



Analysis

Small-scale fish buyers' trade networks reveal diverse actor types and differential adaptive capacities

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ABSTRACT

The importance of understanding how social-ecological interdependencies deriving from global trade influence sustainability has been argued for decades. Even if substantial progress has been made, a research gap remains regarding how the adaptability of small-scale fish buyers, whose daily operations have implications for the livelihood of more than 100 million people, are affected by networks of trade relationships. Adaptability is here defined as fish buyers' abilities to adapt using their relationships with others. We elaborate how these capacities relate to the precise patterns in which a fish buyer is entangled with other fish buyers, with the fishers, and with the targeted fish species, by combining a multilevel social-ecological network model with empirical data from a small-scale fishery in Mexico. Further, we also identify types of fish buyers distinguishable by how they operate, and how they are embedded in the trading network. Our results suggest that adaptability differs substantially amongst these types, thus implying that fish buyers' abilities to respond to changes are unevenly distributed. This study demonstrates the need for a more profound understanding of the consequences of the different ways in which fish buyers operate commercially, and how these operations are affected by patterns of social and social-ecological interdependencies.

1. Introduction

Fish buyers (also known as intermediaries or middlemen) are key actors in small-scale fisheries (SSF), and their importance is expected to increase in an era of globalization characterized by trade, liberalization policies and increased market integration (Basurto et al., 2013; Crona et al., 2015). Fish buyers mediate between fishing activities and diverse market demands of fish products arising further away in supply chains. Previous research has demonstrated that through this mediating role, they can influence fisher's behavior, which in turn influence how local fish stocks are utilized and managed (e.g. Crona et al., 2010; Miñarro et al., 2016; Nascimento et al., 2017). This is especially true in developing countries, where formal governance is often weak (Basurto et al., 2013) and lacks the capacity to effectively influence fisheries management. The importance of fish buyers, and the post-harvesting activities they engage in, has recently also been formally recognized in FAO's Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries in the Context of Food Security and Poverty Eradication, herein SSF Guidelines (FAO, 2015:10–12).

Increasing scholarly focus has been directed at fish buyers in SSF

recently, with particular attention to the fish buyers and their complex relationships within value chains (e.g. Drury O'Neill and Crona, 2017; Rosales et al., 2017). Since fish buyers mediate between fishing activities and market demands, how they respond and adapt to environmental and market changes will be an essential component of guaranteeing food provisioning and governing the exploitation level of fish stocks towards sustainable levels. The importance of improving peoples' capacities to individually decide if and how to act upon changes has recently been emphasized as crucial in building adaptive capacity, especially to climate change (Cinner et al., 2018). We acknowledge that high adaptive capacity of an individual does not imply his/her propensity towards increasing fishery sustainability since they could choose to use such capacity to increase overly exploitive practices (Mahon et al., 2008). However, fish buyers' adaptive capacity can have profound implications for small-scale fisheries sustainability in a changing context, which has not been much addressed in the literature.

This paper contributes to better understanding of the role of fish buyers, by using a case study in the state of Baja California Sur, Mexico. We begin by mapping fish buyers and their trade relationships in a finfish value chain to analyze their pattern of trade relationships using a

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network approach (Section 3.1). This allows us to identify and characterize types of fish buyers based on their patterns of relationships (Section 3.2). This approach is novel and builds on a bottom-up empirically driven characterization of buyer types based on their position in the network of trade relationships, which allows us to subsequently link these fish buyer types with their presumed capacity to proactively adapt to changing economic, social and environmental conditions (Section 3.3). In particular, by focusing on how fish buyers are embedded in various trade relationships with others, we are able to hypothesize how their capacity to adapt is both constrained and enhanced by individuals' abilities to utilize their existing trade relationships in their daily operations. This study thus contributes to the current stream of research arguing for the importance of adaptive capacity (e.g. Mahon et al., 2008; Cinner et al., 2018) by furthering a deeper understanding of how social organization can contribute to fish buyers' individual capacities to adapt to changes. From this perspective, adaptive capacity is assumed to be inherently linked to how trade relationships between individuals or organizations enable (constrain) people's actions. We acknowledge that other components of adaptive capacity (e.g. assets, agency, learning) and the broader set of livelihoods and social relationships also influence adaptive capacity (Cinner et al., 2018), but in order keep our focus on trade arrangements, we deliberately excluded them from our specific analyses.

We utilize recent interdisciplinary social-ecological network approaches to develop a series of propositions characterizing the different types of fish buyers in terms of their adaptive capacity, drawing on insights from existing literature on the relationships between fishers and traders and amongst traders (Section 1.1), as well as theories from new institutional economics, network exchange theory and environmental governance. The approach we follow is based on an interpretation on how certain patterns of trade relationships amongst fish buyers, between fish buyers and fishers, and between fish buyers and fish resources relate to certain aspects of fish buyers' ability to influence their own and others' operations (cf. Bodin and Tengö, 2012; Bodin, 2017).

1.1. Theoretical background

We define trade relationships as repeated fish exchange relationships that supersede occasional economic transactions (i.e. not spot markets) in a context of inter-personal social relationships (Granovetter and Swedberg, 2011). Repeated fish exchange relationships between fishers and fish buyers, and amongst fish buyers, are typically associated with a set of commonly agreed upon norms and rules by the parties of the exchange (Bagozzi, 1975; Wilson, 1980; Drury O'Neill and Crona, 2017). These exchange relationships, and their associated norms and rules, guide and constrain the parties behaviours (Granovetter, 1985; Ostrom, 1990) and therefore have implications for the capacity of fish buyers to adapt to environmental and other changes and ultimately to influence sustainability in SSF.

We define fish buyer's adaptive capacity following three different dimensions: i) fish buyer's adaptive capacity in relation to other fish buyers; ii) fish buyer's adaptive capacity in relation to fishers; and iii) fish buyer's capacity to deal with short-term resource fluctuations (in resource price and availability). Each of the dimensions of adaptive capacity (i-iii) dealt with here are based on different concepts relating to how social organization affects people's actions (cf. Cinner et al., 2018). Namely power and control over resource flows in exchange networks (e.g. see Cook and Emerson, 1978), capacity to influence in fish buyer-fisher relationships (e.g. see Merlijn, 1989), and flexibility of resource access (e.g. see Williamson, 1981), respectively. These dimensions are reflected by different structures of the trade network (Fig. 1), which is further detailed in the analytical framework described in Section 2.4 and Table 1.

Adaptive capacity in relation to other buyers and their capacity to deal with resource fluctuations, relates to the role of the diversity of

trade relationships that fish buyers have with each other. Trade relationships amongst fish buyers will affect their economic performance and benefit distribution amongst actors in the trade network (Vignes and Etienne, 2011; Drury O'Neill et al., 2018), and likely influence how they operate in linking the supply from fishers and ecosystems to the various market demands. For example, trade relationships based on reciprocity and loyalty can increase the capacity of fish buyers to deal with variabilities and uncertainties regarding their abilities to acquire the right amount of resources in order to provide supply chains with certain quantity and quality of fish (Wilson, 1980; Cannon and Perreault, 1999). Trade relationships amongst fish buyers have been described in fisheries and fish markets around the world. However, the potential influences of such relationships on fishery sustainability is poorly understood (Hamilton-Hart and Stringer, 2016), and thus deserves, as we argue here, further attention.

Concerning relationships between fishers and fish buyers, a well-documented example within the SSFs literature comes in a form of Patron-Client arrangements (therein PCs). In PCs, a set of fishers are (often exclusively) tied to a specific fish buyer that buys their catches (e.g. Platteau and Abraham, 1987; Merlijn, 1989; Crona et al., 2010; Basurto et al., 2013). The exact nature of PCs varies across different contexts (Ferrol-Schulte et al., 2014), but fish buyers – i.e., patrons in this context – usually provide fishing rights, marketing services, credits, fishing equipment and/or other financial assistance; in exchange for labor, fish and/or money (Merlijn, 1989; Basurto et al., 2013; Ferrol-Schulte et al., 2014). These interlinked relationships are usually reinforced by norms such as loyalty and reciprocity (Johnson, 2010; Lindkvist et al., 2017). PCs are thought to strongly influence fisher's decision making on what and how to fish (Miñarro et al., 2016; Nascimento et al., 2017), often controlling access to fisheries and markets (Bailey et al., 2016). Further, it has been suggested that PCs buffer income variations for fishers, which could diminish fishers' incentives to adapt their fishing efforts to environmental changes and fluctuations (Crona et al., 2010).

2. Methods

This study follows a mixed-methods approach. It combines quantitative multi-level network analysis with qualitative analyses drawing on data gathered through surveys, interviews and participant observation. We first map the existing patterns of reoccurring fish exchange relationships in the studied SSF community, and by combining these with empirical data on the nature of such relationships we characterize different types of fish buyers. Second, we analyze each type of fish buyer in terms of their adaptive capacity following a network modelling framework.

2.1. Study case: southern Corredor region

We conducted a case study in the state of Baja California Sur, Mexico. Baja California Sur is the third most important state for Mexican fisheries in terms of volume (9%) and fourth in terms of value (CONAPESCA, 2013). Fisheries management in Mexico builds on a property-rights system aiming to avoid overexploitation, which is based on fishing permits over specific fisheries as the main management tool (Cinti et al., 2010; Basurto et al., 2012). Permits can be granted to cooperatives or to private persons that become permit-holders, locally named "permisionarios" (Cinti et al., 2010; Basurto et al., 2013). Some of these permit-holders are fish buyers that employ independent fishers through PCs (Cinti et al., 2010; Basurto et al., 2013). Hence, the seafood trading system is embedded in the management and governance system. Therefore, Mexico constitutes an interesting setting to understand the interplay between fish buyers and SSFs sustainability.

In particular, this study analyzed the trade of finfish from southern Corredor region to the city of La Paz (Fig. A.1). La Paz is the state's capital and the biggest commercialization center (Tovar Lee et al.,

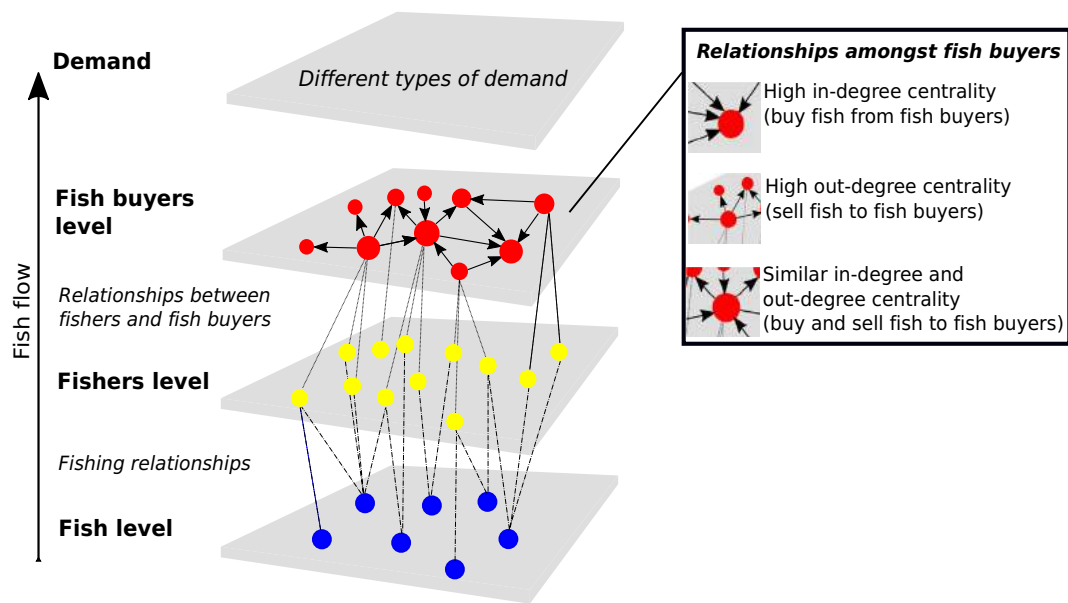


Fig. 1. Supply chain as a multi-level social-ecological network. The relationships amongst fish buyers can involve buying and/or selling fish, which is represented by directed links (from seller to buyer) and measured with network centrality scores (i.e., in-degree and out-degree). Fish buyers also sell fish to satisfy different market demands (to local consumers and/or deliver fish for tourism, national and/or international markets) through links not included in the figure.

2015), supplying seafood to local, national and international markets. The finfish fishery is a multi-species fishery that predominates in southern Corredor. See Appendix A for a detailed description of the study case.

2.2. Data collection

We designed our data collection methods based on the objective to reveal the patterns and the nature of fish exchange relationships

Table 1

Analytical framework of adaptive capacity: network building blocks are linked to three dimensions of adaptive capacity based on the influence that actors would be able to exercise in the commercialization system, making explicit the relationships between fish buyers, fishers, and fish resources.

Building block	Description	References
i) Adaptive capacity in relation to other fish buyers		
Open trading network	When a fish buyer in the center position (red colored) trades with two sellers or two buyers, the fish buyer would have more control and power over the exchange. Fish buyers in the edges (white colored) would have less control over the exchange (unless they are the only potential exchange partners of a specific fish group in a given moment).	Wilson, 1980; Cook et al., 1983; Walker et al., 2000; van Assen, 2010.
Closed trading network	Fish buyers could have symmetrically distributed control over the trading system in a closed network, since everyone has the same exchange partners. The closed network suggests that individual fish buyers will be less likely to seek short-run advantage (opportunism) due to high reputational cost, as compared to a dyadic seller-buyer relationship.	Granovetter, 1985; Grabowski, 1997; Wathne and Heide, 2000; Geyskens et al., 2006.
ii) Adaptive capacity in relation to fishers		
Patron-Client	Fish buyers are patrons that have a high capacity to influence fishers . Fishers usually have an informal agreement with the patron, who can provide fishing rights, marketing services, credits, fishing equipment and/or other financial assistance to fishers; in exchange for labor, fish and/or money.	Platteau and Abraham, 1987; Merlijn, 1989; Crona et al., 2010; Johnson, 2010; Basurto et al., 2013; Lindkvist et al., 2017.
Fish buyers with freelancer	Fishers can be seen as “multi-source clients” that are connected to several fish buyers. Each fish buyer has a lower capacity to influence fishers (in comparison with a patron above) . If fish buyers do not exchange fish they may have even lower capacity to influence a common fisher than if they exchange fish (since then the fishers have higher abilities to put one buyer against the other in bargaining for a better deal).	Crona and Bodin, 2010; Kininmonth et al., 2017.
iii) Capacity to deal with short-term resource fluctuations (availability and price)		
Connected fish buyers	Fish buyers that exploit identical species with established trade relationships have greater capacity to deal with short-term environmental and market fluctuations since they can access the resource either through ‘their’ fishers and/or through other fish buyers. These trade relationships give flexibility to fish buyers, especially if embedded in a broader network. When based on relational norms, commitment and/or trust, they can reduce risk and uncertainty.	Wilson, 1980; Lusch and Brown, 1996; Geyskens et al., 2006; Palmatier et al., 2007.
Independent fish buyers	Fish buyers that exploit identical species without established trade relationships have less capacity to deal with environmental or market fluctuations (in relation to connected fish buyer above). They can be competing with each other for a reliable supply of a particular species. However, fish buyers could rely on other individual strategies to increase their buffering capacity.	Wilson, 1980; Geyskens et al., 2006

amongst the key actors outlined above. Years of fieldwork and engagement with local NGOs in this area (e.g. Niparajá, see www.niparaja.org) facilitated getting access to fishing communities, fish buyers and other local and regional actors, and setting the boundaries for the focal social-ecological system. Although our overarching aim was to collect empirical data in order to capture the quantitative characteristics of the community-level network of fish exchange relationships, we followed a mixed-methods approach where substantial efforts were also made to gather qualitative data that could inform about various characteristics of different actors and their relationships, such as their motives for doing what they were doing, and their perceptions about important factors determining how the whole system of fish buyers and fishers perform. Adopting a network perspective, recurrent fish exchange relationships are conceptualized as links connecting different actors (e.g. fishers and fish buyers). While this is conceptually similar to value chain mapping (see e.g. [Kaplinsky and Morris, 2001](#)) the method of systematically assessing a community of fishers and fish buyers as nodes and links, and constructing a whole network allows us to analyze structural patterns of relations amongst actors ([Wasserman and Faust, 1994](#)). We conceptualized this system as a three-level network with two types of social nodes (i.e., fishers and fish buyers, each occupying their own level) and one type of ecological node (i.e., fish resources/stocks) to map a small-scale fishery supply chain ([Fig. 1](#)). This multilevel network thus captures recurrent fish exchange relationships amongst fish buyers and between fishers and fish buyers, while it also captures how fishers are tied to different fish resources. It therefore also indirectly captures ties between fish buyers and fish resources as explained below.

In a first step of network characterization, we identified fishers and fish buyers engaged in trading species fished in the fishing communities of southern Corredor to La Paz city ([Fig. A.1](#)). Both a bottom-up and a top-down approach were used to map all relevant stakeholders and identify their trade relationships and their interconnection with different fish species. On the one hand, we made use of data coming from a survey conducted with southern Corredor's fishers in June–July 2016 as part of another study ([Nenadovic, 2017](#)). The survey asked 52 fishers from the region to whom they sell their catch. This was used to identify fish buyers at the first selling point and their relationship with fishers. It is estimated that the survey sample represents 70–75% of the fishing boats that operate in the fishing communities. On the other hand, we selected key informants with an extensive knowledge of the local trade system and then used a snowballing sampling technique to identify the actors in La Paz that commercialize fish from southern Corredor ([Reed et al., 2009](#)). These actors are named fish buyers thereafter. Note that each municipal market was considered one fish buyer because the municipal markets as a whole are considered key trading points in the city by fish buyers, even if they comprise 4–7 fish shops (note that there are individual fish shops, but all fish buyers unload the product at the same collective space where everyone knows each other). Through these two approaches, we identified 28 fish buyers as participants of southern Corredor supply chain. We did not map the supply chain extending beyond the city of La Paz, e.g. fish buyers outside of La Paz, or selling points to consumers (i.e., restaurants, hotels, individual fish shops). Eventually, fish buyers identified through the bottom-up and top-down approaches coincided, suggesting that the most important stakeholders have been included (see [Appendix B](#) for a detailed description of the data collection methodology).

In a second step, we managed to contact 23 of the 28 identified fish buyers (October–December 2016), which represents most of the total population of fish buyers of interest for this study (estimated as 81%, see [Appendix B](#)). We then applied two types of data gathering methods: 17 semi-structured interviews, and short-term participant observations. The characteristics of the interviews varied, ranging from 10-minute phone interviews to 1.5-hour in-person interviews, depending on interviewee's availability and context. The participant observation targeted entities that comprise multiple individuals, such as the municipal

markets, and the fishing communities. Through these methods we gathered qualitative and quantitative information about the relationships amongst fish buyers, between fishers and fish buyers, and what fish resources (i.e., species) different fishers and fish buyers were targeting. Questions to build the network were included in all interviews and asked during the participant observation (see [Table A.2](#)). All information was captured in field notes or transcripts, and analyzed as explained below ([Section 2.3.1](#)). The limitation of conducting phone and shorter interviews impeded gathering in-depth qualitative information from all fish buyers, which impedes a quantitative analysis of the types of relationships ([Section 3.1](#)) and trading dynamics.

2.2.1. Network characterization

The empirical network derived from the two steps included 23 fish buyers and their repeated exchange relationships. These fish buyer-to-fish buyer relationships were drawn from a survey question designed to capture network relationships included in the interviews and participant observation explained above (see [Appendix B](#)). Relationships were coded according to the frequency of the exchange. We differentiated *infrequent relationships*, which occur occasionally or less than once a month; and *regular relationships*, which occur weekly, monthly, or during a specific season. Fish buyers reported few exchange relationships that occurred sporadically, which were not included in the network (e.g. “I sold to this fish buyer only once”).

Fisher-to-fish buyer relationships were assessed using the previous survey conducted in 2016 described above, from which 43 fishers, only those representing different fishing boats, were included in the network. In addition, the survey was used to assess the links between fishers and fish resources. Fishers showed to be tied to 15 fish resources defined as the most important (see [Appendix C](#)). These data were also corroborated through the participatory observations and the interviews. By merging the fisher-to-fish with the fisher-to-buyer networks, a simplified two-layer network directly linking fish buyer-to-fish resources was built. The relevance of the fish buyer-to-fish network is built on the assumption that the most important species for the fishers are also important for their fish buyer. This may only hold true when the population of fish buyers are strongly attached to the studied population of fishers (which were shown to be the case for the majority of fish buyers in the study case, although we acknowledge that several of the fish buyers also acquired fish resources from fishers in other areas). We also assume that a relationship between fish buyers connected to the same species implies that they can trade that species (since relationships at this level are rarely species specific in this study case).

2.3. Data analysis

2.3.1. Qualitative analysis

[Appendix B](#) provides a full description of the qualitative methods and their application to different entities. In brief, two different analytical methods were used depending on the purpose of the analysis. First, themes and concepts emerging from the data were identified to describe the nature of the relationships between actors and how the actors tend to operate in the studied community. Second, other themes were defined following the interview questions detailed in the [appendix](#), which were coded to validate the network and complement the description of different fish buyer types (e.g. to identify market demands traders sell to, or possession of fishing permits).

2.3.2. Network analysis

The empirically derived network of fish exchange relationships was analyzed looking at the different nodes within and across the three different network levels (nodes representing fish buyers, fishers, and fish species, see [Fig. 2](#)). First, we qualitatively analyzed the overall structure of the network of fishers and fish buyers as a whole, and used network measures to identify different roles of fish buyers in the supply chain. Then we analyzed the social and social-ecological networks

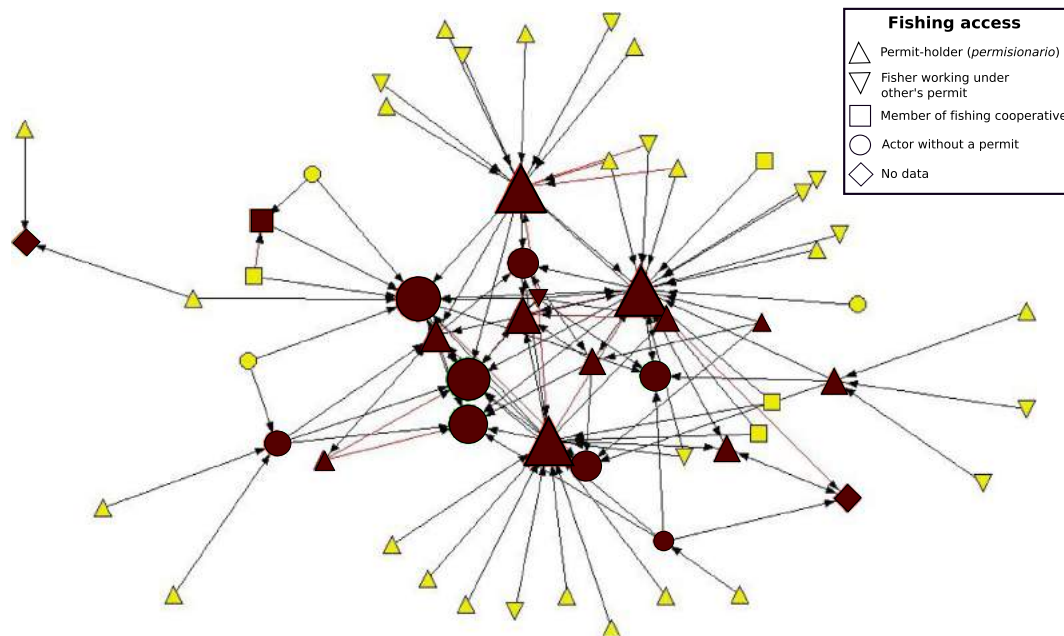


Fig. 2. Trade network. The network shows fisher-to-fish buyer and fish buyer-to-fish buyer trade relationships, which can be infrequent relationships (red links) or regular relationships (black links). Fishers (yellow) and fish buyers (brown) have different fishing rights to access southern Corredor's fisheries. Size represents *indegree* centrality. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

through a minimal building block approach to characterize the different types of fish buyers in terms of their adaptability. The minimal building block approach builds on the conceptualization of the network as being composed of certain micro-level structures (i.e., building blocks), and is described in depth elsewhere (e.g. Bodin et al., 2016; Wang et al., 2013). Building block-based interpretation of network structures can draw on a wide range of theories (Bodin and Tengö, 2012). This includes social science theories (e.g. to analyze collaboration (McAllister et al., 2015)); ecology (e.g. to analyze species' roles (Stouffer et al., 2012)); and social-ecological systems research (e.g. to analyze social-ecological fit (Bodin and Tengö, 2012)). The presumed relationships between certain building blocks and the three different characteristics of adaptive capacity at focus for this study were defined drawing on existing literature, and it is further described below. Three fish buyers out of the 23 included in the network provided only limited information and were therefore excluded from the quantitative analysis.

The analysis of the fish buyer's network structure was used to identify certain roles in the network that we associate with varying roles and ways of operation in the supply chain. Degree centrality measures –i.e., the number of links for any given node (Wasserman and Faust, 1994) – were used to identify fish buyers with the highest number of direct relationships with other fish buyers. We differentiated between the number of relationships each fish buyer has when it comes to selling fish resources to other fish buyers (outdegree centrality) versus the number of fish buyers any given fish buyer draws from when buying fish resource (indegree centrality) (Wasserman and Faust, 1994). We used outdegree and indegree measures in combination (Fig. 2) in defining three roles that fish buyers have in the supply chain: *buyers*, who mainly buy from other fish buyers (high indegree centrality); *suppliers*, who mainly sell to fish buyers (high outdegree centrality); and *exchangers*, who both buy from and sell to other fish buyers (similar indegree and outdegree measures). We suggest a typology of fish buyers that combines the three buyer's roles and fish buyer's characteristics related to: a) how they are connected with fishers; and b) the type of market demand they reported to be directly connected to (Fig. 1). In this way, we account for relationships amongst fish buyers but also with fishers and markets, since relationships with fishers and different market demands influence the supply for fish (Crona et al.,

2010; Thyresson et al., 2013). Four different types of market demand were present in the study case. Local demand refers to consumers of fish products in the city. “*Tourist demand*” refers to demand for high-value species targeting the tourism sector within Baja California Sur, and was often named like that by fish buyers in the interviews and participant observation. National demand refers to products sent to the mainland of Mexico (e.g. Mexico City, Guadalajara), and international demand to products sent to the USA. The qualitative analysis provided information on these characteristics, and it was also used to further describe and re-analyze the types of fish buyers identified.

We applied a positional based analysis (Bodin et al., 2014) to quantify the positions of each type of fish buyer in the building blocks related to different dimensions of adaptive capacity (described further down). Therefore, the frequency in which fish buyers were present in each defined position of each building block were calculated. We aggregated the count measures by summing the scores of each fish buyer of each type. In that way, we were able to assess to what extent each type of fish buyer was engaged in the different building blocks, and hence through this analysis we were able to associate each type of fish buyers with the three dimensions of adaptability at focus for this study. The positional analysis was applied to the two-level (social) network of fish buyers and fishers, and to the collapsed two-level network of fish buyers and fish resources (Fig. 2). Our assessments of adaptability for any given type of fish buyer should be seen as relative to the adaptability of other fish buyers in the same community network, and not as an absolute measure of adaptive capacity. Likewise, even if we provide quantitative measures, the results provide a qualitative understanding of how each type of fish buyer differs.

2.4. A network-centric assessment of adaptive capacities

Below we describe how the three dimensions of adaptive capacity that are the focus of this study (the adaptive capacity in relation to other fish buyers, the adaptive capacity in relation to fishers, and the capacity to deal with stock fluctuations) are interpreted based on previous empirical work and relevant theory (Table 1). To strengthen the validity of applying such theories and findings to this study case, these interpretations were also contrasted in the light of the insights derived

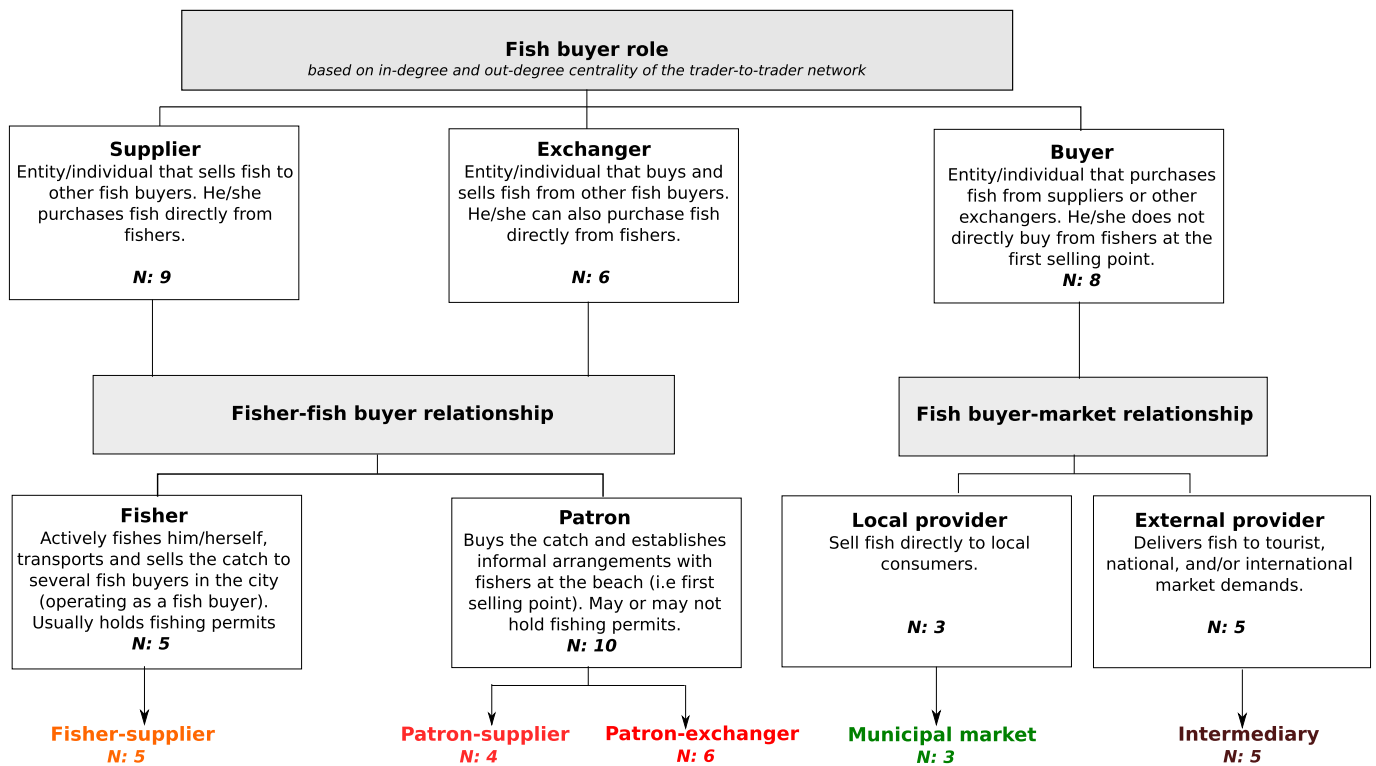


Fig. 3. Fish buyers' roles and characteristics used to define fish buyer's types. N, number of fish buyers in the sample.

from our qualitative analyses (Section 3.1).

2.4.1. The adaptive capacity in relation to other fish buyers

The interpretation of the *open trading network* building block (Table 1) is supported by network exchange theory (e.g. Cook and Emerson, 1978; Cook et al., 1983). When two fish buyers that do not exchange fish supply the same good to a fish buyer (in the center position), that fish buyer is assumed to be in a more advantageous position since it possesses the ability to freely decide from which one to buy from. In other words, the adaptive capacity associated with the center position would be high as compared to the peripheral positions (i.e., edges). This also generally applies to the case when the fish buyer in the center position needs to exchange with both partners to make a profit (Walker et al., 2000). However, fish buyers in the edges would have higher capacity to influence their own operations when these fish buyers constitute the only potential buyers of a specific fish resource (e.g. van Assen, 2010). For example, in our study case, we could observe this phenomenon in cases of gluts of a non-substitutable species that is sold to external markets (i.e., outside the boundaries of the network analyzed), when only few buyers have the capacity to export it. Therefore, some buyers in the edges could experience a high level of adaptive capacity in relation to the others. Contrary to all this, fish buyers in the *closed trading network* (Table 1) would have equal opportunities over the exchange (Cook et al., 1983).

2.4.2. The adaptive capacity in relation to fishers

The building blocks linking fish buyers and fishers (Table 1) are interpreted based on previous empirical knowledge on informal arrangements in small-scale fisheries (e.g. Patron-Client arrangements). A fish buyer that engages with several fishers would have higher capacity to decide upon his/her fish trading operations, both in relation to other fish buyers (since they likely are able to provide substantial fish resources), and in relation to their fishers (especially if the fishers have no trading relationships with other fish buyers, thus no other options they could utilize exists if they are not satisfied with the fish buyer's offer). Fishers that have trading relationships with several fish buyers are

assumed to have higher capacity to decide who to trade with than other fishers only engaged with one trader. Further, they can likely have higher adaptive capacity in relation to their fish buyers, which in particular applies if the fish buyers are not engaged in a trading relationship with each other (cf. network exchange theory, Cook et al., 1983). In other studies, this type of fishers has been called freelancers (e.g. Crona and Bodin, 2010; Kininmonth et al., 2017).

2.4.3. The capacity to deal with fluctuations

Building blocks linking fish buyers and fish resources are interpreted based on new institutional economics theory, to hypothesize the role of trade relationships in facing uncertainty in economic exchanges (e.g. Wilson, 1980; Geyskens et al., 2006). We apply this body of theory to fish buyers that are targeting the same fish resources (through their relationship with fishers). We assume that the presence or absence of trade relationships between fish buyers that target the same fish group has an influence on their capacity to deal with short-term (e.g. daily) fluctuations in the market and in the availability of that fish group. In essence, a fish buyer that has a trade relationship with another fish buyer targeting the same fish resource is thought to be better able to deal with scarcity or market gluts of that resource, since each fish buyer may have different access to resources and connections to markets. For example, such fish buyers may be able to provide a certain amount of the fish resource higher up in the supply chain, even when resources captured by his/her fishers fluctuate. This assumption stems from the fact that the fish buyer can draw from two different sources: its "own" fishers and indirectly other fish buyers' fishers, since fish buyers are embedded in a network that allows flexibility acquiring fish from sources that may have different production capacities (Geyskens et al., 2006). One must note that this does not apply for long-term fluctuations, such as decline in fish populations, or disappearance of one species everywhere at the same time.

3. Results and discussion

3.1. Trading embedded in inter-personal relationships

While we mapped regularly occurring exchange relationships, fish exchange might occur with different frequency (Fig. 2). Although infrequent relationships (those occurring less than once a month) exist, regular relationships dominate in the studied community (Figs. 2 and 3). Infrequent relationships can occur, for example, when family members from time to time provide some assistance in buying/selling fish, therefore even if infrequent, these relationships are not spontaneous or random interactions.

Fish buyers maintain stable relationships with fishers, since many fishers sell exclusively to a single fish buyer (Fig. 2). Interviewees stated that fishers are “attached” to what some fish buyers called “patrons”. This relationship between fish buyers and fishers, sets that fish buyers will provide the daily means for fishing (i.e., gas, bait, ice), and fishers will deliver all their catch to the fish buyer at the first point of commercialization. Some fish buyers stated that there is a “moral commitment” with the fishers, where “their fishers” are expected to sell all of their catch to them. In general, the supplies provided by fish buyers are discounted from the catch's value. Some fish buyers can however give credits in cash to the fishers, or provide other non-fishery related items such as food or medicines. Fish buyers can be permit-holders, and fishers attached to them might work under their permit, even though not all fish buyers linked to fishers are permit-holders, nor do all fishers attached to a permit-holder work under his permit (Fig. 2). The ownership of fishing equipment can also be an important factor mediating these relationships, since some fish buyers can guarantee fishers to have functioning equipment -i.e., motor-, and in turn discount 12% of the catch's price at every delivery. However, lending equipment is not a practice shared amongst all fish buyers.

Despite the prevalence (or “moral commitment”) to sell to only one fish buyer, some fishers sell to two or more fish buyers (Fig. 2). Fishers and fish buyers reported three different informal agreements motivating these relationships: 1) fishers deliver different species to each fish buyer; 2) fishers have a main fish buyer but can sell to another fish buyer when the former is not providing the means for fishing, creating an infrequent relationship; and 3) fishers sell to each fish buyer with a given frequency maintaining a specific agreement with both of them.

Relationships between fish buyers are also stable, since several fish buyers stated that “each supplier has his own buyers” and vice versa. However, these trade relationships can be of different nature and the norms guiding the exchange can vary for different fish buyers. Even if we cannot provide a quantitative description of the different types of relationships, we here describe general patterns emerging from the qualitative data. Some fish buyers highlight the importance of maintaining relationships with particular fish buyers based on many years exchanging fish. Stability, trust and commitment describe many relationships where there is continuous communication between the two partners (e.g. regarding what and how much fish is needed by the different partners). In some cases, fish buyers aim to have a reliable seller/buyer for periods of gluts or fish scarcity, thus they establish relationships where they prioritize to whom would they sell/buy expecting reciprocity in the most challenging seasons. Some have several relationships as such because they do not trust that all exchange partners will comply with the usual agreement. Some trade relationships also comprise credit arrangements, where one fish buyer can lend fish to another, similarly to the assistance relationships between traders described by Drury O'Neill and Crona (2017). Still, some fish buyers might also base all or some of their exchange relationships on the highest bidder, but they tend to have exchange partners who they trade with repeatedly and do not trade in spot markets.

3.2. Identifying types of fish buyers from the trade network

Fig. 3 describes the process through which we defined types of fish buyers. We combined and cross-referenced fish buyer's roles that emerge from a network analysis; and a qualitative understanding of their relationships with fishers and market demands. Five different types of fish buyers were identified in the studied trade network (Fig. 3): 1) patron-exchangers; 2) patron-suppliers; 3) fisher-suppliers (this refers to fishers who also function as traders, herein named entrepreneur fishers); 4) municipal markets (buyers); and 5) inter-mediaries (buyers). Traders with the role of *buyer* do not establish arrangements with fishers but they are differentially connected to market demands, which will influence their capacity to commercialize different types of resources. We nonetheless acknowledge that more or other types of fish buyers could be present in other communities, since traders are expected to belong to one of the three trader roles identified (Fig. 3), but these roles can be combined in different ways with the type of relationships fish buyers establish with fishers and with market demands. One must note that the fisher-fish buyer relationship “patron” has been widely described in the literature (e.g. Basurto et al., 2013), but we found two types of patrons in terms of their differential role as supplier versus exchanger. For instance, this is similar to the diversity patrons identified by Ferse et al. (2012) in Indonesia who qualitatively distinguish “small” versus “big” patrons. Fig. 4 and the text below further describe these five fish buyer types based on network measures and qualitative data resulting from interviews and participant observation.

Patrons-exchangers have fishers working for them in one or more communities in Baja California Sur and transport fish from the fishing communities to the city, like other patrons. They tend to have more connections in the network of exchange relationships than other individual fish buyers (degree centrality 8.8, Fig. 4). All patrons-exchangers, except one, own several fishing permits that allow them to exploit more than one fishery. They identify themselves as seafood producers besides being fish buyers. Moreover, permits allow them to fish within one or more municipalities, some having fishing rights in the whole state of Baja California Sur. This allows many to “move their fishers” or their permits to different fishing communities or camps following fishing seasons. Thus they can produce a higher volume and they might have more flexibility regarding where and when they enter different fisheries. Patrons-exchangers can have higher storage capacity since they usually have a warehouse in the city where fresh fish can be processed (e.g. filleting), but not all patrons-exchangers own a warehouse. In addition, these patrons can establish credit arrangements with other fish buyers, and provide assistance buying or selling fish during challenging times. Patron-exchangers can also own fish shops in the city and send deliveries to satisfy tourist, national, and/or international demands.

Patrons-suppliers have different characteristics than exchangers. They also transport fish from the fishing communities and sell in the city, but they do not have storage capacity or freezing facilities. Most mainly trade fish from southern Corredor (not from alternative locations). Patrons-suppliers buying from more than three fishers had fishing permits, whereas those patron-suppliers buying from less fishers did not.

Entrepreneur fishers are also suppliers and usually own fishing permits. They go fishing, transport and sell fish in the city. Thus, they cover the cost of fishing and transporting the product to the city and assume the risks inherent to both fishing and trading activities. Most of these fishers live both in the communities and in the city and aim to acquire higher prices than if they sold their catch in the communities. Some move to fish in other communities during “wind season” in the Gulf of California (characterized by low catches). In general, entrepreneur fishers tend to have fewer connections in the fish buyer-to-fish buyer network than other fish buyers (degree centrality 3.75, Fig. 4). Both patrons-suppliers and entrepreneur fishers can own fish

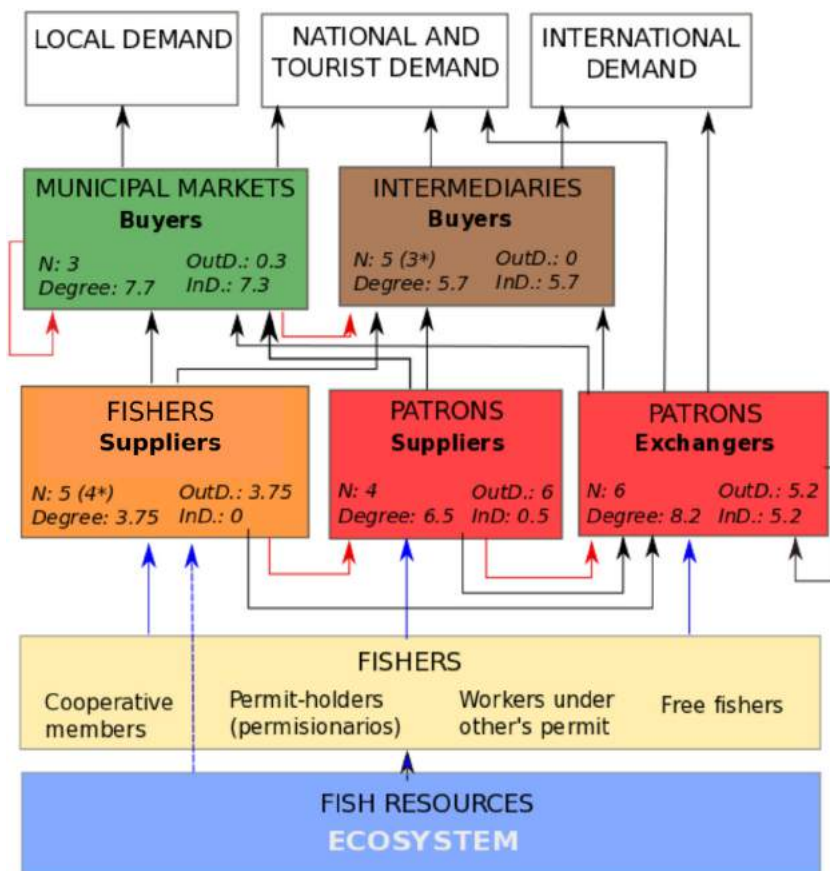


Fig. 4. Conceptual map of the trading system. The types of fish buyers identified establish trading relationships and satisfy three different types of demand. The mean centrality measures of fish buyers' degree, outdegree (OutD) and in-degree (InD) centrality were calculated per fish buyer type. *N*, number of fish buyers identified per fish buyer type. Arrows show the fish flow: dotted lines, fishing; blue, trading with fishers; black, flows in the fish buyer's network and their market connections; and red, infrequent relationships. See Appendix C for the disaggregated data. *In brackets is the number of fish buyers with complete information that were included in the calculations. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

shops in the city and be directly linked to local demand (not included in Fig. 4), but this is not the case for most.

The three municipal markets in the city are places that gather between 4 and 7 fish shops and this type of entity is nearly as connected as the patron-exchanger (degree centrality 7.7, Fig. 4). They receive fish and sell it mainly to local consumers. Some fish shops of the municipal markets are also suppliers to regional hotels and/or restaurants or local supermarkets, thus selling larger amounts on a regular or occasional basis. Fish shops outside municipal markets were not included in this study, but they could have similar behavior to the municipal markets. Intermediaries usually specialize in satisfying a concrete type of demand for high-value fish. Two send fish to the international demand, and two to the tourist and/or national markets. It must be noted that two intermediaries have few connections in the network and their role might not be fully captured in this supply chain because their links with the study case region are scarce (see Appendix C); therefore, they have been excluded from the quantitative analysis.

3.3. Adaptive capacity of diverse fish buyers

Fish buyer's potential adaptability differs amongst types of fish buyers (Table 2). In general, the adaptive capacity in relation to fishers would be high for all patrons, because they are mainly connected to fishers that do not report selling to other fish buyers (patron-client structure), and when two fish buyers buy from a "freelancer" they often have trade relationships between them. Patrons-exchangers stand out in that, in relation to the other types, they maintain a higher ratio of center positions versus the edge positions in the open-trading structure (Table 2, i), potentially having higher adaptive capacity in relation to the city trading system. They are also more often part of connected fish buyer's structures than independent fish buyer's structures as opposed to others (Table 2, iii), and therefore seem to have a higher









adaptability. The fact that many own a warehouse and/or a fish shop, deliver fish directly to external markets (i.e., tourist, national and/or international), and hold fishing permits across the state Baja California Sur (Section 3.2), supports their prominent role in the system. They might promote asymmetric relationships in the supply chain but they can also provide assistance to fishers and to other fish buyers through PCs, as it has been found elsewhere (e.g. Ferse et al., 2012; Drury O'Neill and Crona, 2017).

Patron-suppliers have lower adaptive capacities than patron-exchangers but higher than entrepreneur fishers (see Table 2). For example, they maintain a lower ratio of center positions versus edge positions than patron exchangers, but higher ratio in these positions than entrepreneur fishers (Table 2, i). Entrepreneur fishers can be seen as freelancers whose activities are not constrained by any particular patron (Crona and Bodin, 2010; Kininmonth et al., 2017), but they might have less adaptability and occupy more vulnerable positions in the trade network (six times less often part of center than edge positions in the open-trading structure) (cf. Wilson, 1980).

Municipal markets have high adaptive capacity in relation to intermediaries since they maintain a higher ratio of center positions in the open-trading structures than edge positions (Table 2, i). One should note that municipal markets are constituted by independent vendors, but these market places have a prominent role in the city as reference selling points for other fish buyers. They also constitute a selling point of diverse lower value fish to local consumers, and some also to restaurants and the tourist sector (Section 3.2), which may increase their adaptive capacity in relation to resource or market fluctuations. Intermediaries appear to have less adaptive capacity as, for example, patrons (e.g. intermediaries are about five times more often in edge positions than center positions in the open-trading structure). However, they may nonetheless have a high adaptive capacity in relation to other fish buyers even when occupying the edge position, since they can be the

Table 2

Position of fish buyer types in relation to fish buyer's adaptability. The positional analysis of the network reveals the percentage (and number of times) each fish buyer type occupies a position in the selected network building blocks. Since the number of times any type of fish buyer would be expected to be found in any of these building blocks also depends on how many fish buyers there are of each type, the results in the table are best interpreted qualitatively by comparing the distribution of percentages across types. For example, patron suppliers are relatively more often taking the position of independent than connected fish buyers (nearly three times more often), if we compare to patron exchangers that are more often taking the position of a connected than independent fish buyers (one and a half times more often). N, is the number of fish buyers included in the positional analysis. Observe that N is lower for the last categories of adaptability since 4 patron-exchangers work with fishers outside Southern Corridor and therefore their interactions with fishers and fish resources are not captured in this network.

Building block	Patron-exchanger	Patron-supplier	Entrepreneur fishers (suppliers)	Intermediary (buyers)	Municipal markets
i) Adaptive capacity in relation to other fish buyers					
N	6	4	4	3	3
Open-trading (edge, red) 	41.3% (154)	52.3% (101)	68.5% (74)	71% (115)	52.6% (92)
Open-trading (center, red) 	35.1% (131)	26.4% (51)	11.1% (12)	14.2% (23)	29.1% (51)
Closed-trading 	23.59% (88)	21.2% (41)	20.4% (22)	14.8% (24)	18.29% (32)
ii) Adaptive capacity in relation to fishers					
N	2	4	4	NA	NA
Patron-Clients 	87.8% (72)	93% (93)	62.5% (5)	NA	NA
Related fish buyers with freelancer 	9.8% (8)	6% (6)	25% (2)	NA	NA
Unrelated fish buyers with freelancer 	2.4% (2)	1% (1)	12.5% (1)	NA	NA
iii) Capacity to deal with short-term resource fluctuations (availability and price)					
N	2	4	4	NA	NA
Independent fish buyers 	38.7% (48)	76.3% (142)	74.4% (93)	NA	NA
Connected fish buyers 	61.3% (76)	23.7% (44)	25.6% (32)	NA	NA

main buyers for specific high-value resources exported to the international market (Tables 1, 2).

3.4. Implications for Small-Scale Fisheries sustainability research

To include fish buyers in decision-making processes towards responsible and sustainable fisheries like the FAO's SSF Guidelines state (FAO, 2015), one must consider the diversity of fish buyer's roles and the complexities of their relationships. Fisheries governance is increasingly promoting changes in the structure of trade relationships to increase fisheries sustainability (Bailey et al., 2016). For example, alternative trading structures such as market-oriented fisher's organizations (i.e. cooperatives, associations), auctions, or fishery certification schemes, are often promoted to bypass fish buyers and, in that way, increase fishers' income and strengthen sustainable resource use in SSF (e.g. Micheli et al., 2014; Bailey et al., 2016; Purcell et al., 2017). Our findings reveal that fish buyers are not a homogeneous group, even at the level of a single rural community, since they are actors with diverse trade relationships and market approaches. From this perspective, increased understanding of the role this diversity plays in small-scale fisheries, should be a first step to develop more effective policy interventions and recommendations.

Our results show how fish buyer's adaptability in the market place can vary significantly across actors, when taking a relationship-centered approach to defining adaptive capacity. This approach has two advantages. First, it allows the characterization of buyer types. Second, by analyzing fish buyers as embedded in trade relationships that are

interlinked with social processes, we can theorize how the structure of such relationships can constrain or enable individual capacities to adapt to changes. In light of the diversity of fish buyers (Section 3.2) and the uneven distribution of adaptive capacities across fish buyer types (Section 3.3), we expect fish buyers to experience different constraints or opportunities in promoting responsible and sustainable production of fish. While this study does not allow more than mere speculation regarding fish buyers' potential contribution towards sustainability as a result of their social relations, our proposed analytical framework could, and should, be extended to also examine implications for fisheries sustainability.

For instance, patrons can have a key role to promote or impede SSFs sustainability in line with previous research (e.g. Crona et al., 2010; Bailey et al., 2016), but we suggest that different types of patrons (i.e. suppliers and exchangers) might respond differently to market and environmental changes, with potential implications for sustainability and attempts to change the structure of trade relationships. As another example, municipal markets are important selling points for many different fish buyers and might have potential to promote the adaptive capacity of multi-species fisheries, but fish shops in the markets operate as individual entities and these actors are under-researched in SSF sustainability literature.

The analysis of trade networks contributes to a deeper understanding of the structure of trade relationships, allowing hypothesizing about the implications of the relationships in which people are embedded. Further, the network approach provides a common language to integrate insights from different disciplines investigating trade

relationships and supply chains (Borgatti and Li, 2009). This early work, however, suffers from some limitations. First, further research is needed to account for different types of social relationships and how they interact with trade, to understand how differences in the nature of fish trade relationships as described here (Section 3.1) can influence actor's behavior and ultimately the post-harvesting structure and processes. Secondly, other dimensions of adaptive capacity could also influence fish buyers and interact with trade relationships, and there is a need to study the interactions between different dimensions of adaptive capacity. Thirdly, fish buyers' roles could change over time, but this dynamic component has not been assessed since we lack longitudinal data and this is a one-shot (cross-sectional) analysis of the trading system. Fourth, the quantitative results measuring adaptive capacity are only descriptive, lacking precise estimates of significance levels, since statistical methods for this new type of analysis are still to be developed. Nonetheless, it serves as a solid start, and we hope future studies will address these limitations more thoroughly.

Future empirical work may allow testing the hypotheses we elaborate, and extend this approach to also analyze how they influence fish buyer's contributions to sustainability. For instance, this study analyzed a multi-species finfish fishery but the approach could be applied to other trading networks with different types of actors, allowing comparing supply chains. Further work could also develop the framework presented here based on other network configurations and theories. Thus, we lay the ground for future work aiming to analyze how social organization in trade networks influence individual adaptive capacities, and ultimately sustainability.

Declaration of Competing Interest

None.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.ecolecon.2019.05.018>.

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