

1 **Investigating how fish buyers' entanglements in trade networks influence their adaptive**
2 **capacity: potential implications for small-scale fisheries sustainability**

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22 **Abstract**

23 The importance of understanding how social-ecological interdependencies deriving from
24 global trade influence social-ecological sustainability has been argued for decades. Even if
25 substantial progress has been made, a research gap remains regarding how small-scale fish
26 buyers, whose daily operations have implications for the livelihood of more than 100 million
27 people, are affected by the ways in which they are embedded in complex networks of trade
28 relationships. Here we investigate relationships among fish buyers, relationships between fish
29 buyers and fishers, and their interaction with targeted fish species, using a multilevel network
30 model together with qualitative data from a small-scale fishery in Mexico. We elaborate how
31 different and distinctive patterns of relationships determine fish buyer's adaptive capacity
32 defined as: i) adaptive capacity in relation to other fish buyers; ii) adaptive capacity in relation
33 to fishers; and iii) capacity to deal with short-term fish stock fluctuations. Further, we combine
34 network analyses and qualitative methods to identify five types of fish buyers distinguishable
35 by how they operate. Our results suggest that adaptability differs substantially amongst these
36 types, thus implying that fish buyers' abilities to respond to changes and guarantee food
37 provisioning and livelihoods are unevenly distributed, which potentially influences the
38 sustainability of small-scale fisheries. This study demonstrates the need for a more profound
39 understanding of the consequences of the different ways in which fish buyers operate
40 commercially, and how these operations are affected by their relationships with others.

41

42 **Keywords:** Small-Scale Fisheries, fish buyers, network analysis, trade, supply chain, Social-
43 Ecological, Mexico

44 **1. Introduction**

45 Fish buyers (also known as intermediaries or middlemen) are key actors in small-scale fisheries
46 (SSF), and their importance is expected to increase in an era of globalization characterized by
47 trade, liberalization policies and increased market integration (Basurto et al. 2013; Crona et al.
48 2015). Fish buyers mediate between fishing activities and diverse market demands of fish
49 products arising further away in supply chains. Previous research has demonstrated that
50 through this mediating role, they can influence fisher's behavior, which in turn influence how
51 local fish stocks are utilized and managed (e.g. Crona et al. 2010; Miñarro et al. 2016;
52 Nascimento et al. 2017). This is especially true in developing countries, where formal
53 governance is often weak (Basurto et al. 2013) and lacks the capacity to effectively influence
54 fisheries management. The importance of fish buyers, and the post-harvesting activities they
55 engage in, has recently also been formally recognized in FAO's Voluntary Guidelines for
56 Securing Sustainable Small-Scale Fisheries in the Context of Food Security and Poverty
57 Eradication, herein SSF Guidelines (FAO 2015:10-12).

58 Increasing scholarly focus has been directed at fish buyers in SSF recently, with particular
59 attention to the fish buyers and their complex relationships within value chains (e.g. Drury
60 O'Neill and Crona 2017; Rosales et al. 2017). Since fish buyers mediate between fishing
61 activities and market demands, how they respond to environmental and market changes will be
62 an essential component of guaranteeing food provisioning and governing the exploitation level
63 of fish stocks toward sustainable levels. The importance of improving peoples' capacities to
64 individually decide if and how to act upon changes has recently been emphasized as crucial in
65 building adaptive capacity, especially to climate change (Cinner et al. 2018). However, fish
66 buyers' adaptive capacity, and its potential implications for small-scale fisheries sustainability,
67 has not been much addressed in the literature.

68 This paper aims to contribute to better understand the role of fish buyers. It uses a case study
69 in the state of Baja California Sur, Mexico, to begin to assess the adaptive capacity of fish
70 buyers and hypothesize what this may mean for overall SSF's sustainability in the face of
71 market and environmental changes. We begin by mapping fish buyers and their trade
72 relationships in a finfish value chain to analyze their pattern of trade relationships using a
73 network approach (section 3.1). This allows us to identify and characterize types of fish buyers
74 according to the pattern of relationships between individual actors (section 3.2). This approach
75 is novel and builds on a bottom-up empirically driven characterization of buyer types based on
76 their position in the network of trade relationships, which allows us to subsequently link these
77 fish buyer types with their capacity to proactively adapt to changing economic, social and

78 environmental conditions (section 3.3). In particular, by focusing on how fish buyers are
79 embedded in various trade relationships with others, we are able to elaborate how their capacity
80 to adapt is both constrained and enhanced by individuals' abilities to utilize their existing trade
81 relationships in their daily operations. This study thus contributes to the current stream of
82 research arguing for the importance of adaptive capacity (e.g. Mahon et al. 2008; Cinner et al.
83 2018) by furthering a deeper understanding of factors contributing to fish buyers' individual
84 capacities to adapt to changes. We acknowledge that high adaptive capacity of an individual
85 does not imply his/her propensity towards increasing fishery sustainability since they could
86 choose to use such capacity to increase overly exploitive practices (Mahon et al. 2008). We
87 nonetheless engage in a discussion on how the levels of adaptive capacity of different types of
88 fish buyers possibly influence overall sustainability in face of change (section 3.4).

89 We utilize recent interdisciplinary social-ecological network approaches to develop a series of
90 propositions characterizing the different types of fish buyers in terms of their adaptive capacity,
91 drawing on insights from existing literature on the relationships between fishers and traders
92 and amongst traders (section 1.2), as well as theories from new institutional economics,
93 network exchange theory and environmental governance. We here define adaptive capacity
94 following three different dimensions: i) fish buyer's adaptive capacity in relation to other fish
95 buyers; ii) fish buyer's adaptive capacity in relation to fishers; and iii) fish buyer's capacity to
96 deal with short-term resource fluctuations (in resource price and availability). The approach
97 we follow is based on an interpretation on how certain patterns of trade relationships amongst
98 fish buyers, between fish buyers and fishers, and between fish buyers and fish resources relate
99 to certain aspects of fish buyers' ability to influence their own and others' operations (cf. Bodin
100 and Tengö 2012, Bodin 2017). Adaptive capacity is thus assumed to be inherently linked to
101 agency, here the capacity of an actor to exert influence over its own operations.

102

103 **1.2. Theoretical background**

104 We define trade relationships as repeated fish exchange relationships that supersede occasional
105 discrete economic transactions (i.e. not spot markets) in a context of inter-personal social
106 relationships (Granovetter and Swedberg 2011). These repeated fish exchange relationships
107 between fishers and fish buyers, and amongst fish buyers, are typically associated with a set of
108 commonly agreed upon norms and rules by the parties of the exchange (Bagozzi 1975; Wilson
109 1980; Drury O'Neill and Crona 2017). These exchange relationships, and their associated
110 norms and rules, guide and constrain the parties behaviours (Granovetter 1985, Ostrom 1990)

111 and therefore have implications for the capacity of fish buyers (and fishers) to adapt to
112 environmental and other changes and ultimately to influence sustainability in SSF.

113 A well-documented example of trade relationships within the SSFs literature comes in a form
114 of Patron-Client arrangements (therein PCs). In a PC arrangement, a set of fishers are (often
115 exclusively) tied to a specific fish buyer that buys their catches (e.g. Platteau and Abraham
116 1987, Merlijn 1989, Crona et al. 2010, Basurto et al. 2013). The exact nature of PCs varies
117 across different contexts (Ferrol-Shulte et al. 2014), but fish buyers – i.e., patrons– usually
118 provide fishing rights, marketing services, credits, fishing equipment and/or other financial
119 assistance; in exchange for labor, fish and/or money (Merlijn 1989, Basurto et al. 2013, Ferrol-
120 Shulte et al. 2014). These interlinked relationships are usually reinforced by norms such as
121 loyalty and reciprocity (Johnson et al. 2010; Lindkvist et al. 2017). PCs are thought to strongly
122 influence fisher's decision making on what and how to fish (Miñarro et al. 2016; Nascimento
123 et al. 2017). Further, it has been suggested that PCs buffer income variations for fishers, which
124 could diminish fishers' abilities to adapt their fishing efforts to environmental changes and
125 fluctuations (Crona et al. 2010).

126 In a similar way, different trade relationships among fish buyers will likely affect their
127 economic performance (Vignes and Etienne 2011), and how they operate in linking the supply
128 from fishers and ecosystems to the various market demands. For example, trade relationships
129 based on reciprocity and loyalty can increase the capacity of fish buyers to deal with
130 variabilities and uncertainties regarding their abilities to acquire the right amount of resources
131 in order to provide supply chains with certain quantity and quality of fish (Wilson 1980;
132 Cannon and Perreault 1999). Trade relationships amongst fish buyers have been at focus of
133 attention in fields such as new institutional economics (e.g. Williamson 1981), economic
134 sociology (e.g. Granovetter 1985), and marketing exchange (e.g. Bagozzi 1975) among others,
135 and described in fisheries and fish markets around the world (e.g. Wilson 1980, Vignes and
136 Etienne 2011; Drury O'Neill and Crona 2017; Rosales et al. 2017). However, the potential
137 influences of such relationships amongst fish buyers on fishery sustainability is poorly
138 understood (Hamilton-Hart and Stringer 2016), and thus deserves, as we argue here, further
139 attention.

140

141 **2. Methods**

142 This study follows a mixed-methods approach. It combines quantitative multi-level network
143 analysis with qualitative analyses drawing on data gathered through surveys, interviews and
144 participant observation. We first map the existing patterns of reoccurring fish exchange

145 relationships in the studied SSF community, and by combining these with empirical data on
146 the nature of such relationships we characterize different types of fish buyers. Second, we
147 analyze each type of fish buyer in terms of their adaptive capacity following a network
148 modelling framework.

149

150 **2.1. Study case: southern *Corredor* region (SC)**

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

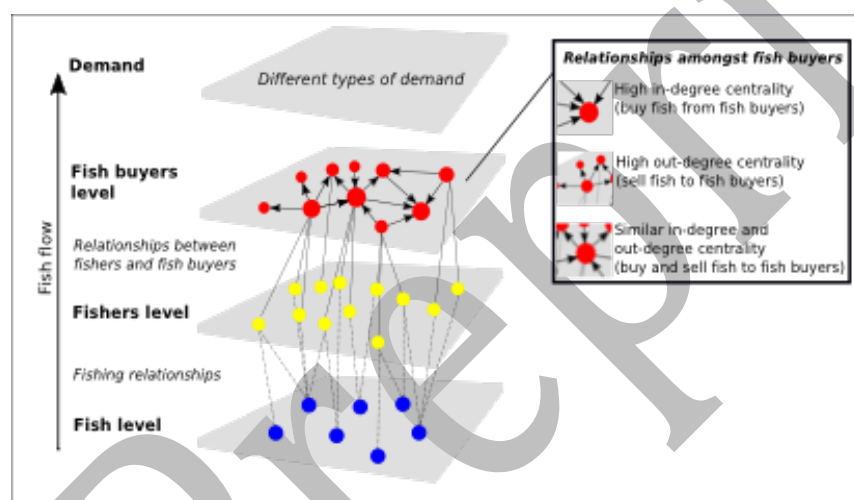
162 In particular, this study analyzed the trade of finfish from southern *Corredor* region (thereafter
163 SC) to the city of La Paz (figure A.1). La Paz is the state’s capital and the biggest
164 commercialization center (Tovar Lee et al. 2015), supplying seafood to local, national and
165 international markets. The finfish fishery is a multi-species fishery that predominates in SC.
166 See appendix A for a detailed description of the study case.

167

168 **2.2. Data collection**

169 We designed our data collection methods based on the objective to reveal the patterns and the
170 nature of fish exchange relationships among the key actors outlined above. Years of fieldwork
171 and engagement with local NGOs in this area (e.g. Niparajá, see www.niparaja.org) facilitated
172 getting access to fishing communities, fish buyers and other local and regional actors, and
173 setting the boundaries for the focal social-ecological system. Although our overarching aim
174 was to collect empirical data in order to capture the quantitative characteristics of the
175 community-level network of fish exchange relationships, we followed a mixed-methods
176 approach where substantial efforts were also made to gather qualitative data that could inform
177 about various characteristics of different actors and their relationships, such as their motives
178 for doing what they were doing, and their perceptions about important factors determining how

179 the whole system of fish buyers and fishers perform. Adopting a network perspective, recurrent
180 fish exchange relationships are conceptualized as links connecting different actors (e.g. fishers
181 and fish buyers). While this is conceptually similar to value chain mapping (see e.g. Kaplinski
182 and Morris 2002) the method of systematically assessing a community of fishers and fish
183 buyers as nodes and links, and constructing a whole network allows us to analyze structural
184 patterns of relations among actors (Wasserman and Faust 1994). We conceptualized this
185 system as a three-level network with two types of social nodes (i.e., fishers and fish buyers,
186 each occupying their own level) and one type of ecological node (i.e., fish resources/stocks) to
187 map a small-scale fishery supply chain (figure 1). This multilevel network thus captures
188 recurrent fish exchange relationships amongst fish buyers and between fishers and fish buyers,
189 while it also captures how fishers are tied to different fish resources. It therefore also indirectly
190 captures ties between fish buyers and fish resources as explained below.
191



192
193 **Figure 1. Supply chain as a multi-level social-ecological network.** The relationships amongst fish
194 buyers can involve buying and/or selling fish, which is represented by directed links (from seller to
195 buyer) and measured with network centrality scores (i.e., in-degree and out-degree). Fish buyers also
196 sell fish to satisfy different market demands (to local consumers and/or deliver fish for tourism, national
197 and/or international markets) through links not included in the figure.
198

199 In a first step of network characterization, we identified fishers and fish buyers engaged in
200 trading species fished in the fishing communities of SC to La Paz city (Figure A.1) Both a
201 bottom-up and a top-down approach were used to map all relevant stakeholders and identify
202 their trade relationships and their interconnection with different fish species. On the one hand,
203 we made use of data coming from a survey conducted with SC's fishers in June-July 2016 as
204 part of another study (Nenadovic 2017). The survey asked 52 fishers from the region to whom
205 they sell their catch. This was used to identify fish buyers at the first selling point and their
206 relationship with fishers. It is estimated that the survey sample represents 70-75% of the fishing

207 boats that operate in the fishing communities. On the other hand, we selected key informants
208 with an extensive knowledge of the local trade system and then used a snowballing sampling
209 technique to identify the actors in La Paz that commercialize fish from SC (Reed et al. 2009).
210 These actors are named fish buyers thereafter. Note that each municipal market was considered
211 one fish buyer because the municipal markets as a whole are considered key trading points in
212 the city even if they comprise 4-7 fish shops. Through these two approaches, we identified 28
213 fish buyers as participants of SC supply chain. We did not map the supply chain extending
214 beyond the city of La Paz, e.g. fish buyers outside of La Paz, or selling points to consumers
215 (i.e., restaurants, hotels, individual fish shops). Eventually, fish buyers identified through the
216 bottom-up and top-down approaches coincided, suggesting that the most important
217 stakeholders have been included (see appendix B for a detailed description of the data
218 collection methodology).

219 In a second step, we managed to contact 23 of the 28 identified fish buyers (October-December
220 2016), which represents most of the total population of fish buyers of interest for this study
221 (estimated as 81%, see Appendix B). We then applied two types of data gathering methods: 17
222 semi-structured interviews, and short-term participant observations. The characteristics of the
223 interviews varied, ranging from 10-minute phone interviews to 1.5-hour in-person interviews,
224 depending on interviewee's availability and context. The participant observation targeted
225 entities that comprise multiple individuals, such as the municipal markets, and the fishing
226 communities. Through these methods we gathered qualitative and quantitative information
227 about the relationships among fish buyers, between fishers and fish buyers, and what concrete
228 fish resources (i.e., species) different fishers were targeting. All information was captured in
229 field notes or transcripts, and analyzed as explained below (section 2.3.1).

230

231 **2.2.1. Network characterization**

232 The empirical network derived from the two steps included 23 fish buyers and their repeated
233 exchange relationships. These fish buyer-to-fish buyer relationships were drawn from a survey
234 question designed to capture network relationships included in the interviews and participant
235 observation explained above (see appendix B). Relationships were coded according to the
236 frequency of the exchange. We differentiated *infrequent relationships*, which occur
237 occasionally or less than once a month; and *regular relationships*, which occur weekly,
238 monthly, or during a specific season. Fish buyers reported few exchange relationships that

239 occurred sporadically, which were not included in the network (e.g. “I sold to this fish buyer
240 only once”).

241 Fisher-to-fish buyer relationships were assessed using the previous survey conducted in 2016
242 described above, from which 43 fishers, only those representing different fishing boats, were
243 included in the network. In addition, the survey was used to assess the links between fishers
244 and fish resources. Fishers showed to be tied to 15 fish resources defined as the most important
245 (see appendix C). These data were also corroborated through the participatory observations and
246 the interviews. By merging the fisher-to-fish with the fisher-to-buyer networks, a simplified
247 two-layer network directly linking fish buyer-to-fish resources was built. The relevance of the
248 fish buyer-to-fish network is built on the assumption that the most important species for the
249 fishers are also important for their fish buyer. This may only hold true when the population of
250 fish buyers are strongly attached to the studied population of fishers (which were shown to be
251 the case for the majority of fish buyers in the study case, although we acknowledge that several
252 of the fish buyers also acquired fish resources from fishers in other areas).

253

254 **2.3. Data analysis**

255

256 **2.3.1. Qualitative analysis**

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

265

266 **2.3.2. Network analysis**

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

272 social-ecological networks through a minimal building block approach to characterize the
273 different types of fish buyers in terms of their adaptability. The minimal building block
274 approach builds on the conceptualization of the network as being composed of certain micro-
275 level structures (i.e., building blocks), and is described in depth elsewhere (e.g. Bodin et al
276 2016, Wang et al 2013). Building block-based interpretation of network structures can draw on
277 a wide range of theories (Bodin and Tengö 2012). This includes social science theories (e.g. to
278 analyze collaboration (McAllister et al. 2015)); ecology (e.g. to analyze species' roles (Stouffer
279 et al. 2012)); and social-ecological systems research (e.g. to analyze social-ecological fit
280 (Bodin and Tengö 2012)). The presumed relationships between certain building blocks and the
281 three different characteristics of adaptive capacity at focus for this study were defined drawing
282 on existing literature, and it is further described below. Three fish buyers out of the 23 included
283 in the network provided only limited information and were therefore excluded from the
284 quantitative analysis.

285 The analysis of the fish buyer's network structure was used to identify certain roles in the
286 network that we associate with varying roles and ways of operation in the supply chain. Degree
287 centrality measures –i.e., the number of links for any given node (Wasserman and Faust 1994)
288 – were used to identify fish buyers with the highest number of direct relationships with other
289 fish buyers. We differentiated between the number of relationships each fish buyer has when
290 it comes to selling fish resources to other fish buyers (outdegree centrality) versus the number
291 of fish buyers any given fish buyer draws from when buying fish resource (indegree centrality)
292 (Wasserman and Faust 1994). We used outdegree and indegree measures in combination (Fig.
293 2) in defining three roles that fish buyers have in the supply chain: *buyers*, who mainly buy
294 from other fish buyers (high indegree centrality); *suppliers*, who mainly sell to fish buyers
295 (high outdegree centrality); and *exchangers*, who both buy from and sell to other fish buyers
296 (similar indegree and outdegree measures). We suggest a typology of fish buyers that combines
297 the three buyer's roles and fish buyer's characteristics related to: a) how they are connected
298 with fishers; and b) the type of market demand they reported to be directly connected to (Fig.
299 1). In this way, we account for relationships amongst fish buyers but also with fishers and
300 markets, since relationships with fishers and different market demands influence the supply for
301 fish (Crona et al. 2010, Thyresson et al. 2013). Four different types of market demand were
302 present in the study case. Local demand refers to consumers of fish products in the city.
303 “*Tourist demand*” refers to demand for high-value species targeting the tourism sector within
304 Baja California Sur, and was often named like that by fish buyers in the interviews and
305 participant observation. National demand refers to products sent to the mainland of Mexico

306 (e.g. Mexico City, Guadalajara), and international demand to products sent to the USA. The
 307 qualitative analysis provided information on these characteristics, and it was also used to
 308 further describe and re-analyze the types of fish buyers identified.



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


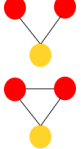


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322 2.4. A network-centric assessment of adaptive capacities

323 Below we describe how the three dimensions of adaptive capacity that are the focus of this
 324 study (the adaptive capacity in relation to other fish buyers, the adaptive capacity in relation to
 325 fishers, and the capacity to deal with stock fluctuations) are interpreted based on previous
 326 empirical work and relevant theory (table 1). To strengthen the validity of applying previous
 327 theories and findings to this study case, these interpretations were also contrasted in the light
 328 of the insights derived from our qualitative analyses (section 3.1).

329

building block	Description	References
i) Adaptive capacity in relation to other fish buyers		
Open trading network	 <p>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*).</p>	Wilson 1980; Cook et al. 1983; Walker et al 2000; van Assen 2010.
Closed trading network	 <p>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</p>	Granovetter 1985; Grabowski 1997; Wathne and Heide 2000; Geyskens et al. 2006.

(opportunism) due to high reputational cost, as compared to a dyadic seller-buyer relationship.		
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.
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).
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.
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.

330 **Table 1. Analytical framework of adaptive capacity:** network building blocks are linked to
 331 three dimensions of adaptive capacity based on the influence that actors would be able to
 332 exercise in the commercialization system, making explicit the relationships between fish
 333 buyers, fishers, and fish resources.

334 **2.4.1. The adaptive capacity in relation to other fish buyers**

335 The interpretation of the *open trading network* building block (table 1) is supported by network
 336 exchange theory (e.g. Cook and Emerson 1978; Cook et al. 1983). When two fish buyers that
 337 do not exchange fish supply the same good to a fish buyer (in the center position), that fish
 338 buyer is assumed to be in a more advantageous position since it possesses the ability to freely
 339 decide from which one to buy from. In other words, the adaptive capacity associated with the
 340 center position would be high as compared to the peripheral positions (i.e., edges). This also
 341 generally applies to the case when the fish buyer in the center position needs to exchange with
 342 both partners to make a profit (Walker et al. 2000). However, fish buyers in the edges would

343 have higher capacity to influence their own operations when these fish buyers constitute the
344 only potential buyers of a specific fish resource (e.g. van Assen 2010). For example, in our
345 study case, we could observe this phenomenon in cases of gluts of a non-substitutable species
346 that is sold to external markets (i.e., outside the boundaries of the network analyzed), when
347 only few buyers have the capacity to export it. Therefore, some buyers in the edges could
348 experience a high level of adaptive capacity in relation to the others. Contrary to all this, fish
349 buyers in the *closed trading network* (Table 1) would have equal opportunities over the
350 exchange (Cook et al. 1983).

351

352 **2.4.2. *The adaptive capacity in relation to fishers***

353 The building blocks linking fish buyers and fishers (table 1) are interpreted based on previous
354 empirically based knowledge on informal arrangements in small-scale fisheries (e.g. Patron-
355 Client arrangements). A fish buyer that engages with several fishers would have higher
356 capacity to decide upon his/her fish trading operations, both in relation to other fish buyers
357 (since they likely are able to provide substantial fish resources), and in relation to their fishers
358 (especially if the fishers have no trading relationships with other fish buyers, thus no other
359 options they could utilize exists if they are not satisfied with the fish buyer's offer). Fishers
360 that have trading relationships with several fish buyers are assumed to have higher capacity to
361 decide who to trade with than other fishers only engaged with one trader. Further, they can
362 likely have higher adaptive capacity in relation to their fish buyers, which in particular applies
363 if the fish buyers are not engaged in a trading relationship with each other (cf. network
364 exchange theory, Cook et al. 1983). In other studies, this type of fishers has been called
365 freelancers (e.g. Crona and Bodin 2010; Kininmonth et al. 2017).

366

367 **2.4.3. *The capacity to deal with fluctuations***

368 Building blocks linking fish buyers and fish resources are interpreted based on new institutional
369 economics theory, to hypothesize the role of trade relationships in facing uncertainty in
370 economic exchanges (e.g. Wilson 1980; Geyskens et al. 2006). We apply this body of theory
371 to fish buyers that are targeting the same fish resources (through their relationship with fishers).
372 We assume that the presence or absence of trade relationships between fish buyers that target
373 the same fish group has an influence on their capacity to deal with short-term (e.g. daily)
374 fluctuations in the market and in the availability of that fish group. In essence, a fish buyer that
375 has a trade relationship with another fish buyer targeting the same fish resource is thought to
376 be better able to deal with scarcity or market gluts of that resource, since each fish buyer may

377 have different access to resources and connections to markets. For example, such fish buyers
378 may be able to provide a certain amount of the fish resource higher up in the supply chain, even
379 when resources captured by his/her fishers fluctuate. This assumption stems from the fact that
380 the fish buyer can draw from two different sources: its “own” fishers and indirectly other fish
381 buyers’ fishers, since fish buyers are embedded in a network that allows flexibility acquiring
382 fish from sources that may have different production capacities (Geyskens et al. 2006). One
383 must note that this does not apply for long-term fluctuations, such as decline in fish
384 populations, or disappearance of one specie everywhere at the same time.

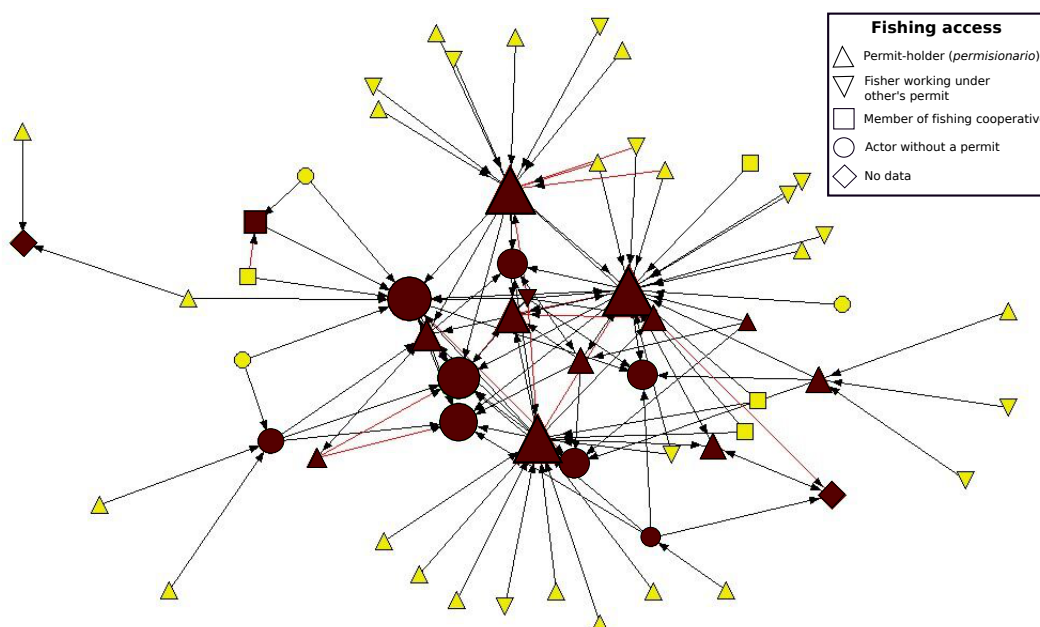
385

386 3. Results and discussion

387

388 3.1. Trading embedded in inter-personal relationships

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



395

396 **Figure 2: Trade network.** The network shows fisher-to-fish buyer and fish buyer-to-fish buyer trade
397 relationships, which can be infrequent relationships (red links) or regular relationships (black links).

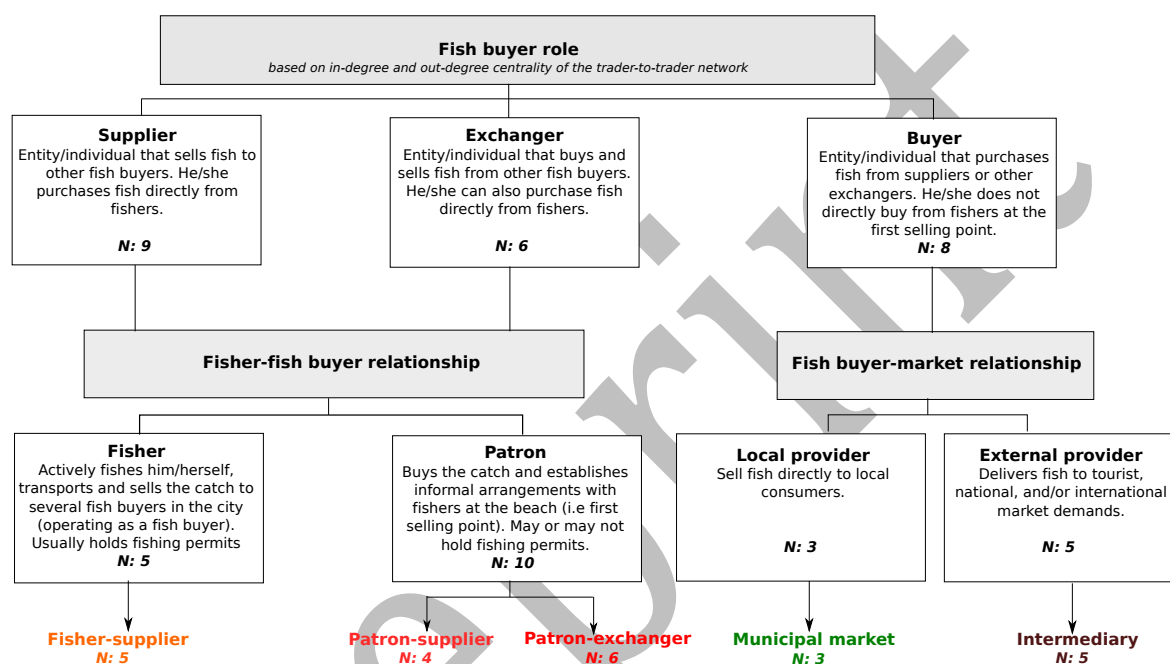
398 Fishers (yellow) and fish buyers (brown) have different fishing rights to access SC's fisheries. Size
399 represent *indegree* centrality.

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

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

421 Relationships between fish buyers are also stable, since several fish buyers stated that "each
422 supplier has his own buyers" and vice versa. However, these trade relationships can be of
423 different nature and the norms guiding the exchange can vary for different fish buyers. Even if
424 we cannot provide a quantitative description of the different types of relationships, we here
425 describe general patterns emerging from the qualitative data. Some fish buyers highlight the
426 importance of maintaining relationships with particular fish buyers based on many years
427 exchanging fish. Stability, trust and commitment describe many relationships where there is
428 continuous communication between the two partners (e.g. regarding what and how much fish
429 is needed by the different partners). In some cases, fish buyers aim to have a reliable
430 seller/buyer for periods of gluts or fish scarcity, thus they establish relationships where they
431 prioritize to whom would they sell/buy expecting reciprocity in the most challenging seasons.

432 Some have several relationships as such because they do not trust that all exchange partners
 433 will comply with the usual agreement. Some trade relationships also comprise credit
 434 arrangements, where one fish buyer can lend fish to another, similarly to the assistance
 435 relationships between traders described by Drury O'Neill and Crona (2017). Still, some fish
 436 buyers might also base all or some of their exchange relationships on the highest bidder, but
 437 they tend to have exchange partners who they trade with repeatedly and do not trade in spot
 438 markets.



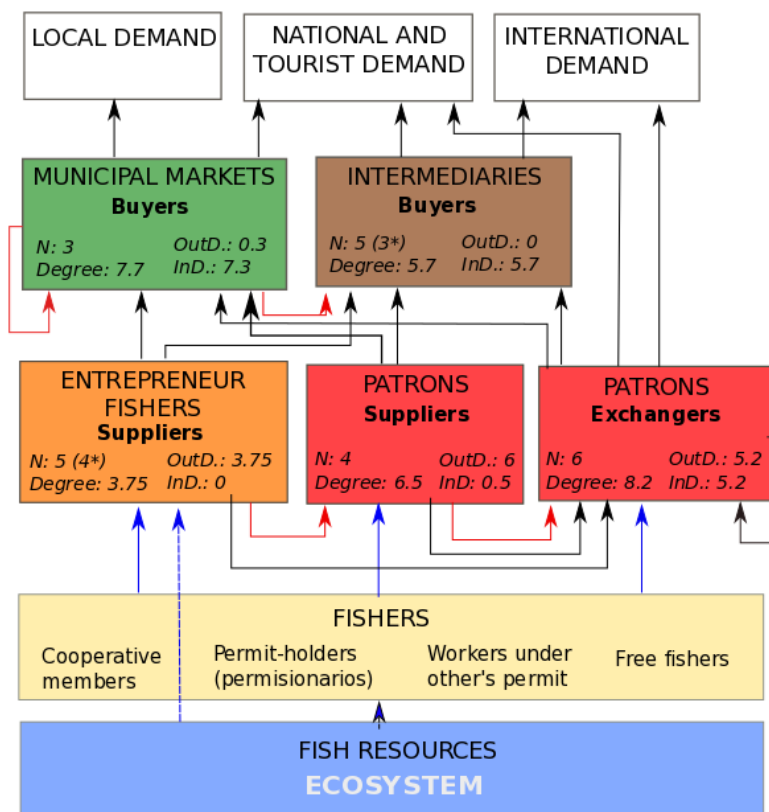
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 440 **Figure 3. Fish buyers' roles and characteristics used to define fish buyer's types.** N, number of
 441 fish buyers in the sample.
 442

443 3.2. Identifying types of fish buyer from the trade network

444 Figure 3 describes the process through which we defined types of fish buyers. We combined
 445 and cross-referenced fish buyer's roles that emerge from a network analysis; and a qualitative
 446 understanding of their relationships with fishers and market demands. Five different types of
 447 fish buyers were identified in the studied trade network (Figure 3): 1) patron-exchangers; 2)
 448 patron-suppliers; 3) fisher-suppliers (this refers to fishers who also function as traders, herein
 449 named entrepreneur fishers); 4) municipal markets (buyers); and 5) intermediaries (buyers).
 450 Traders with the role of *buyer* do not establish arrangements with fishers but they are
 451 differentially connected to market demands, which will influence their capacity to
 452 commercialize different types of resources. We nonetheless acknowledge that more or other
 453 types of fish buyers could be present in other communities, since traders are expected to belong
 454 to one of the three trader roles identified (Figure 3), but these roles can be combined in different

455 ways with the type of relationships traders establish with fishers and with market demands.
 456 One must note that the fisher-trader relationship “patron” has been widely described in the
 457 literature (e.g. Basurto et al. 2013), but we found two types of patrons in terms of their
 458 differential role as supplier versus exchanger. For instance, this is similar to the diversity
 459 patrons identified by Ferse et al. (2012) in Indonesia who qualitatively distinguish “small”
 460 versus “big” patrons. Figure 4 and the text below further describe these five fish buyer types
 461 based on network measures and qualitative data resulting from interviews and participant
 462 observation.

463



464 **Figure 4. Conceptual map of the trading system.** The types of fish buyers identified establish trading
 465 relationships and satisfy three different types of demand. The mean centrality measures of fish buyers’
 466 degree, outdegree (OutD) and indegree (InD) centrality were calculated per fish buyer type. *N*, number
 467 of fish buyers identified per fish buyer type. Arrows show the fish flow: dotted lines, fishing; blue,
 468 trading with fishers; black, flows in the fish buyer’s network and their market connections; and red,
 469 infrequent relationships. See appendix C for the disaggregated data. *In brackets is the number of fish
 470 buyers with complete information that were included in the calculations.

471

472 Patrons-exchangers have fishers working for them in one or more communities in Baja
 473 California Sur and transport fish from the fishing communities to the city, like other patrons.
 474 They tend to have more connections in the network of exchange relationships than other
 475 individual fish buyers (degree centrality 8.8, figure 4). All patrons-exchangers, except one,
 476 own several fishing permits that allow them to exploit more than one fishery. They identify
 477

478 themselves as seafood producers besides being fish buyers. Moreover, permits allow them to
479 fish within one or more municipalities, some having fishing rights in the whole state of Baja
480 California Sur. This allows many to “move their fishers” or their permits to different fishing
481 communities or camps following fishing seasons. Thus they can produce a higher volume and
482 they might have more flexibility regarding where and when they enter different fisheries.
483 Patrons-exchangers can have higher storage capacity since they usually have a warehouse in
484 the city where fresh fish can be processed (e.g. filleting), but not all patrons-exchangers own a
485 warehouse. In addition, these patrons can establish credit arrangements with other fish buyers,
486 and provide assistance buying or selling fish during challenging times. Patron-exchangers can
487 also own fish shops in the city and send deliveries to satisfy tourist, national, and/or
488 international demands.

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

494 Entrepreneur fishers are also suppliers and usually own fishing permits. They go fishing,
495 transport and sell fish in the city. Thus, they cover the cost of fishing and transporting the
496 product to the city and assume the risks inherent to both fishing and trading activities. Most of
497 these fishers live both in the communities and in the city and aim to acquire higher prices than
498 if they sold their catch in the communities. Some move to fish in other communities during
499 “wind season” in the Gulf of California (characterized by low catches). In general, entrepreneur
500 fishers tend to have fewer connections in the fish buyer-to-fish buyer network than other fish
501 buyers (degree centrality 3.75, figure 4). Both patrons-suppliers and entrepreneur fishers can
502 own fish shops in the city and be directly linked to local demand (not included in figure 4), but
503 this is not the case for most.

504 The three municipal markets in the city are places that gather between 4 and 7 fish shops and
505 this type of fish buyer is nearly as connected as the patron-exchanger (degree centrality 7.7,
506 figure 4). They receive fish and sell it mainly to local consumers. Some fish shops of the
507 municipal markets are also suppliers to regional hotels and/or restaurants or local supermarkets,
508 thus selling larger amounts on a regular or occasional basis. Fish shops outside municipal
509 markets were not included in this study, but they could have similar behavior to the municipal
510 markets. Intermediaries usually specialize in satisfying a concrete type of demand for high-
511 value fish. Two send fish to the international demand, and two to the tourist and/or national

512 markets. It must be noted that two intermediaries have few connections in the network and
513 their role might not be fully captured in this supply chain because their links with the study
514 case region are scarce (see appendix C); therefore, they have been excluded from the
515 quantitative analysis.

516









517 **3.3. Adaptive capacity of the diverse fish buyers**

518 Fish buyer's potential adaptability differs amongst types of fish buyers (table 2). In general,
519 the adaptive capacity in relation to fishers would be high for all patrons, because they are
520 mainly connected to fishers that do not report selling to other fish buyers (patron-client
521 structure), and when two fish buyers buy from a "freelancer" they often have trade relationships
522 between them. Patrons-exchangers stand out in that, in relation to the other types, they maintain
523 a higher ratio of center positions versus the edge positions in the open-trading structure (table
524 2), potentially having higher adaptive capacity in relation to the city trading system. They are
525 also more often than others part of connected buyer's structures (Table 2), and therefore seem
526 to have a higher adaptability. The fact that many own a warehouse and/or a fish shop, deliver
527 fish directly to external markets (i.e., tourist, national and/or international), and hold fishing
528 permits across the state Baja California Sur (section 3.2), supports their prominent role in the
529 system. They might promote asymmetric relationships in the supply chain but they can also
530 provide assistance to fishers and to other fish buyers through PCs, as it has been found
531 elsewhere (e.g. Ferse et al. 2012; Drury O'Neill and Crona 2017).

532 Patron-suppliers have lower adaptive capacities than patron-exchangers but higher than
533 entrepreneur fishers (see table 2). For example, they maintain a lower ratio of center positions
534 versus edge positions than patron exchangers, but higher ratio in these positions than
535 entrepreneur fishers (table 2). Entrepreneur fishers can be seen as freelancers whose activities
536 are not constrained by any particular patron (Crona and Bodin 2010, Kininmoth et al. 2017),
537 but they might have less adaptability and occupy more vulnerable positions in the trade network
538 (less center and more edge positions than others in the open-trading structure) (cf. Wilson
539 1980).

540 Municipal markets have high adaptive capacity in relation to other fish buyers since the
541 maintain a high ratio of center positions in the open-trading structures (table 2). They also
542 constitute a selling point of diverse fish of lower value to local consumers, and some also to
543 restaurants and the tourist sector (section 3.2), which may increase their adaptive capacity in
544 relation to resource or market fluctuations. Intermediaries appear to have less adaptive capacity
545 as, for example, patron-exchangers (e.g. they maintain nearly twice as high ratio of edge

546 positions in the open-trading structure). However, they may nonetheless have a high adaptive
 547 capacity in relation to other fish buyers even when occupying the edge position, since they can
 548 be the main buyers for specific high-value resources exported to the international market (table
 549 1, 2).
 550

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

551 **Table 2: Position of fish buyer types in relation to fish buyer's adaptability.** The positional analysis
 552 of the network reveals the number of times (and percentage) each fish buyer type occupy a position in
 553 the selected network building blocks. Since the number of times any type of fish buyer would be
 554 expected to be found in any of these building blocks also depends on how many fish buyers there are
 555 of each type, the results in the table are best interpreted by comparing the distribution of percentages
 556 across types. For example, patron suppliers are relatively less often taking the position of a connected
 557 fish buyer than patron exchangers (23.7% vs. 61.3%). N, is the number of fish buyers included in the
 558 positional analysis. Observe that N is lower for the last categories of adaptability since 4 patron-
 559 exchangers work with fishers outside SC and therefore their interactions with fishers and fish resources
 560 are not captured in this network.
 561

562 3.4. Possible implications for Small-Scale Fisheries sustainability

563 In light of the uneven distribution of adaptive capacities across fish buyer types (section 3.3),
564 we expect fish buyers to experience different constraints or opportunities in promoting
565 responsible and sustainable production of fish. For instance, we suggest that patrons can have
566 a key role to promote or impede SSFs sustainability in line with previous research (e.g. Crona
567 et al. 2010; Ferse et al. 2014), but different types of patrons might respond differently to market
568 and environmental changes. On the one hand, the high adaptive capacity of patron-exchangers
569 (section 3.3) indicates that they have a high capacity to influence the supply chain, but they
570 might also have fewer incentives for local stewardship since they operate regionally and do not
571 depend in any particular fishing community (section 3.2). Thus they can more likely promote
572 overexploitation (e.g. less likely to respond to local ecosystem feedbacks, cf. roving bandits
573 (Berkes et al. 2006)). On the other hand, patron-suppliers are often part of fishing communities
574 and/or have kinship bonds with fishers and other community members (section 3.2), therefore
575 they might have more incentives to promote sustainability and guarantee fisher's livelihoods.
576 However, they might face constraints for trade since they do not tend to sell fish to each other,
577 they have less capacity to influence other fish buyers in the city network (section 3.3), and they
578 do not market their products to high-value markets directly (figure 4). This decreased
579 adaptability can create incentives to promote unsustainable exploitation patterns, because
580 patron's investments in fishing and trading activities can make them reluctant to change their
581 operations even if fish catches decline (Crona and Bodin 2010). Still, the ultimate effect any
582 type of patron will have depends on his/her willingness to utilize such adaptive capacity for or
583 against sustainability.

584 Entrepreneur fishers, or freelancers, are the most tightly linked to local ecosystems. They have
585 been represented as actors with high potential to promote sustainability because they would
586 have higher capacity to respond to ecological feedbacks (Crona and Bodin 2010; Kininmoth et
587 al. 2017). However, they have less potential influence in the trade network than other traders
588 (section 3.3), which may limit their ability to adapt to supply or market changes. Further, these
589 entrepreneur fishers have investments in fishing and trading activities like other suppliers;
590 therefore, they might also have incentives to increase resource exploitation even if fish catches
591 decline (cf. Crona and Bodin 2010), assuming they would not change to an alternative
592 livelihood.

593 Municipal markets showed to have high adaptive capacity (section 3.3), thus their influence
594 can play out in combination with changes in the demand for high value fish; especially because
595 most fishers, suppliers and exchangers target both high and low value fish and they do not
596 specialize in one single resource. Providers of local fish as such have a potential influence over

597 fishing patterns, and they may be key in promoting the adaptive capacity of multi-species
598 fisheries. These actors should not be disregarded even if global trade is increasing its influence
599 over local communities through other buyers such as intermediaries.

600

601 **3.5. Concluding remarks**

602 To include fish buyers in decision-making processes towards responsible and sustainable
603 fisheries like the FAO's SSF Guidelines state (FAO 2015), one must consider the diversity of
604 fish buyer's roles and the complexities of their relationships. As our results suggest, fish
605 buyer's potential contribution towards sustainability can vary significantly across actors, when
606 we account for actor's relationships with each other. This study analyzed fish buyers as
607 embedded in trade relationships that are interlinked with social processes. However, further
608 research is needed to understand how differences in the nature of fish trade relationships as
609 described here, can influence actor's behavior and ultimately the post-harvesting structure and
610 processes.

611 The network approach provides the opportunity to compare supply chains and trading systems.
612 This study analyzed a multi-species finfish fishery, but the approach could be applied to other
613 trading systems such as those based on cooperatives, or supply chains mainly targeting global
614 markets or certified products. We hypothesize that such systems might show different patterns
615 of trade relationships and various types of fish buyers, with potential implications for social-
616 ecological sustainability. Even if this remains a question for future research, we provide a first
617 direction for future enquiry.

618

619 **4. References**

620

621 Bagozzi, R. P. 1975. Marketing as Exchange. *Journal of Marketing* 39(4):32-39

622 Basurto, X., A. Bennett, A. Hudson Weaver, S. Rodriguez-Van Dyck, and J.-S. Aceves-
623 Bueno. 2013. Cooperative and Noncooperative Strategies for Small-scale Fisheries' Self-
624 governance in the Globalization Era: Implications for Conservation. *Ecology and Society*
625 18(4):38.

626 Berkes, F., T. P. Hughes, R. S. Steneck, J. A. Wilson, D. R. Bellwood, B. Crona, C. Folke, L.
627 H. Gunderson, H. M. Leslie, J. Norberg, M. Nystrom, P. Olsson, H. Osterblom, M. Scheffer,
628 and B. Worm. 2006. Globalization, roving bandits, and marine resources. *Science*
629 311(5767):1557-1558.

630 Bodin, Ö. 2017. Collaborative environmental governance: Achieving collective action in
631 social-ecological systems. *Science*, 357(6352).

632 Bodin, Ö., and M. Tengö. 2012. Disentangling intangible social-ecological systems. *Global*
633 *Environmental Change* 22(2):430-439.

- 634 Bodin, Ö., B. Crona, M. Thyresson, A. L. Golz, and M. Tengö. 2014. Conservation success
635 as a function of good alignment of social and ecological structures and processes.
636 *Conservation biology* 28(5):1371–1379.
- 637 Bodin, Ö., G. Robins, R. R. J. McAllister, A. M. Guerrero, B. Crona, M. Tengö, and M.
638 Lubell. 2016. Theorizing benefits and constraints in collaborative environmental governance:
639 a transdisciplinary social-ecological network approach for empirical investigations. *Ecology*
640 *and Society* 21(1).
- 641 Cannon, J. P., and W. D. Perreault JR. 1999. Buyer-Seller Relationships in Business Markets.
642 *Journal of Marketing Research* 36:439-460.
- 643 Cinner, J. E., W. N. Adger, E. H. Allison, M. L. Barnes, K. Brown, P. J. Cohen, S. Gelcich,
644 C. C. Hicks, T. P. Hughes, J. Lau, N. A. Marshall, and T. H. Morrison. 2018. Building
645 adaptive capacity to climate change in tropical coastal communities. *Nature Climate Change*
646 8(2):117–123. <https://doi.org/10.1038/s41558-017-0065-x>
- 647 Cinti, A., W. Shaw, R. Cudney-Bueno, and M. Rojo. 2010. The unintended consequences of
648 formal fisheries policies: Social disparities and resource overuse in a major fishing
649 community in the Gulf of California, Mexico. *Marine Policy* 34(2):328–339.
- 650 CONAPESCA. 2013. *Anuario estadístico de acuacultura y pesca*. Comisión Nacional de
651 Acuacultura y Pesca, Mazatlán, México.
- 652 Cook, K. S., & Emerson, R. M. 1978. Power, equity and commitment in exchange
653 networks. *American sociological review*, 721-739.
- 654 Cook, K. S., Emerson, R. M., Gillmore, M. R., & Yamagishi, T. 1983. The distribution of
655 power in exchange networks: Theory and experimental results. *American journal of*
656 *sociology*, 89(2), 275-305.
- 657 Crona, B. I., T. Van Holt, M. Petersson, T. M. Daw, and E. Buchary. 2015. Using social-
658 ecological syndromes to understand impacts of international seafood trade on small-scale
659 fisheries. *Global Environmental Change* 35:162–175.
- 660 Crona, B., and Ö. Bodin. 2010. Power asymmetries in small-scale fisheries: A barrier to
661 governance transformability? *Ecology and Society* 15(4).
- 662 Crona, B., M. Nyström, C. Folke, and N. Jiddawi. 2010. Middlemen, a critical social-
663 ecological link in coastal communities of Kenya and Zanzibar. *Marine Policy* 34(4):761–771.
- 664 Drury O'Neill, E., and B. Crona. 2017. Assistance networks in seafood trade – A means to
665 assess benefit distribution in small-scale fisheries. *Marine Policy* 78:196–205.
- 666 FAO. 2015. *Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries in the*
667 *Context of Food Security and Poverty Eradication*. Food and Agriculture Organization of the
668 United Nations, Rome.
- 669 Ferrol-Schulte, D., S. C. A. Ferse, and M. Glaser. 2014. Patron–client relationships,
670 livelihoods and natural resource management in tropical coastal communities. *Ocean &*
671 *Coastal Management* 100:63–73.
- 672 Ferse, S. C. A., L. Knittweis, G. Krause, A. Maddusila, and M. Glaser. 2012. Livelihoods of
673 Ornamental Coral Fishermen in South Sulawesi/Indonesia: Implications for Management.
674 *Coastal Management* 40(5):525–555.
- 675 Geyskens, I., J.-B. E. M. Steenkamp, and N. Kumar. 2006. Make, buy or ally: A transaction
676 cost theory. *Academy of Management Journal* 49(3):519–543.

- 677 Grabowski, R. 1997. Agriculture, markets and economic development. *Canadian Journal of*
678 *Development Studies* 18(1):49–69.
- 679 Granovetter, M. 1985. Economic Action and Social Structure: The Problem of Emeddedness.
680 *American Journal of Sociology* 3(3):69–83.
- 681 Granovetter, M. S., and R. Swedberg. 2011. *The sociology of economic life*. Westview Press.
- 682 Hamilton-Hart, N., and C. Stringer. 2016. Upgrading and exploitation in the fishing industry:
683 Contributions of value chain analysis. *Marine Policy* 63: 166-171.
- 684 Johnson, D. S. 2010. Institutional adaptation as a governability problem in fisheries: patron-
685 client relations in the Junagadh fishery, India. *Fish and Fisheries* 11:264–277.
- 686 Kaplinsky, R., and M. Morris. 2001. *A handbook for value chain research (Vol. 113)*.
687 Ottawa: Idrc.
- 688 Kininmonth, S., B. Crona, Ö. Bodin, I. Vaccaro, L. J. Chapman, and C. A. Chapman. 2017.
689 Microeconomic relationships between and among fishers and traders influence the ability to
690 respond to social-ecological changes in a small-scale fishery. *Ecology and Society* 22(2).
- 691 Lindkvist, E., X. Basurto, M. Schlüter, J. Groeneveld, C. Klassert, and R. Martin. 2017.
692 Micro-level explanations for emergent patterns of self-governance arrangements in small-
693 scale fisheries—A modeling approach. *PLOS ONE* 12(4):e0175532.
- 694 Lusch, R. F., and J. R. Brown. 1996. Interdependency, contracting, and relational behavior in
695 marketing channels. *Journal of Marketing* 60(4).
- 696 Mahon, R., P. McConney, and R. N. Roy. 2008. Governing fisheries as complex adaptive
697 systems. *Marine Policy* 32(1):104–112.
- 698 McAllister, R. R. J., C. J. Robinson, K. Maclean, A. M. Guerrero, K. Collins, B. M. Taylor,
699 and P. J. De Barro. 2015. From local to central: a network analysis of who manages plant pest
700 and disease outbreaks across scales. *Ecology and Society* 20(1).
- 701 Merlijn, A. G. 1989. The Role of middlemen in small-scale fisheries: A case study of
702 Sarawak, Malaysia. *Development and Change* 20(4):683–700.
- 703 Miñarro, S., G. Navarrete Forero, H. Reuter, and I. E. van Putten. 2016. The role of patron-
704 client relations on the fishing behaviour of artisanal fishermen in the Spermonde Archipelago
705 (Indonesia). *Marine Policy* 69:73–83.
- 706 Nascimento, D. M., R. R. N. Alves, R. R. D. Barboza, A. J. Schmidt, K. Diele, and J. S.
707 Mourão. 2017. Commercial relationships between intermediaries and harvesters of the
708 mangrove crab *Ucides cordatus* (Linnaeus, 1763) in the Mamanguape River estuary, Brazil,
709 and their socio- ecological implications. *Ecological Economics* 131:44–51.
- 710 Nenadovic, M. 2017. *Cambios Socioeconomicos en el Corredor (2009-2016). Capitulo 10.*
711 *Presentacion de resultados: Zonas de refugio pesquero*. Niparaja. Pp. 48.
- 712 Ostrom, E. 1990. *Governing the Commons: The Evolution of Institutions for Collective*
713 *Action*. Cambridge University Press.
- 714 Palmatier, R. W., R. P. Dant, and D. Grewal. 2007. A Comparative Longitudinal Analysis of
715 Theoretical Perspectives of Interorganizational Relationship Performance. *Journal of*
716 *Marketing* 71(4):172–194.
- 717 Platteau, J., and A. Abraham. 1987. An inquiry into quasi-credit contracts: The role of
718 reciprocal credit and interlinked deals in small-scale fishing communities. *Journal of*
719 *Development Studies* 23(4):461–490.

- 720 Reed, M. S., A. Graves, N. Dandy, H. Posthumus, K. Hubacek, J. Morris, C. Prell, C. H.
721 Quinn, and L. C. Stringer. 2009. Who's in and why? A typology of stakeholder analysis
722 methods for natural resource management. *Journal of Environmental Management*
723 *90(5):1933–1949*.
- 724 Rosales, R. M., R. Pomeroy, I. J. Calabio, M. Batong, K. Cedo, N. Escara, V. Facunla, A.
725 Gulayan, M. Narvadez, M. Sarahadil, and M.A. Sobrevega. 2017. Value chain analysis and
726 small-scale fisheries management. *Marine Policy*, *83*:11-21.
- 727 Stouffer, D. B., M. Sales-Pardo, M. I. Sirey, and J. Bascompte. 2012. Evolutionary
728 conservation of species' roles in food webs. *Science* *335(6075):1489–1492*.
- 729 Thyresson, M., B. Crona, M. Nyström, M. de la Torre-Castro, and N. Jiddawi. 2013. Tracing
730 value chains to understand effects of trade on coral reef fish in Zanzibar, Tanzania. *Marine*
731 *Policy* *38:246–256*.
- 732 Tovar Lee, N., S. Lluch Cota, and J. I. Urciaga García. 2015. Subdesarrollo en las localidades
733 pesqueras del municipio de La Paz, Baja California Sur. *Región y sociedad* *63:127-154*.
- 734 van Assen, M. A. 2010. The incidence of strong power in complex exchange networks.
735 In Shane R. Thye, Edward J. Lawler (ed.) *Advances in Group Processes (Advances in Group*
736 *Processes, Volume 27)*, Emerald Group Publishing Limited, pp.205 - 238
- 737 Vignes, A., and J. M. Etienne. 2011. Price formation on the Marseille fish market: Evidence
738 from a network analysis. *Journal of Economic Behavior and Organization* *80(1):50–67*.
- 739 Walker, H., S. R. Thye, B. Simpson, M. J. Lovaglia, D. Willer and B. Markovsky. 2000.
740 Network Exchange Theory: Recent Developments and New Directions. *Social Psychology*
741 *Quarterly* *63(4)*.
- 742 Wang, P., G. Robins, P. Pattison, and E. Lazega. 2013. Exponential random graph models for
743 multilevel networks. *Social Networks* *35:96–115*.
- 744 Wasserman, S., and K. Faust. 1994. *Social network analysis: Methods and applications*.
745 Cambridge University Press, New York, USA.
- 746 Wathne, K. H., and J. B. Heide. 2000. Opportunism in Interfirm Relationships: Forms,
747 Outcomes, and Solutions. *Journal of Marketing* *36(64):36–51*.
- 748 Williamson, O. E. 1981. The economics of organization: The transaction cost
749 approach. *American journal of sociology*, *87(3)*, 548-577.
- 750 Wilson, J. A. 1980. Adaptation to Uncertainty and Small Numbers Exchange: The New
751 England Fresh Fish Market. *The Bell Journal of Economics* *11(2):491–504*.