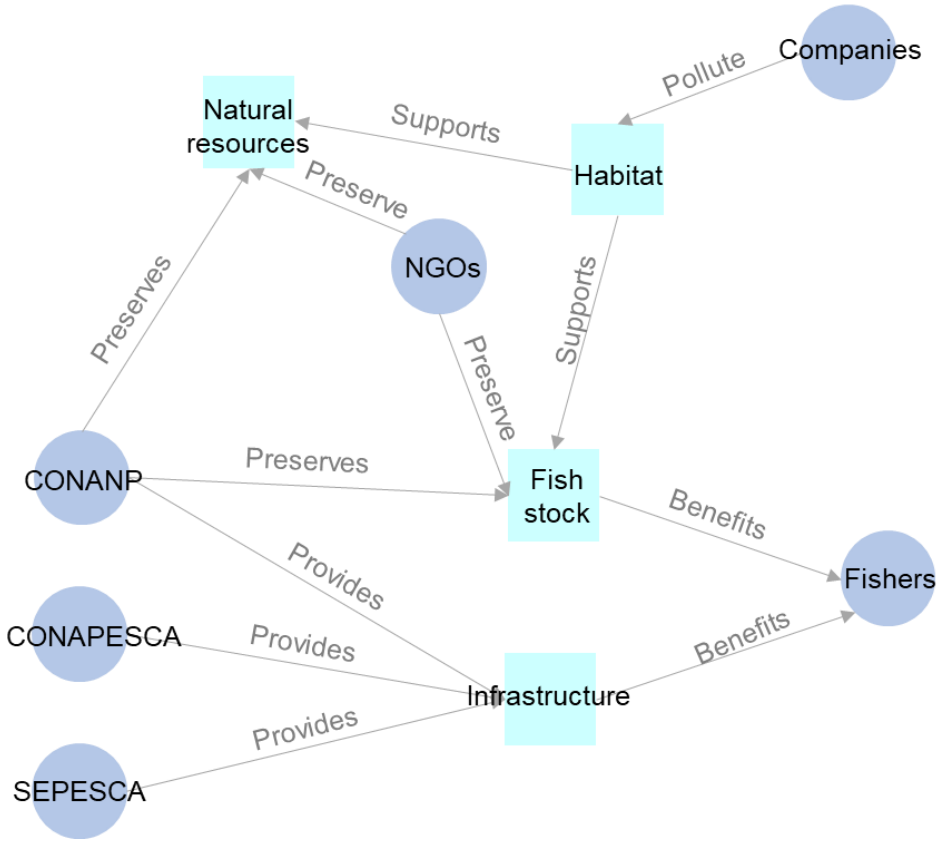
Knowledge	Information Knowledge Knowledges Research Socio-economic studies of the concession Research, validate	
Natural resources	Animals Environment, nature and trees Flora and fauna Mangroves Species (fish and other animals) The natural environment	Birds + Crocodiles + Mangrove, Environment, Flora and fauna and ecologic equilibrium + Crocodile, Hydric connectivity + Birds + Forest + Ecological diversity + Non-commercial species + Mammals + Natural resources, Nature (trees, estuaries, sea) + Resource found here, Water resources + Fauna (mammals and birds) + Wood resources (mangrove, *tulares*, *popales*), Wood + Wild fauna and birds,
No-take areas and closed seasons	Areas Closed lagoons Closed seasons No-take areas	Closed seasons + No-take areas, Forbidden areas + Closed season, No-take areas + Closed seasons, No-take areas + Local closed seasons,
Responsible fishing	Fishing with responsibility Fishing with responsibility and care Program Respect, make the activity responsibly Responsible fishing Responsible fishing process Responsible fishing program Responsible fishing project The fishing they know, the responsible fishing	Fishing with responsibility + They talk about responsible fishing

Table A.5.3 Qualitative aggregation of actions

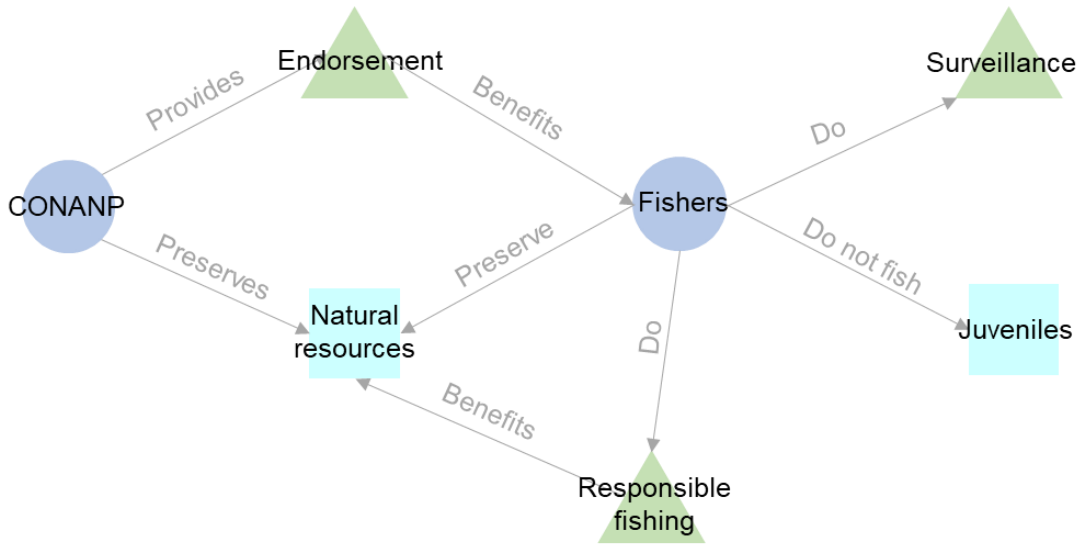
Final concept	Concepts in the IMMs that have been homogenized	Concepts in the IMMs that have been aggregated
Capacity building	Courses Talks Train Training Trainings Workshop	Consultancy + Courses, Courses + Events+ Exchange of experiences, sport events + cayuco races, Courses + Learn, Games + Tournaments for motivation, Talks + Workshops, Training + Exchange of experiences, Trainings + Teach how to participate in assemblies,
Commercialization	Joint commercialization	Cool box + Very good quality + Selling + Favourable market + Better price, Commercialization + Products, Differentiate, certificate + Product quality + Improve post-harvest processes to add in situ value + Improve commercialization processes, Generating added value + Better harvest registration + Better facilities + Better prices, Improving + Price, Integrating company + Organic certificate + Filleting + Fish transformation + Fish added value, Joint commercialization + Product classification + Cool box, Good price, Increase value + Marketing to better markets, Product's size and weight + Prices, Projects + Cool boxes + Premise + Fridge + Offices + Selling to international and local market, Selling + Product, Selling + Product with quality + Direct marketing + Market or restaurant,
Endorsement	Accompaniment and support Validation Guidance	Accompaniment + Endorsement + Reference + Credibility
Preserve	Care Respect	Care, respect + Control through Environmental Management Unities, To do not finish up + Work harmoniously,
Surveillance	Monitoring Monitoring respect Supervision tours Surveillance	Surveillance + Monitoring and surveillance tours + Water quality, fish size + Fishing gears that meet the rules

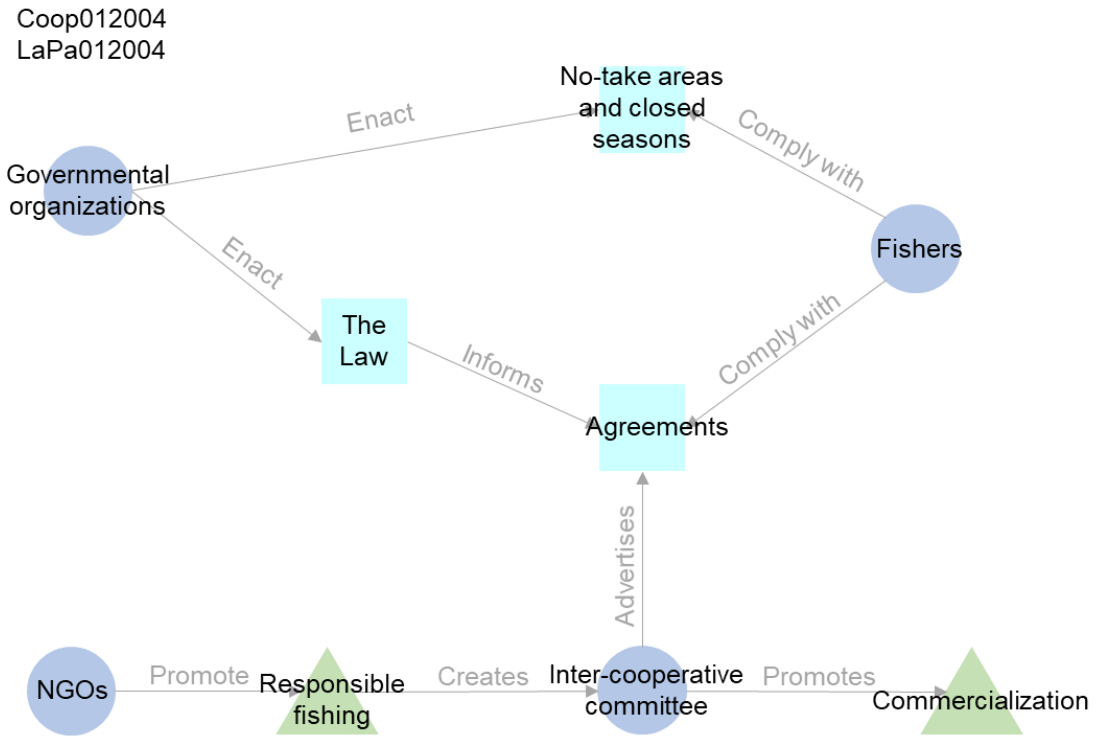
Appendix 6: Individual mental models

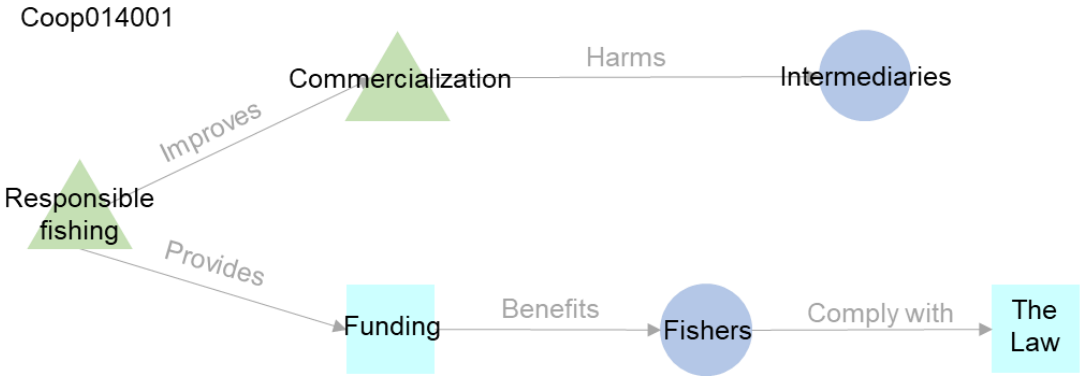
Coop05001



Coop012002




Coop012004
LaPa012004
Governmental organizations
Enact
No-take areas and closed seasons
Comply with
Fishers
Enact
The Law
Informs
Comply with
Agreements
Advertises
NGOs
Promote
Responsible fishing
Creates
Inter-cooperative committee
Promotes
Commercialization


Coop014001
Commercialization
Harms
Intermediaries
Improves
Responsible fishing
Provides
Funding
Benefits
Fishers
Comply with
The Law

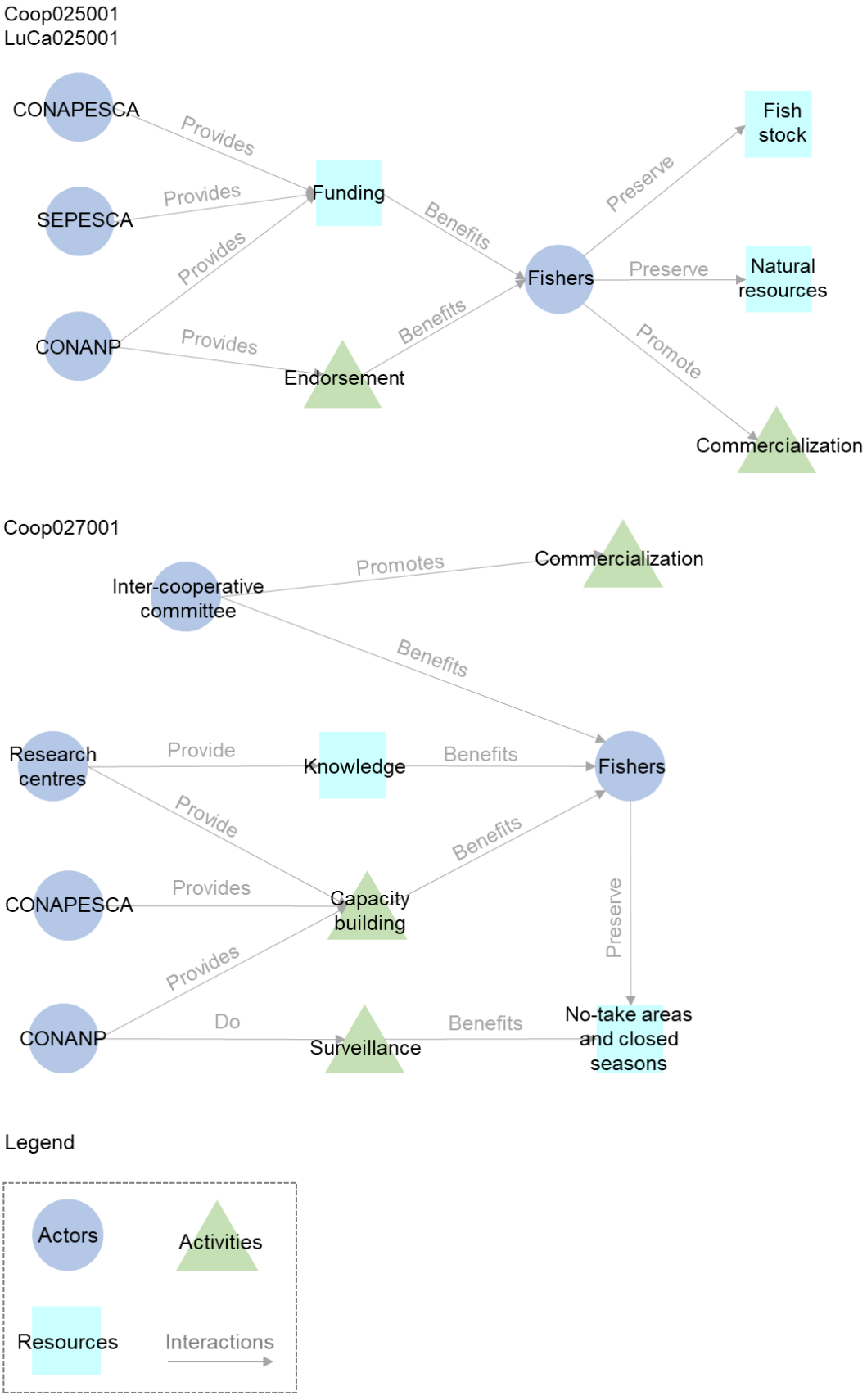
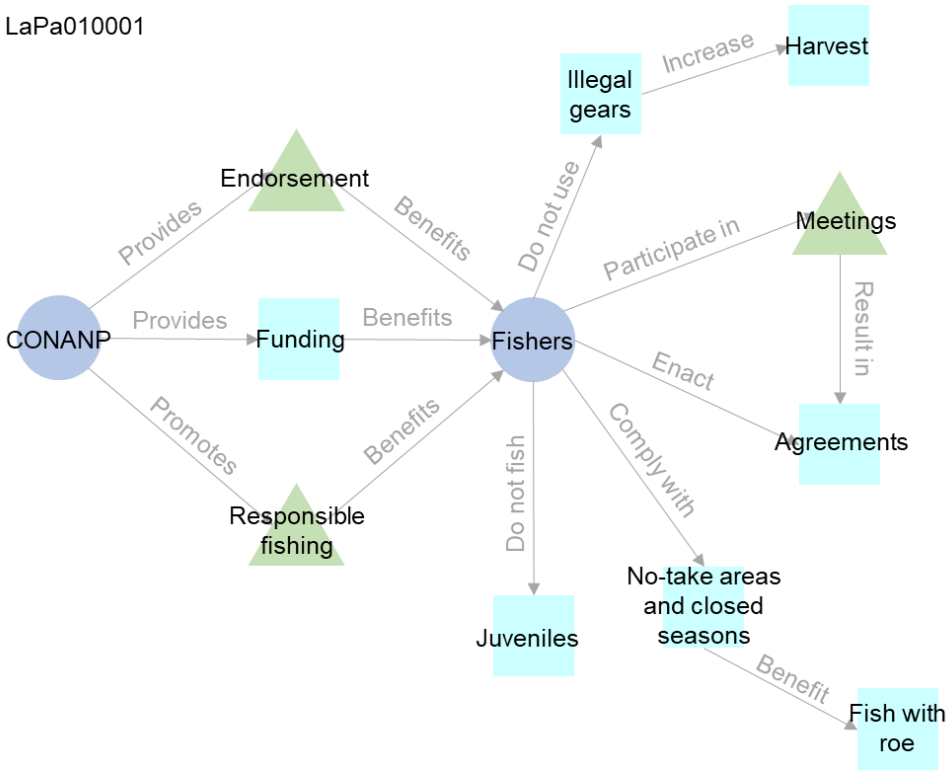
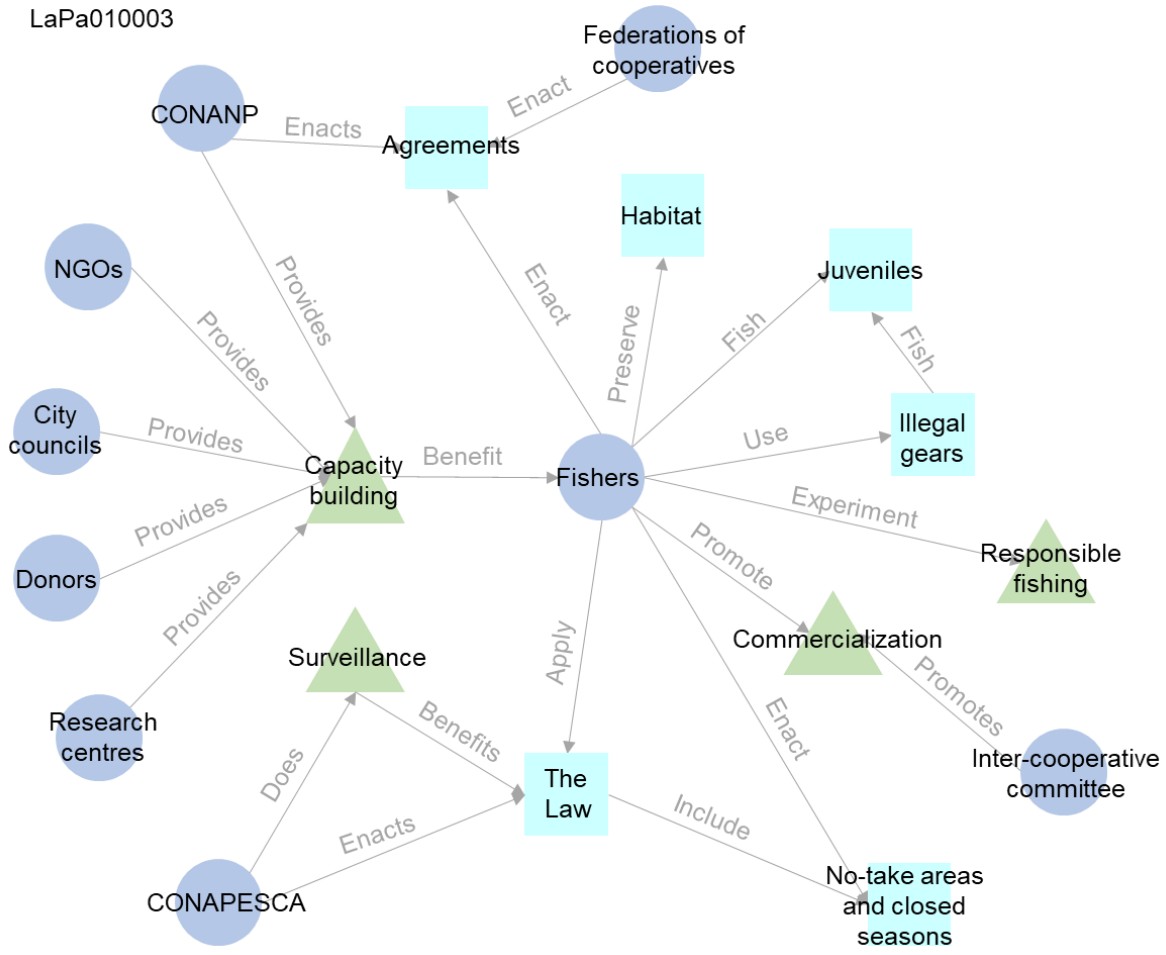
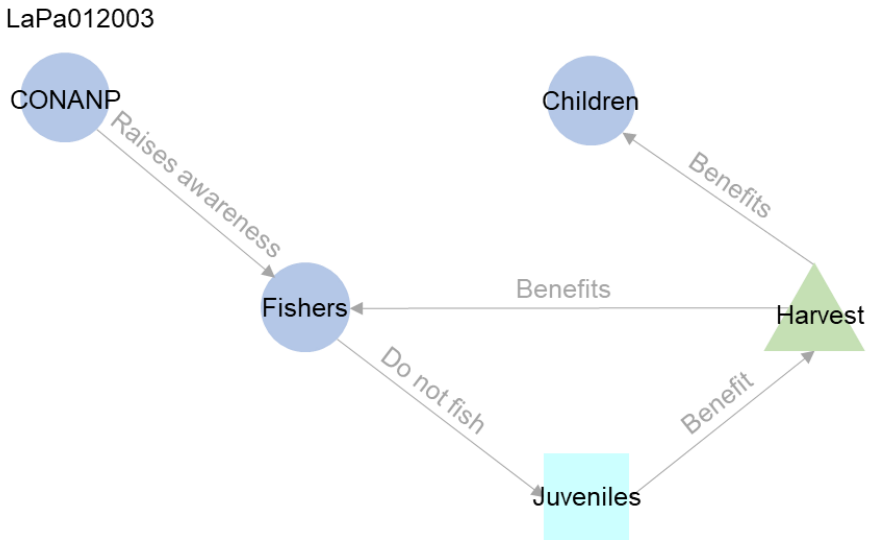
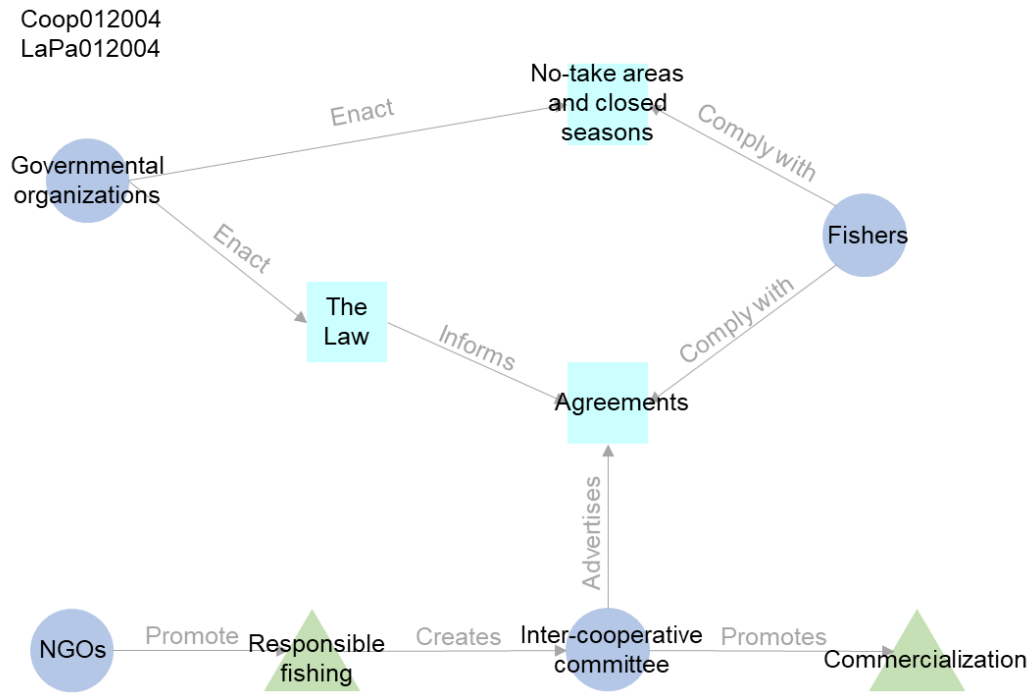


Figure A.6.1 Individual mental models of six fishing cooperatives' leaders

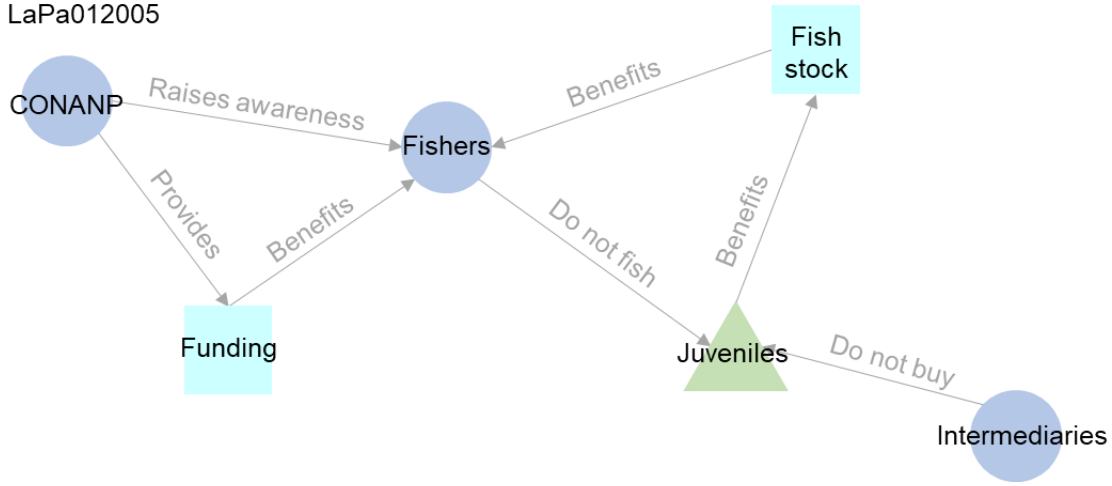

LaPa010001
Harvest
Increase
Illegal gears
Endorsement
Provides
Benefits
Do not use
Participate in
Meetings
Result in
CONANP
Provides
Funding
Benefits
Fishers
Enact
Agreements
Promotes
Benefits
Responsible fishing
Do not fish
Comply with
No-take areas and closed seasons
Juveniles
Benefit
Fish with roe


LaPa010003
Federations of cooperatives
CONANP
Enacts
Enact
Agreements
Habitat
NGOs
Provides
Provides
Enact
Preserve
Juveniles
Fish
Fish
City councils
Provides
Capacity building
Benefit
Fishers
Use
Illegal gears
Experiment
Provides
Donors
Provides
Promote
Responsible fishing
Commercialization
Surveillance
Apply
Promotes
Research centres
Benefits
Enact
Inter-cooperative committee
Does
The Law
Include
Enacts
CONAPESCA
No-take areas and closed seasons


LaPa012003
CONANP
Raises awareness
Children
Benefits
Fishers
Benefits
Harvest
Do not fish
Benefit
Juveniles

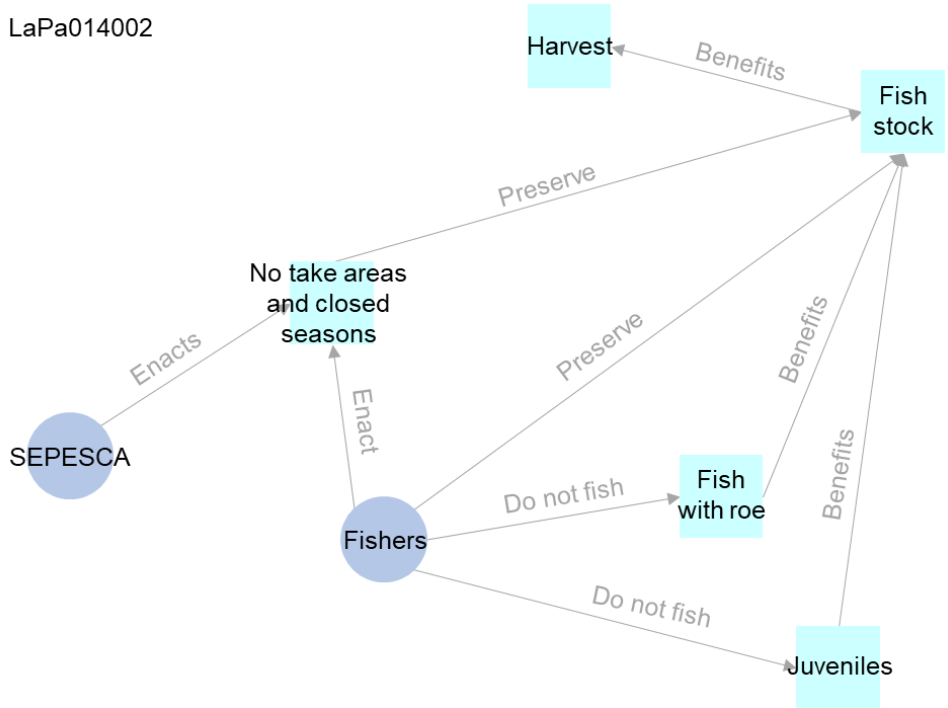

Coop012004
LaPa012004
No-take areas and closed seasons
Enact
Comply with
Governmental organizations
Enact
Fishers
The Law
Informs
Comply with
Agreements
Advertises
NGOs
Promote
Responsible fishing
Creates
Inter-cooperative committee
Promotes
Commercialization

LaPa012005



LaPa013003

LaPa014002



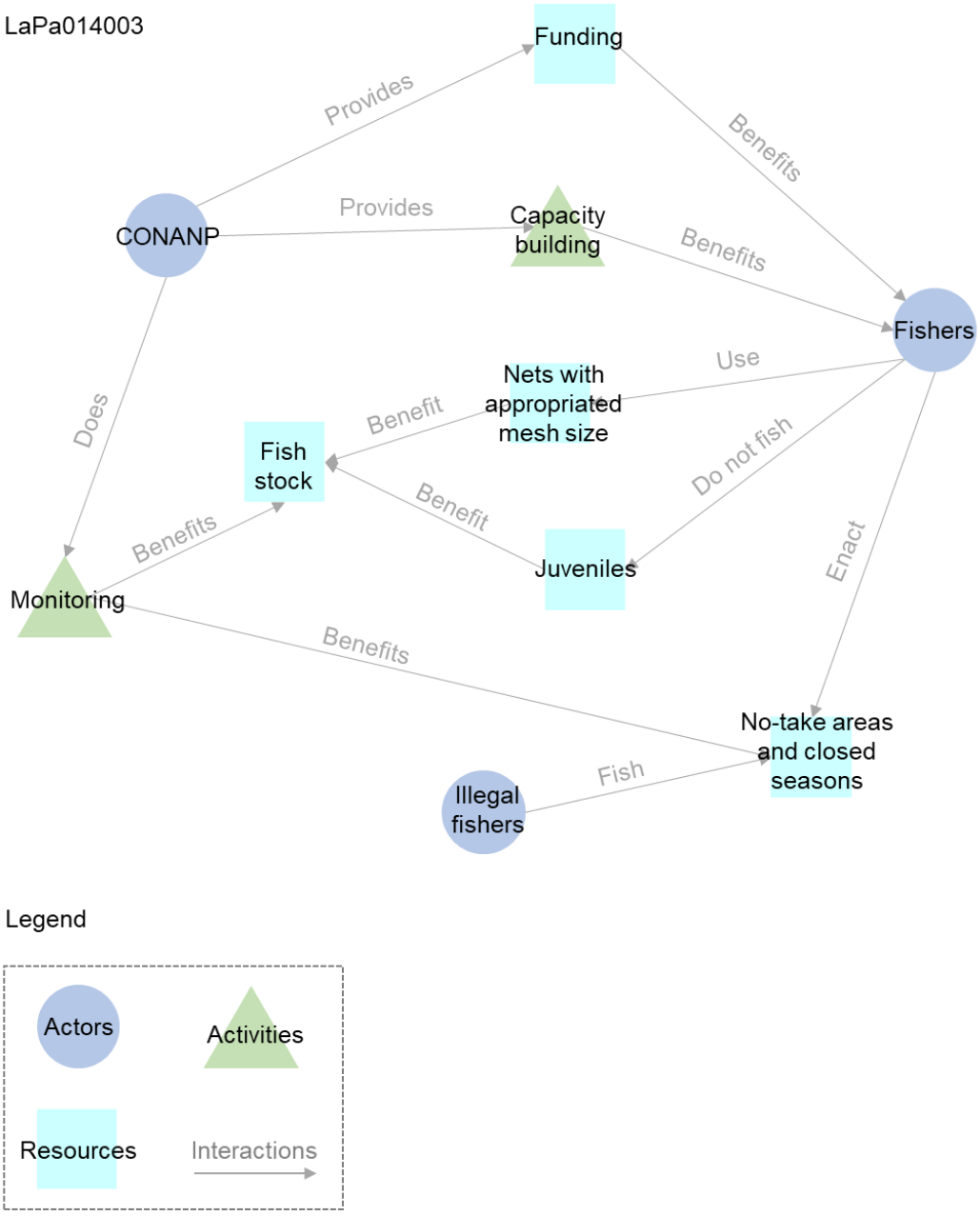
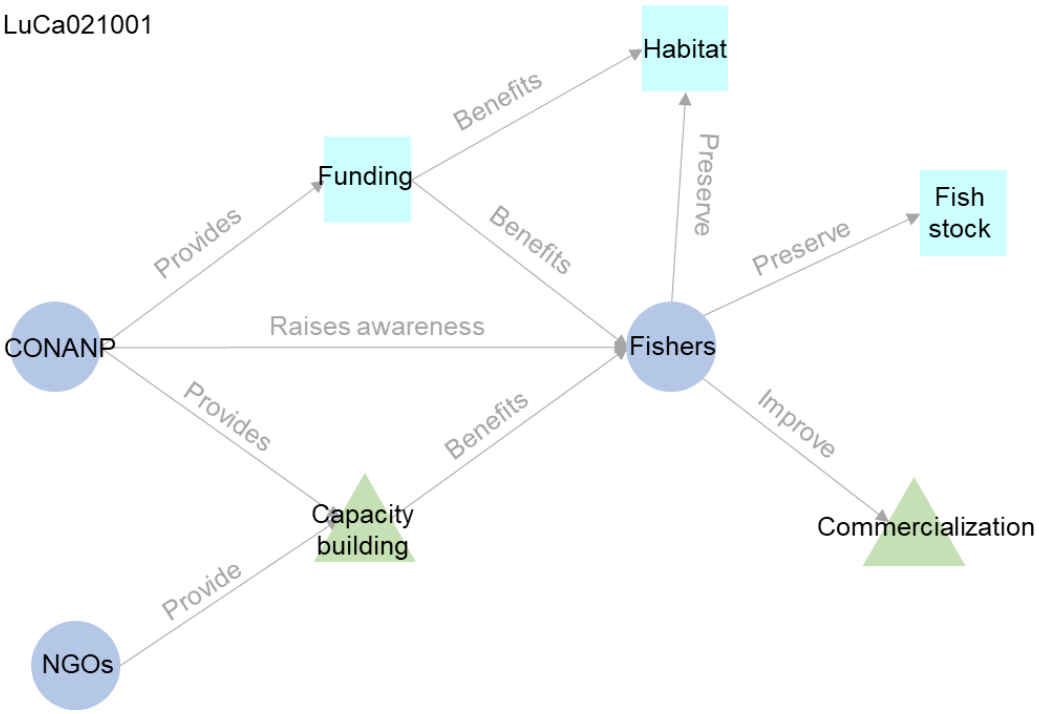
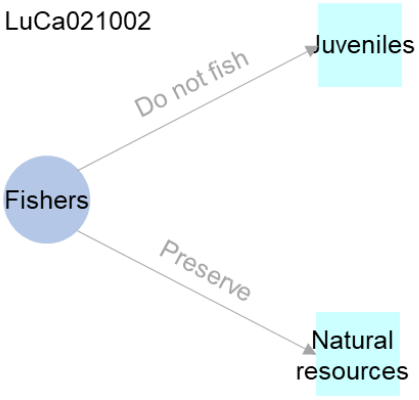


Figure A.6.2 Individual mental models of seven members of *La Palma* fishing cooperative

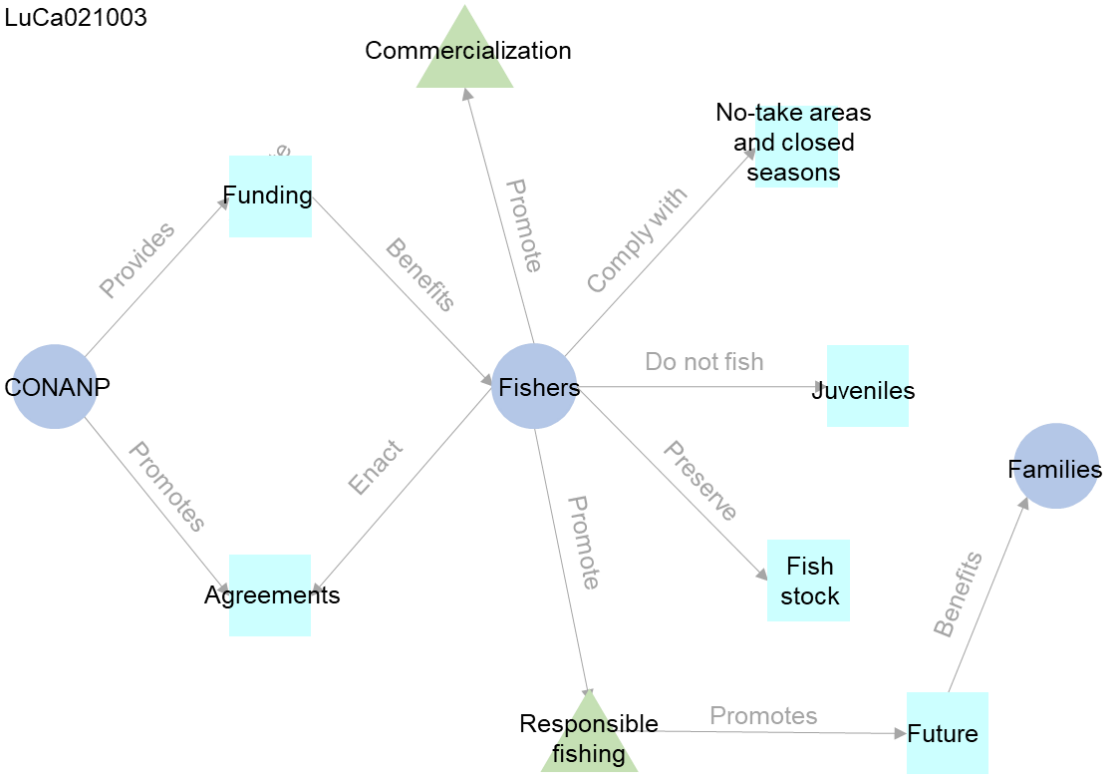
LuCa021001



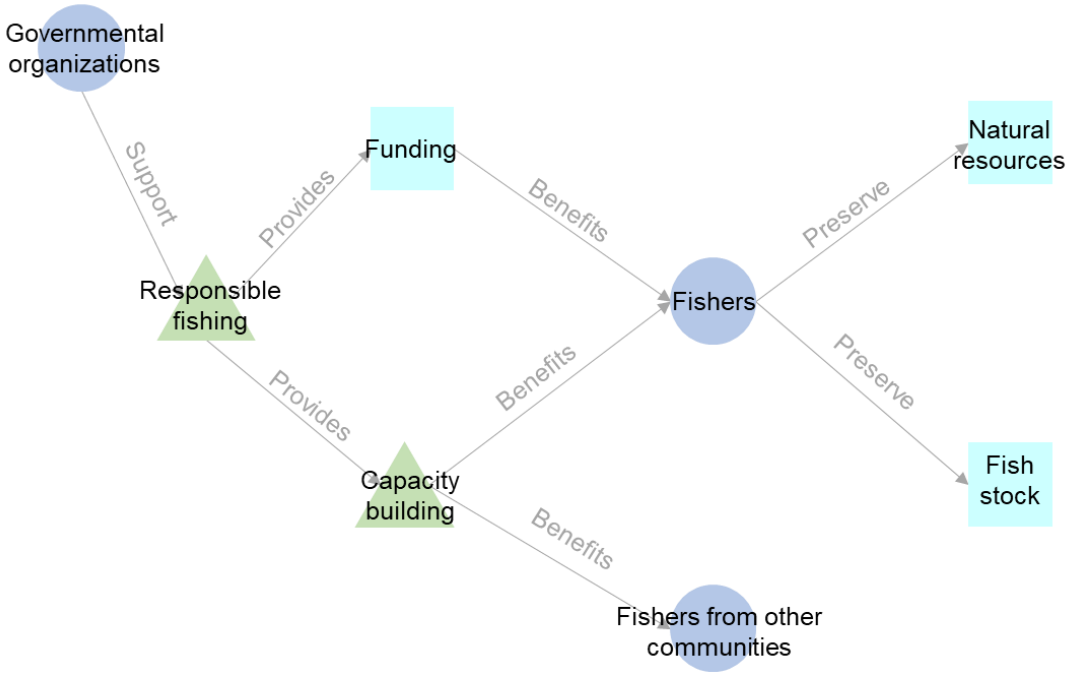
LuCa021002

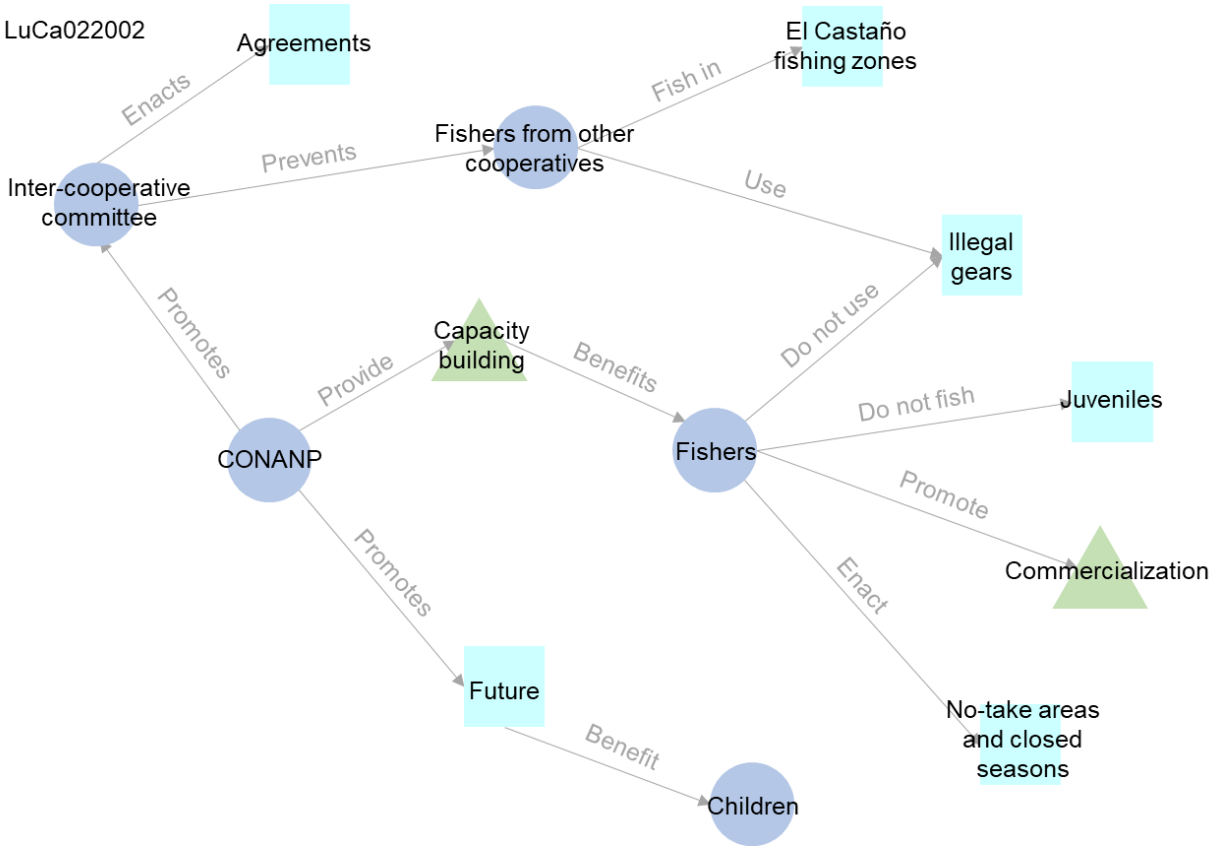


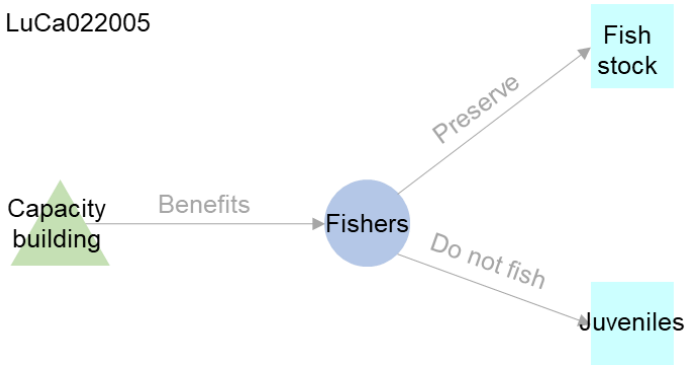
LuCa021003



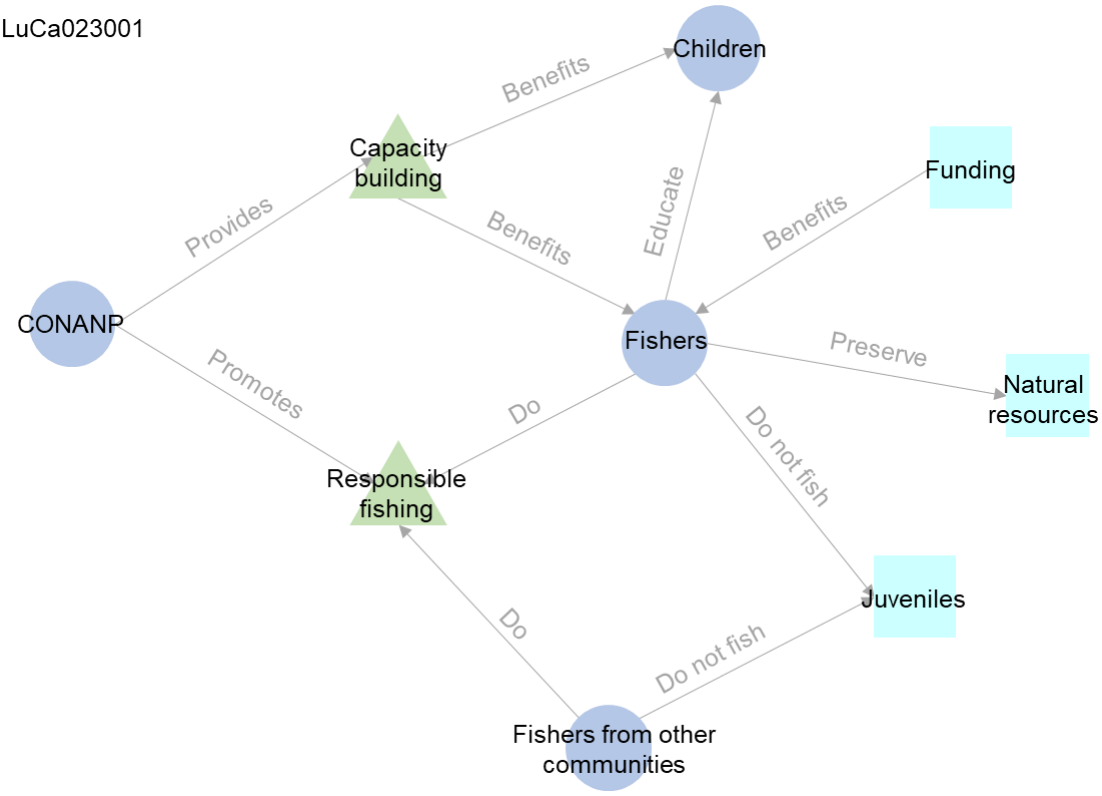
LuCa022001



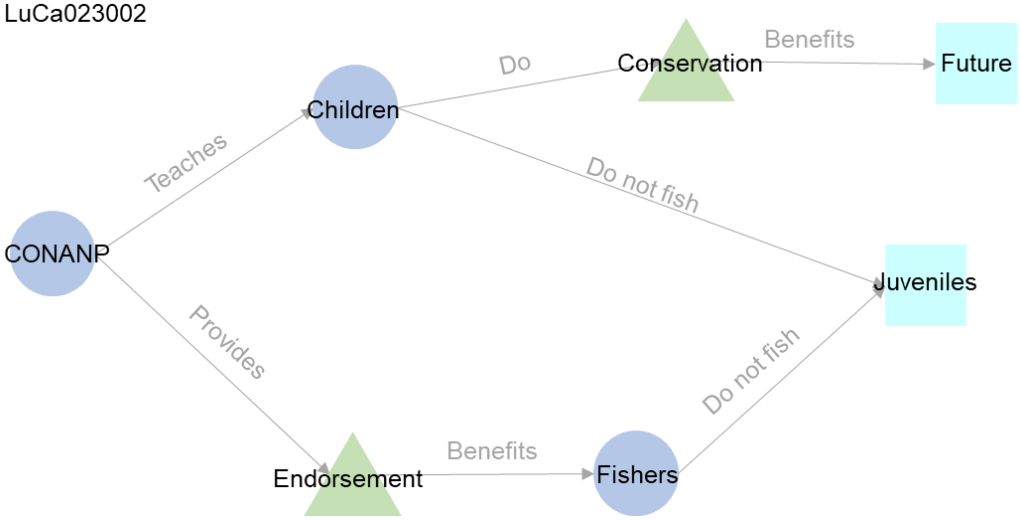

LuCa022002
Agreements
Enacts
El Castaño fishing zones
Fish in
Fishers from other cooperatives
Prevents
Inter-cooperative committee
Use
Illegal gears
Promotes
Capacity building
Provide
Benefits
Do not use
Do not fish
Juveniles
CONANP
Fishers
Promote
Commercialization
Promotes
Enact
Future
No-take areas and closed seasons
Benefit
Children

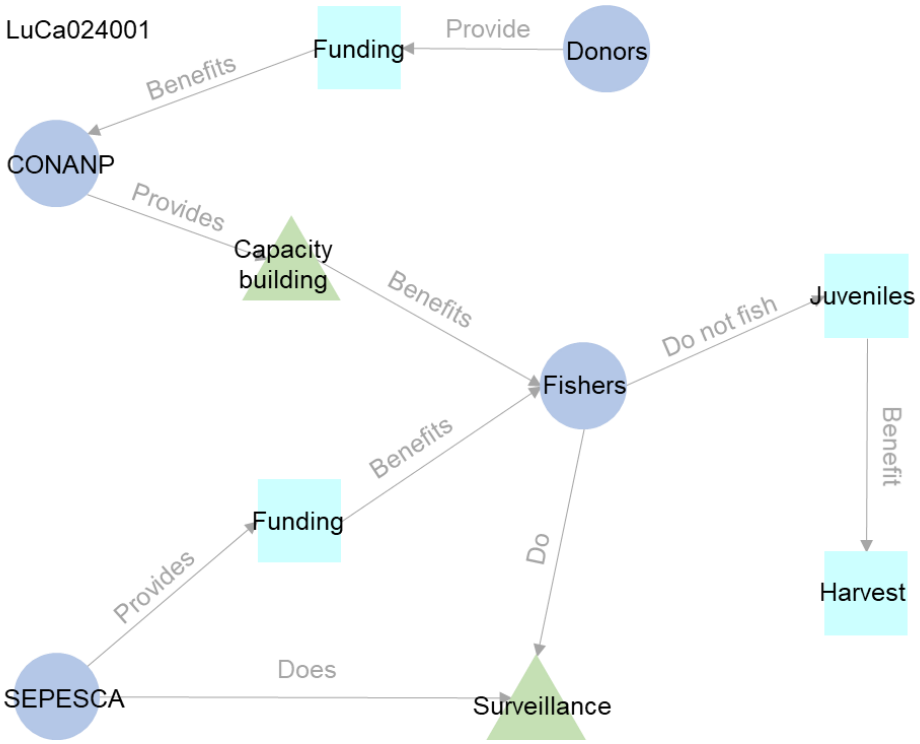

LuCa022005
Fish stock
Preserve
Capacity building
Benefits
Fishers
Do not fish
Juveniles

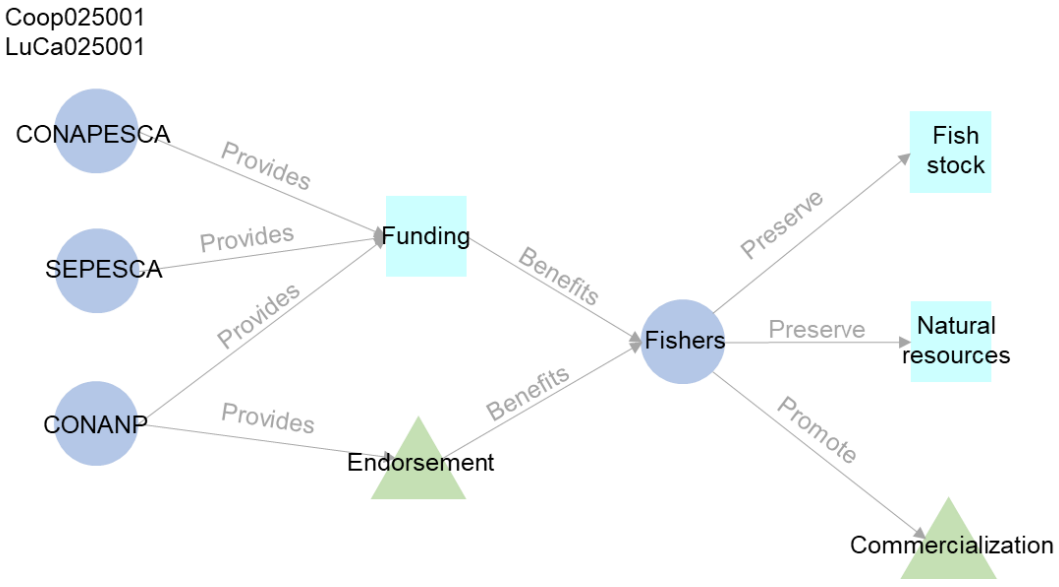
LuCa023001



LuCa023002




LuCa024001
Funding
Provide
Donors
Benefits
CONANP
Provides
Capacity building
Benefits
Juveniles
Do not fish
Fishers
Benefit
Benefits
Funding
Do
Harvest
Provides
Does
SEPESCA
Surveillance


Coop025001
LuCa025001
CONAPESCA
Provides
Fish stock
Provides
Funding
Preserve
SEPESCA
Benefits
Provides
Fishers
Preserve
Natural resources
CONANP
Provides
Benefits
Endorsement
Promote
Commercialization

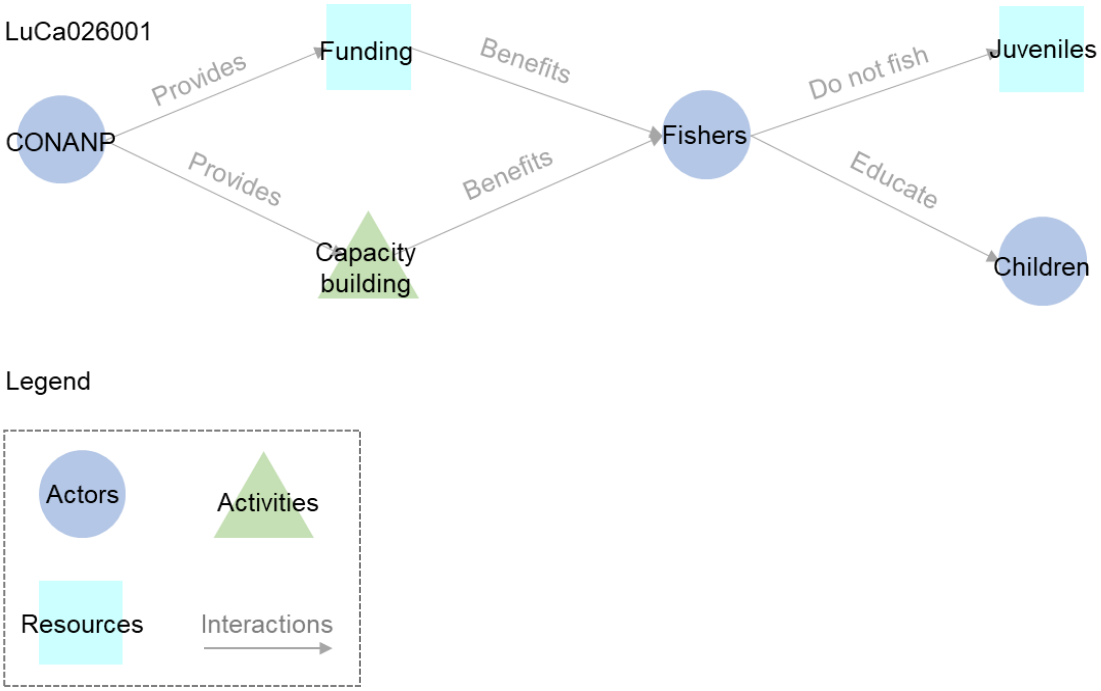
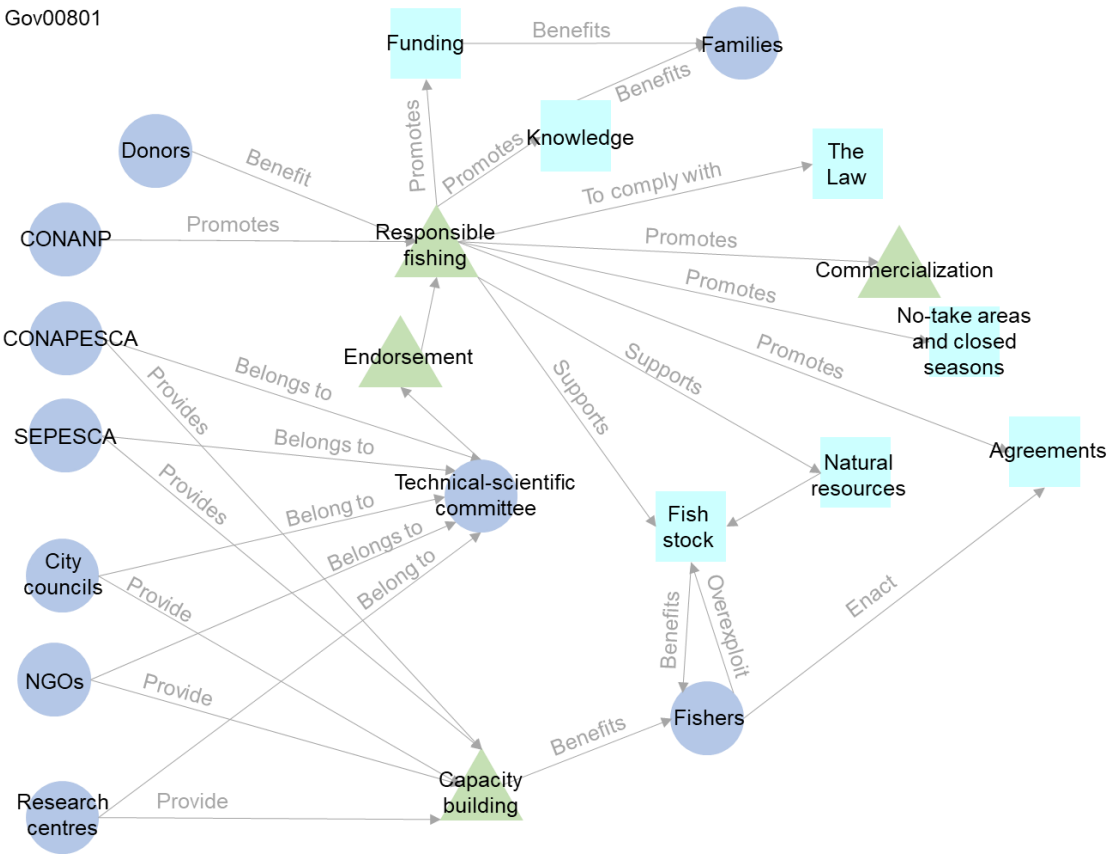
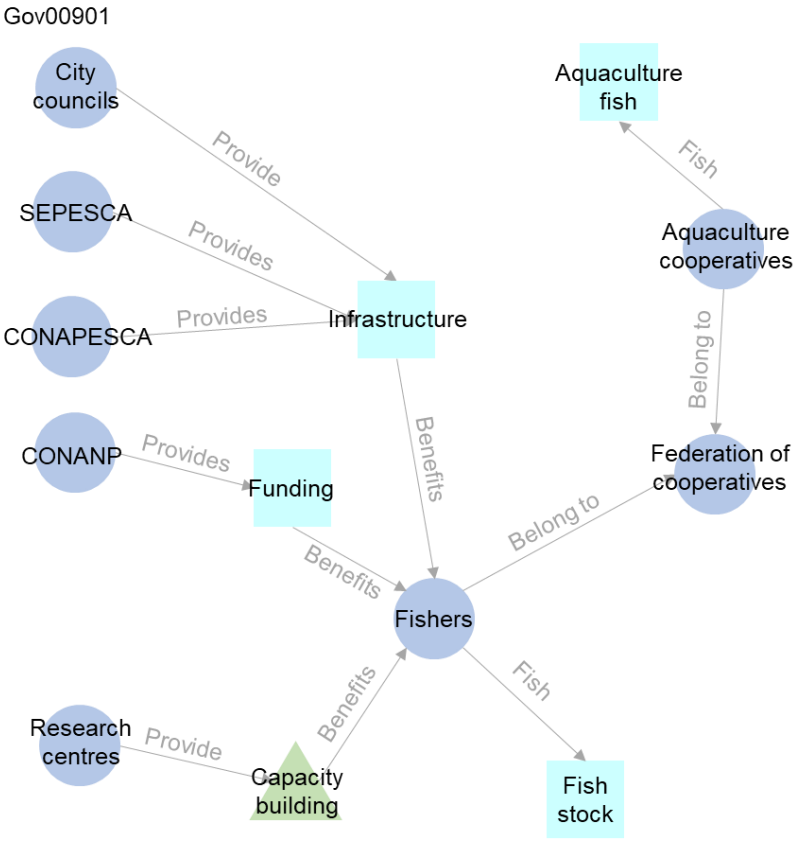


Figure A.6.3 Individual mental models of eleven members of *Luchadores del Castaño* fishing cooperative




Gov00901
City councils
SEPESCA
CONAPESCA
CONANP
Research centres
Provide
Provides
Provides
Provides
Provide
Infrastructure
Funding
Capacity building
Benefits
Benefits
Benefits
Fishers
Belong to
Fish
Fish stock
Aquaculture fish
Fish
Aquaculture cooperatives
Belong to
Federation of cooperatives

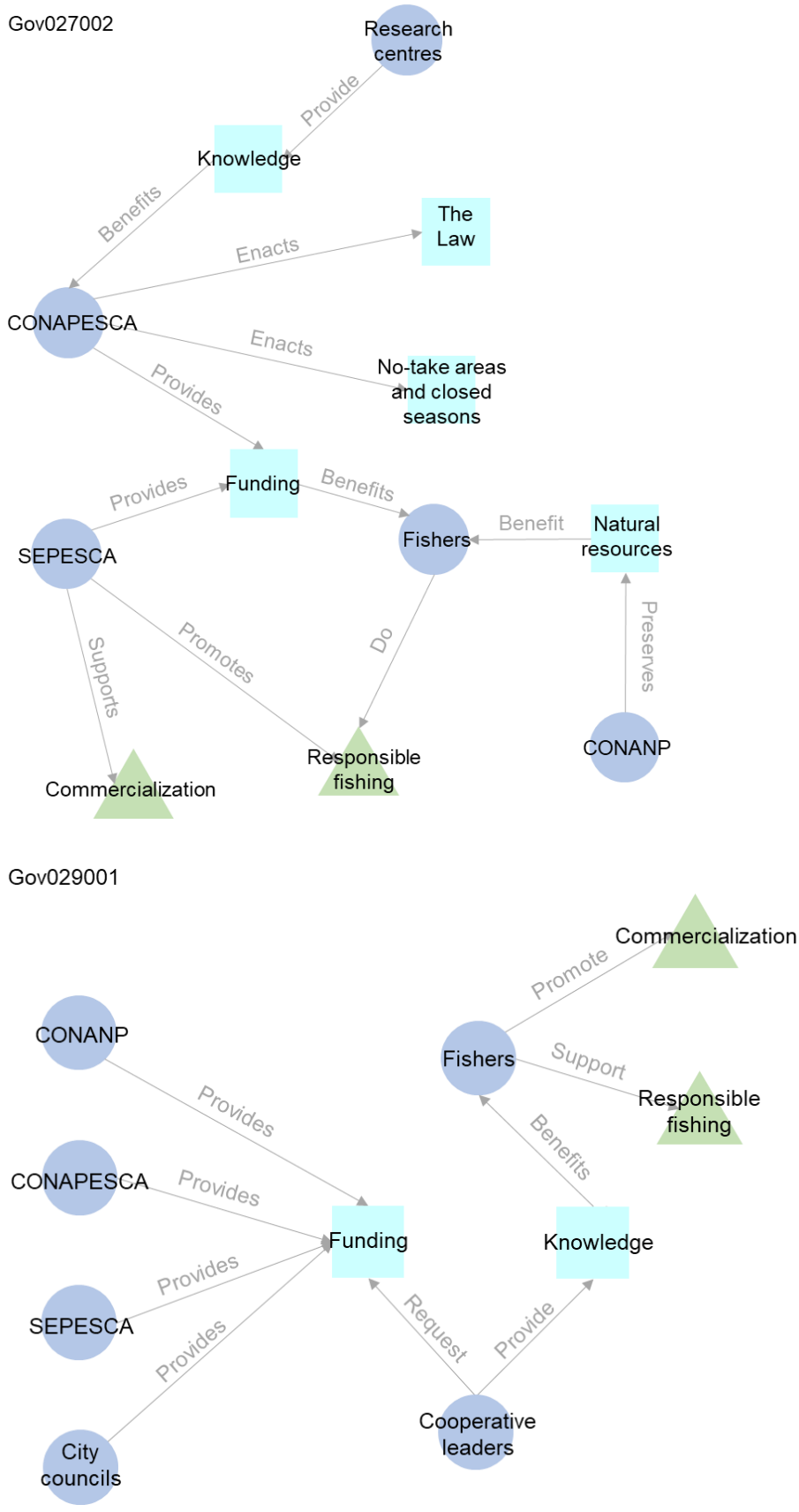
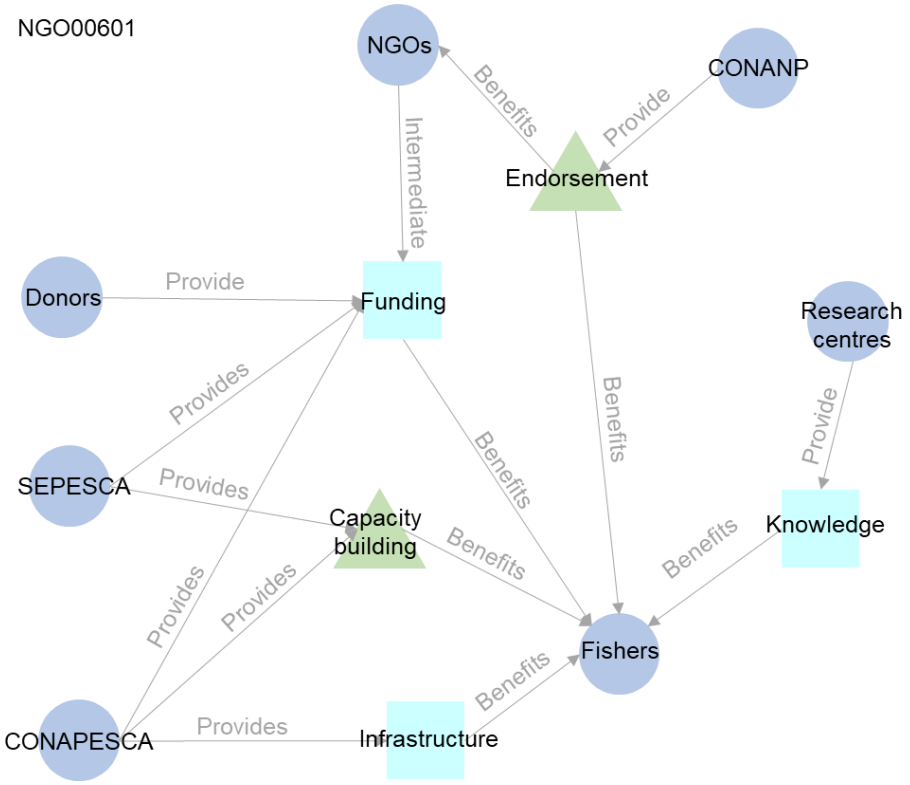
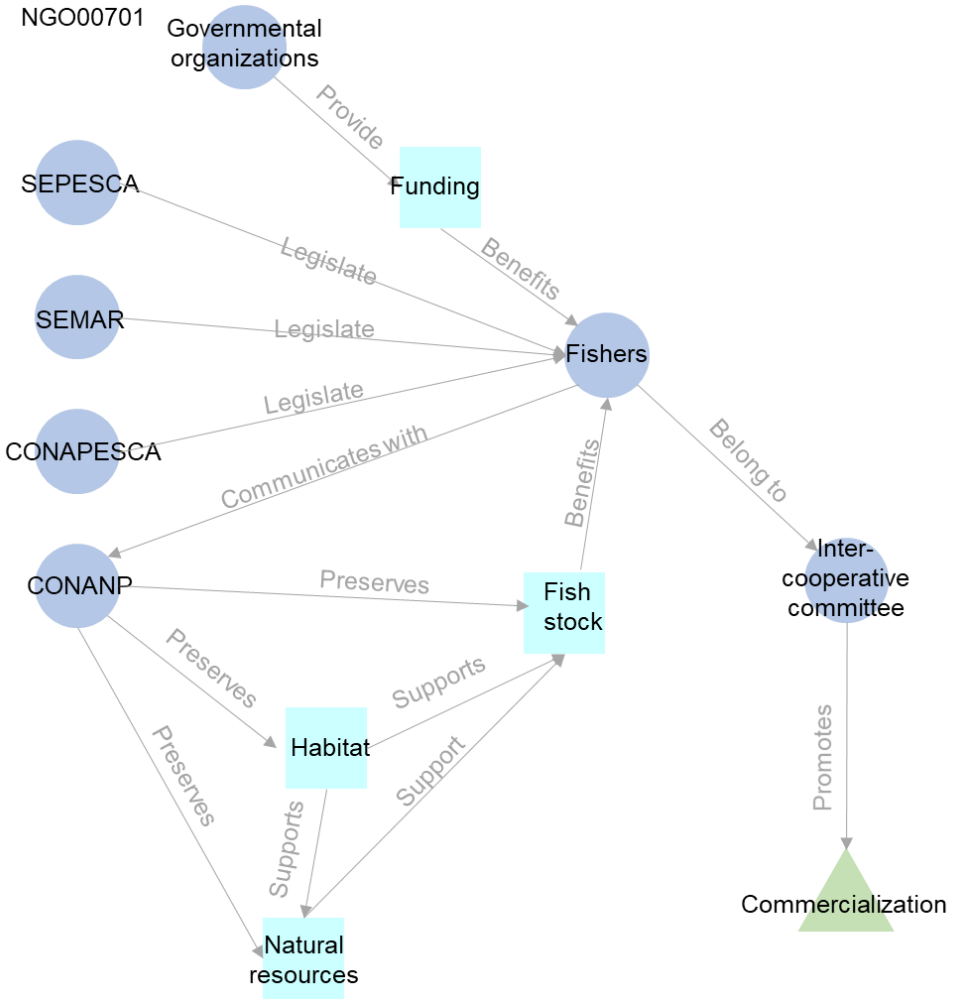
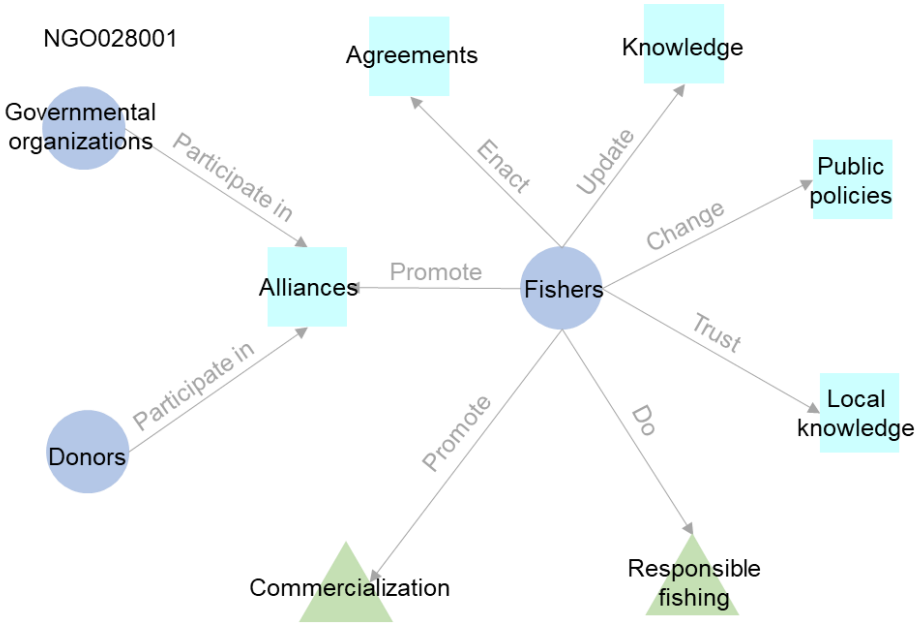


Figure A.6.4 Individual mental models of four government agencies' representatives


NGO00601
NGOs
CONANP
Benefits
Provide
Intermediate
Endorsement
Donors
Provide
Funding
Research centres
Provides
Benefits
Benefits
Provide
SEPESCA
Provides
Capacity building
Benefits
Benefits
Knowledge
Provides
Provides
Fishers
Benefits
CONAPESCA
Provides
Infrastructure


NGO00701
Governmental organizations
Provide
Funding
SEPESCA
Legislate
Benefits
SEMAR
Legislate
Fishers
Legislate
CONAPESCA
Communicates with
Benefits
Belong to
Inter-cooperative committee
CONANP
Preserves
Fish stock
Preserves
Supports
Habitat
Preserves
Support
Supports
Natural resources
Promotes
Commercialization


NGO028001
Agreements
Knowledge
Governmental organizations
Participate in
Enact
Update
Public policies
Change
Alliances
Promote
Fishers
Trust
Local knowledge
Participate in
Donors
Promote
Do
Commercialization
Responsible fishing

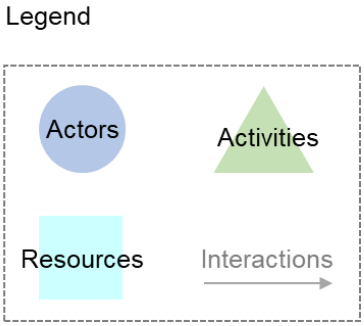
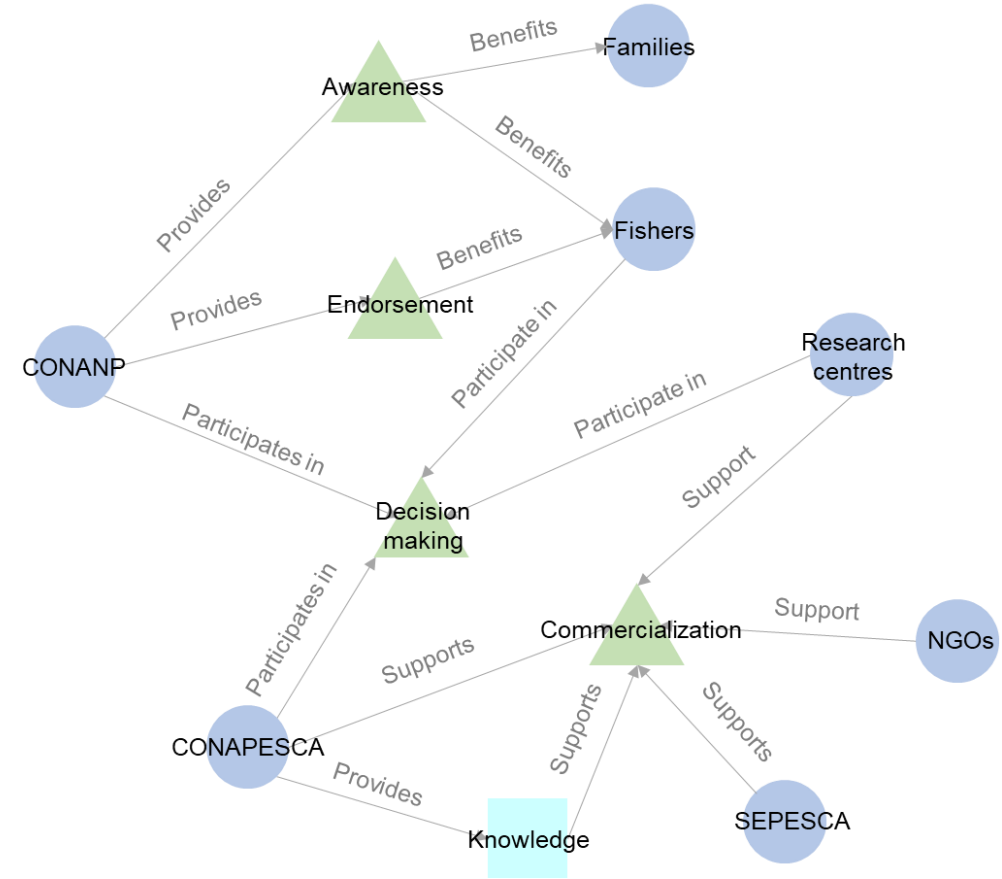


Figure A.6.5 Individual mental models of three NGOs' representatives



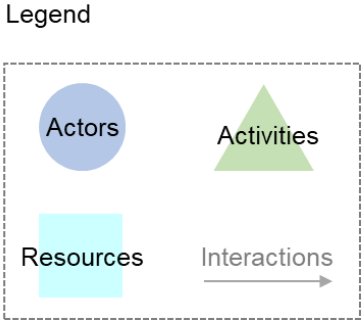


Figure A.6.6 Individual mental model of a research centre's representative