Crona, B., and Ö. Bodin. 2010. Power asymmetries in small-scale fisheries: a barrier to governance transformability? *Ecology and Society* **15**(4): 32. [online] URL: http://www.ecologyandsociety.org/vol15/iss4/art32/

Research, part of a Special Feature on Social Network Analysis in Natural Resource Governance

Power Asymmetries in Small-Scale Fisheries: a Barrier to Governance Transformability?

Beatrice Crona [1] *and Örjan Bodin* [2]

ABSTRACT. Both global and local environmental problems call for the transformation of many contemporary and unsustainable governance approaches. Therefore, recent interest has sprung up around factors that facilitate and hinder societies from transforming governance of natural resources. Using a social-network approach, we study links between informal power structures and knowledge sharing and consensus building. We examine how this interaction may have affected the (in)ability of a community to move from open-access to some form of collective action for resource management. Individuals occupying central positions in a knowledge network can be instrumental in determining which knowledge and interpretation of ecological signals is most dominant. If the same individuals are also influential in other areas, they are highly likely to become opinion leaders. We use this notion of opinion leaders to frame our study. The study is set in a rural fishing community in East Africa where access to fishing equipment is of utmost importance for generating household income, but such gear ownership is not evenly distributed in the village. Hence, we use gear-exchange networks to explore power. Our results show a clear and strong relationship between centrality in the knowledge network and in-degree centrality (reflecting gear-lending capacity) in the gear-exchange network, supporting the idea that opinion leaders exist. We also indicate that a majority of these potential opinion leaders demonstrate little recognition of declining fisheries. We relate our findings to existing theories of influence and governance transformability at the community level, and explore ideas about how social networks can help identify potential change agents in communities experiencing inertia with respect to collective action for improved resource management.

Key Words: *comanagement; governance; local ecological knowledge; natural resources; power; social networks; transformation*

INTRODUCTION

This study is set in a rural fishing community in East Africa. In such a setting, where the majority of the community is dependent directly or indirectly on the inshore fishery and poverty levels are high, access to gear to extract fishing resources is of utmost importance for generating household income. At the same time, gear ownership is not evenly distributed among villagers. Access to gear through lending is often related to social factors such as ethnicity or kinship, and owners often require significant commitments from those borrowing (Crona et al. 2010). Those who depend on others for gear use become constrained in their ability to change extractive practices. Thus, gear ownership implies a form of power over those dependent on using it, and it is likely to affect the ability of dependent individuals to change their extractive behavior.

We explore whether an in-depth look at the power relations stemming from asymmetric access to fishing gear in combination with an examination of knowledge-sharing networks, can help us to understand why a community with a high dependence on local fisheries has not initiated any form of collective action to deal with documented inshore habitat degradation and a declining fishery (Ochiewo 2004, Crona and Bodin 2006, Maina et al. 2008). In light of this apparent inertia, we explore the interaction between informal power structures and knowledge-sharing networks to examine whether the way in which these are linked creates barriers for transformability in the village. The underlying rationale stems from the literature on

[1]Stockholm Resilience Center, Stockholm University, Sweden, [2]Stockholm Resilience Center and Department of Systems Ecology, Stockholm University

opinion leaders, which argues that individuals in powerful positions often enjoy a comparative advantage in transmitting their opinions to others (Kingdon 1970, Booth and Babchuck 1972, Saunders et al. 1974, Brett and Kernaleguen 1975). If such opinion leaders exist in the studied community, they are likely to have a disproportionately high impact on the community's (in)ability to transform its fisheries management.

The interplay between power and knowledge and the consequences of this for social processes has been studied from many perspectives, from the classic work of Focault (1980), to power dynamics among firms in joint ventures (e.g., Inkpen and Beamish 1997), or the legitimacy of different knowledge systems vis-à-vis each other (e.g., Nadasdy 1999, Moller et al. 2004, Robbins 2006). Despite its documented impact on social outcomes, explicit discussion of power has, with a few exceptions (e.g., Ernstson et al. 2008, Hornborg 2009), been curiously absent from much of the work on natural-resource governance and resilience. However, to further understand the dynamic linkages and feedbacks within social–ecological systems, it is imperative that the literature engages more clearly with this issue.

One important type of social–ecological feedback is the knowledge of the natural environment that develops through resource users' interactions with local ecosystems, often referred to as local ecological knowledge (LEK), and its relation to management practices and decision making. This is particularly important in communities where states have devolved some degree of authority to local communities to govern natural resources. How, and which, LEK is fed into the decision-making process thus becomes crucial for the rules that develop around resource use and regulation. In other words, involving local resource users and stakeholders may not by itself lead to new and more ecologically sustainable management practices. The reason is that even small communities are often surprisingly heterogeneous (Agrawal 1997, Crona 2006), characterized by large differences among actors in levels of LEK, perceptions, and interpretations of the natural environment. Such differences in the perceptions of the dynamics of the natural resource and how it responds to different management actions could also prevent a community from collectively responding to communal resource-related problems. Ostrom (2005) argues that initiation of collective action in resource-management contexts is largely dependent on a common understanding of the problem and how it can be solved. When attempting to move or transform a system characterized by ongoing resource depletion to a state of more ecologically sustainable resource governance, the ability of stakeholders to subscribe to such a shared vision is of particular importance (c.f. sense-making, see e.g., Olsson et al. 2004).

An important issue, with bearing on how a common vision and understanding is built, is the ability of local actors to influence others' LEK (Crona and Bodin 2006, Bodin and Crona 2009). From a social-network perspective, actors who are central in a knowledge-sharing network are better positioned to influence the views of others than actors with low centrality (Degenne and Forsé 1999). This may result in some views and perceptions being systematically depressed or neglected while others flourish. Therefore, examining the individuals in a community who appear to be influential in furthering their knowledge and views can demonstrate how shared understanding is (or is not) achieved, and around which issues it is formed. For example, if, in a community where current practices are contributing to resource degradation, a shared view is reached but the prevailing perception is that no resource-related problems exist, consensus per se cannot be seen as enough to transform the social–ecological system to a more desirable state. Therefore, linking back to our aim of studying opinion leaders, we will address this pertinent research question: What influences the views and perceptions of individuals who appear particularly influential in a knowledge-sharing network?

We begin by examining the relationship between high centrality in the LEK-sharing network and the gear-exchange network. This equates to examining the relationship between the "potential for influence in the knowledge network" and "power defined as the ability to lend fishing gear to many others." Finding a strong and significant relationship, we then examine the individuals who rank high in both networks, and address some of the potential influences on their perceptions and views of the status of the fishery. We conclude by discussing the implications of our findings for fisheries management in the study area, and on the ability of communities to transform to more sustainable management practices in general.

METHODS

Study Site and Data Collection

Data was collected in a rural fishing community on the south coast of Kenya (Fig. 1; for more detailed information see Crona 2006, Crona and Bodin 2006, Bodin and Crona 2008). Of the approximately 1,000 inhabitants (206 households), a large percentage (44% of households) rely on fishing as their main income source, and many others depend indirectly on fisheries resources for their livelihoods. Farming and small-scale businesses are several of the alternative livelihoods in the community. Despite strong indications of declining fisheries and inshore habitat degradation, at the time of data collection the community had not initiated any collective action to regulate the fishery. In addition, although a recent initiative from the government now mandates local co-management units including fishers and fisheries officials (called Beach Management Units) at all landing sites (Government of Kenya 2005, Cinner et al. 2009), no significant changes have yet been seen in the management of the fishery (Oluoch and Obura 2008).

A nearly complete (83%) network data set was gathered based on interviews with the heads of 171 of the 206 households (see Crona and Bodin 2006 for network data-collection methods). Social-network data was collected using a survey instrument. The focus here is on networks used for exchange of gear and knowledge relating to the state and extraction of natural resources. The questions used to elicit data for these two networks are found in Table 1. To arrive at a network for LEK sharing, relations captured by questions 1 and 2 were combined (see Crona and Bodin 2006 for further details). For the purpose of our analysis, we included only relations of gear exchange where high-value goods were exchanged, such as nets or boats. We excluded the exchange of less valuable goods such as bait or hooks. Recall methods were used for collection of both networks. (For a discussion on recall as opposed to recognition methods for eliciting relational data, readers are referred to Marsden 1990, Wasserman and Faust 1994). In addition to relational data, data on personal attributes such as gender, age, civil status, clan, tribe, occupation, and residence time in the village were collected for each respondent. In addition, a set of key individuals were interviewed in-depth to assess, among other things, their perception of the state of the fishery (see also Bodin and Crona 2008). All interactions with respondents were conducted in Swahili.

Theoretical Background and Analytical Approach

We use social network analysis to investigate the link between informal power and knowledge building and sharing, and explore how this interaction may have affected the (in)ability of the community in question to move from open access to some form of collective action for resource governance. As outlined, the majority of community members are dependent on the inshore fishery, and poverty levels are high. Therefore, access to fishing gear is critical, but gear ownership is not evenly distributed in the village. That is, whereas a few fishers own their own canoe/boat or fishing gear, far from everyone enjoys this comfort, and the situation creates a "lenders' market," with many fishers and fewer lenders. Consequently, many fishers rely on individuals who own boats and nets from whom they can borrow equipment to be able to engage in fishing. Knight (1992:41) claims that "to exercise power over someone or some group is to affect by some means the alternatives available to that person or group." He goes on to suggest that parties that have many possible alternatives if a specific relationship does not work out will be more powerful than those which have few such alternatives, because they can more credibly threaten to break off bargaining, thus affecting the other's feasible set of alternatives. Given the asymmetrical dependency in the gear-exchange network described here, we treat power as a relational construct and, following Oskarsson et al. (2009:175; following Farell 2004), define it as "the level of cost incurred if one unilaterally withdraws from a relationship." Thus, a low cost of withdrawal implies high power, whereas a high cost implies low power (Cook et al. 1983). Given the lenders' market situation, we apply this definition to our gear-exchange network in the following way. In a dyad, the individual who lends gear to another is seen as having relatively higher power than the receiver of gear because the cost of withdrawal from the arrangement is minimal for the former but can be significant for the latter. In a cumulative fashion, an individual with a high in-degree centrality, i.e., many others turn to them to borrow gear (see e.g., Wasserman and Faust 1994), is thus seen as having relatively higher power in relation to those who lend

Fig. 1. Map of the study area with the target community indicated in the inset of the left-hand corner. The area is located on the southern Kenyan coast at 4º25'S and 39º50'E, approximately 50 km south of Mombasa.

gear from them, and also in relation to those who lend gear to only one other. Individuals who borrow gear from several people could be seen as having multiple sets of alternatives and, thus, they enjoy higher power than their fellow fishers with only one "patron" (Cook et al. 1983). However, we note that the multiple set of ties to owners of gear could also be seen as constraining. We will discuss this particular group of actors further.

A fisher who is considered knowledgeable and is often consulted by others (i.e., high degree centrality in the LEK network), is well-placed to disseminate his views on ecosystem dynamics and the status of the resource to others. He could be said to enjoy a high potential influence. In many fields of investigation, actors who are central and influential in one area have also been shown to enjoy an influential role in another area (c.f. Kingdon 1970, Booth and Babchuck 1972, Saunders et al. 1974, Brett and Kernaleguen 1975). Kadushin (1968:688) contends that influence "concerns the extent to which a person provides some of the framework within which outcomes occur, and it involves communication about values." Individuals who enjoy such influence have been referred to as opinion leaders (see also Marcus and Bauer 1964 and Kopller 1984 for a review of the concept). Here, we conceptualize opinion leaders as those who simultaneously enjoy high centrality in both gear-exchange and knowledge-sharing networks. The reason for this is that: (1) gear owners to some extent define the context within which lenders are constrained, and (2) centrality in a LEK sharing network suggests a higher potential in disseminating ideas to others in the network. An individual who possesses both of these characteristics would arguable be a likely opinion leader. Thus, a first step in our analysis is to test to what degree a general relationship exists between power, measured through high in-degree centrality in the gear network, and perceived knowledge, measured

Table 1. Different types of social networks examined, and the questions used to elicit information about social ties for each network.

Network name	Type of network	Question asked
Knowledge network	Exchange of information and knowledge regarding natural resources	Q1: If you noticed changes in the natural environment (e.g., the number of fish caught, the condition of the mangrove forest or reef, availability of firewood etc.), who would you discuss this with? Q 2:Do you exchange information with anyone which is useful for you to carry out your common occupation? (e.g., information about practices, good fishing spots, equipment, timing and season, etc.)
Gear-dependency network	Dependency network, i.e., who are respondents dependent upon to carry out their occupation (e.g., lease of fishing equipment).	Q 3: Is there any person(s) on whom you depend, or who depend on you, to carry out your (their) occupation? (Y/N) If yes, name persons in table below. (I.e., do you need someone else's boat, gear, nets, etc. to carry out your occupation?)

through a high degree centrality in the knowledge network. We test this by correlating in-degree centrality of all individuals in the gear-exchange network with the degree centrality of the knowledge network, using Pearson's correlation. We use undirected degree centrality for the LEK network because we consider the direction of knowledge flow to be less unidirectional, whereas gear exchange is clearly directed, as we have explained.

Next, we map the gear-exchange network in the village and, based on the revealed pattern of relations, we suggest three distinctive categories of individuals: (1) those who own gear and deploy them with the help of others (referred to as owners), (2) those who depend on one gear owner to fish (referred to as clients), and (3) those who borrow gears from several owners (referred to as multi-source clients). Relating these categories to our discussion of power, we note that owners enjoy high power, whereas clients have low power and multi-source clients can be both empowered or constrained by this arrangement. We test how well the defined categories actually correspond to our network of gear exchange using generalized blockmodeling (see e.g., Doreian et al. 2005) and calculate how many of the owners were in fact fishers themselves. Generalized blockmodeling is based on the idea that actors in a network can be grouped according to some definition of equivalence. Definitions of equivalence are based on the pattern of relations among and within the defined groups. In using generalized blockmodeling, the researcher starts by defining an image matrix where each row and column corresponds to some defined groups, and where each cell represents the relational pattern between these groups, or, for the diagonal cells, the pattern of relations within the groups (see Appendix 1 for more details on blockmodeling as a method). When the image matrix has been defined, the generalized blockmodel will algorithmically rearrange the actors into the different groups in such a way that the number of deviations from the ideal image matrix is minimized (see Doreian et al. 2005 and references therein). The fit of the model is given by the number of deviations remaining once the blockmodeling algorithm has finished.

Using the results from the blockmodeling exercise, we return to the correlation between LEK centrality and in-degree centrality in the gear network. Foreshadowing these results somewhat, we see a strong and significant relationship between in-degree centrality in the gear-exchange network and degree centrality in the LEK network. This suggests that a clear relationship exists between power as defined through gear exchange, and potential influence in the LEK network, although we cannot infer any causality. Therefore, based on the

assumptions outlined above, we ask the following question: If the categories of individuals defined on the basis of gear-exchange patterns do exist, and if those with more capital (owners) are likely to be more influential in transmitting their LEK (i.e., opinion leaders), do owners in fact rank higher than clients in terms of centrality in the knowledge network? To test the validity of this, we identify the top 20 most central individuals in the knowledge network to examine if owners are in fact over-represented in this group. To gain a richer understanding of the relation between power defined by gear exchange and potential influence on LEK, we also examine the proportion of the top 20 individuals who fall into each of the three gear-exchange categories, and calculate the likelihood of getting this distribution given our sample population (n=206). In doing this, we are particularly interested in understanding where in the LEK network the multi-source clients are positioned.

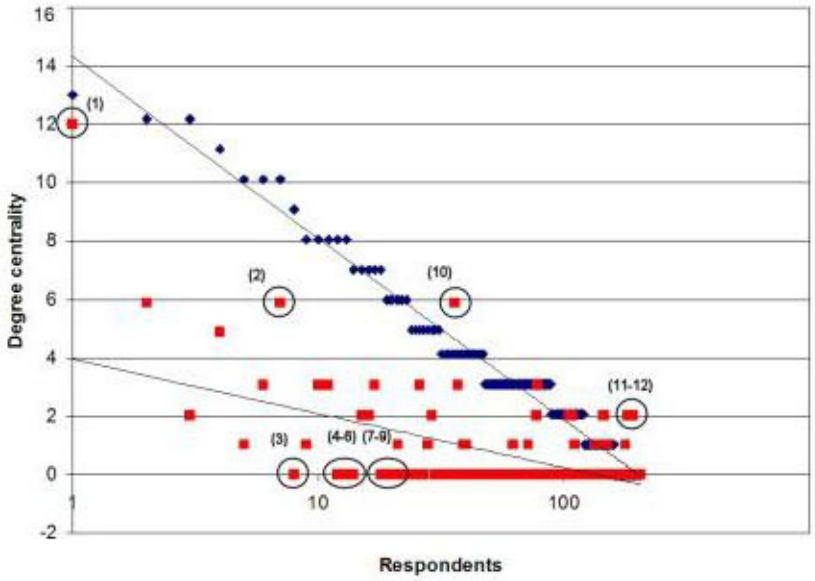
Given that those who possess gear (owners) have invested capital in the current form of resource extraction, it seems plausible that these sunken costs would create a certain amount of resistance to changing resource use and to management practices that would interfere with this gear use. To explore whether this is the case in our community of study, we examine to what degree these individuals expressed views indicating a willingness to change current resource practices. Interviews and participant observation from four years of fieldwork in the area provide the data for this analysis. In these interviews, respondents, all of whom were highly ranked in the gear-exchange network (see also Bodin and Crona 2008), were asked about their perceptions of issues related to the coastal resource in the area. They were also asked if (1) they saw themselves continuing their life in the village in the future and where they wished their children to grow up, and (2) they had any ties to actors engaged in resource management external to the village. The former of these questions was asked to assess to what degree respondents who perceived no problems with the fishery felt this way because of a perceived ability to move out of the area or exit the fishery. The latter was asked to assess the degree to which respondents could promote their views to actors outside of the village.

Our final analysis concerns those individuals who deviate from the relationship tested in the first analytic step, that is, the correlation between gear exchange and LEK centrality. These would be individuals who (1) lend no capital to others but are seemingly influential in promoting their knowledge (i.e., have a low centrality in the gear network but high centrality in the knowledge network), or (2) have capital to lend to others but do not seem to be influential in the knowledge network (i.e., have a high centrality in the gear network but low centrality in the knowledge network). Here, we are particularly interested in the first category, as we believe they could represent potentially important change agents. To identify who they are, we begin by ordering all actors based on their degree centralities in the knowledge network. A curve is fitted to actors' centralities (Fig. 2). Using the same ordering of actors, another curve is then fitted to the actors' in-degree centralities in the gear-dependency network. If the knowledge and gear centralities were perfectly correlated, the two curves would be shaped identically. Furthermore, assuming such a correlation exists between the two different types of centralities, any actors significantly deviating from this general pattern are defined as outliers. We identified these outliers by qualitatively examining data points that deviated from the general trend captured by the fitted curves in Fig. 2. We then examined these more closely by exploring demographic data and data from previous interviews and participant observation.

RESULTS

Results from the generalized blockmodel show fairly good support for the three categories of individuals we identified, based on patterns of gear exchange. The generalized blockmodeling approach does not provide any objective significance measures; thus, it is up to the researcher to evaluate whether the model fit is good enough or not. Here, the blockmodeling optimization could not do better than 25 deviations in total, where 24 were among the owners. In other words, virtually all clients and multi-source clients were correctly classified by the model, whereas 24 of the 33 identified owners deviated to some extent from the pre-specified category. However, these deviations were a result of owners lending gear to other owners and, as such, this does not affect the supposed power assumption related to gear ownership upon which our analysis rests. Therefore, we judge that the modeling results support our postulated categories, although we acknowledge that many fishermen classified as owners often lend gear to other owners. Thus, the

Fig. 2. Correlation between individual in-degree centrality in the gear network and degree centrality in the knowledge network.



Note: Respondents have been sorted according to their centrality in the LEK network and the x-axis is logarithmically scaled. Blue diamonds represent centrality scores in the knowledge network. Red squares represent centrality scores in the gear exchange network. Black lines indicate the logarithmic curves fitted to each individual data set (polynomial fit). Deviations from this pattern have been qualitatively identified and are indicated with circles in the graph. Numbers in brackets correspond to the numbers in the column "Deviations" in Table 3.

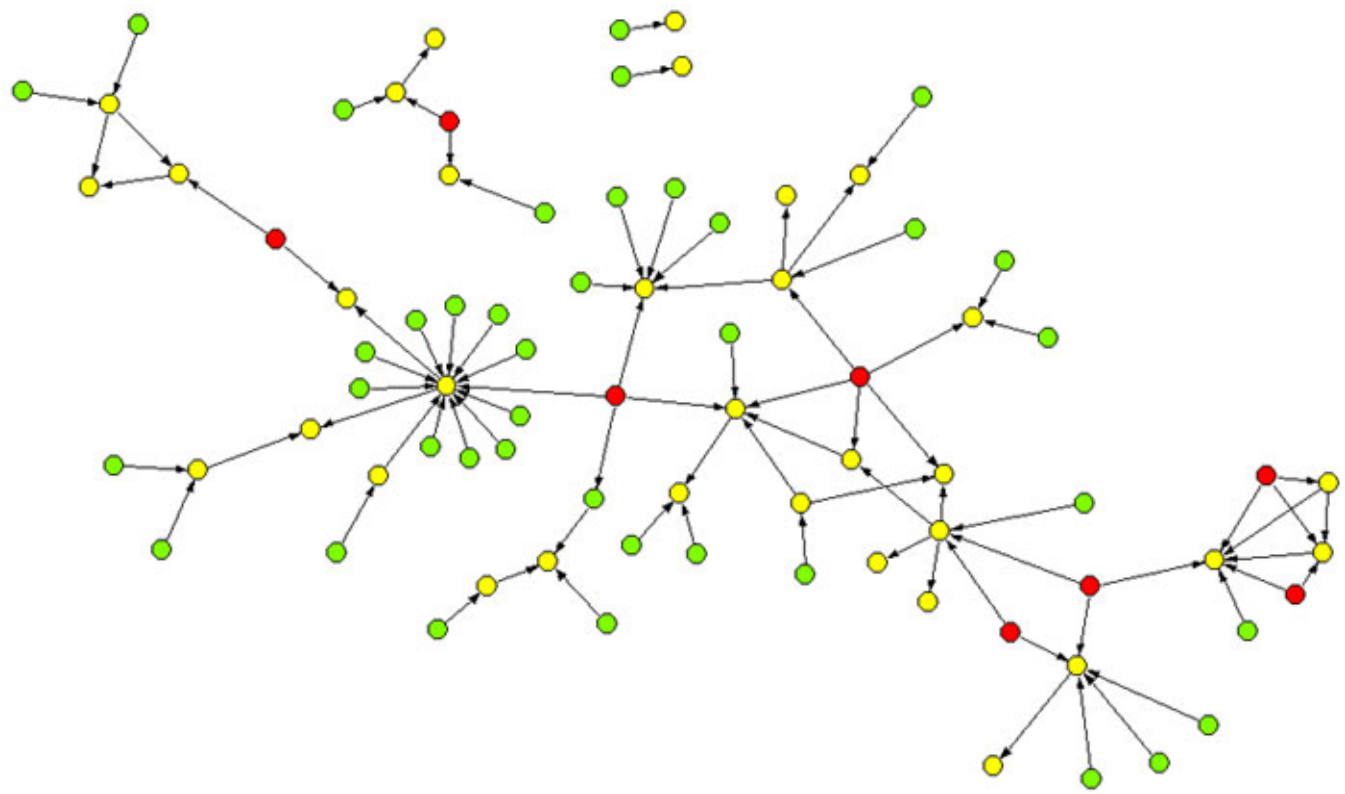
owner category seems less strict than the other two categories, based on boat and gear owners often collaborating to engage in fishing operations.

When presenting the gear-exchange network graphically, we clearly see a pattern where owners are surrounded by clients and multi-source clients (and in some cases also by other owners), whereas clients are only linked to one owner (Fig. 3). It is interesting to note that 88% of owners are in fact fishers of various types, and of the remaining 12%, two are local businessmen, one is a fish trader, and one has listed no specific occupation. Of fishing owners, 45% are deep-sea fishers and 18% are seine netters.

We also find support for our proposition that powerful individuals are also frequently asked for advice in understanding natural-resource dynamics. This is seen in the high degree of correlation (0.5684, <0,001) between individual in-degree centrality in the gear network and high degree centrality in the knowledge network (Fig. 2).

Our hypothesis about opinion leaders suggests that owners should rank high in the knowledge network, whereas clients should have a low rank. This means that owners should be well represented in the 20 most central individuals in the knowledge network. In examining these 20 individuals, we find that 13 are owners, three are multi-source clients, and two are clients. Testing the likelihood of obtaining these distributions given the distribution of fisher categories in the total population, we see that owners and multi-source clients are significantly over-represented among the most highly ranked individuals in the knowledge network, whereas isolates are highly under-represented (Table 2).

Fig. 3. Network of gear exchange among villagers.



Note: Categories based on gear lending ability are indicated by colour. Yellow nodes represent owners, green nodes represent clients, and red nodes represent multi-source clients.

Using interview data, we look more closely at the owners represented among these topmost 20 individuals (Table 3). Of these, a majority are deep-sea fishers, fishing from larger vessels, most often using larger purse seine nets and primarily targeting pelagic stocks that are less vulnerable to over fishing at a local scale. Another three use the currently illegal seine net as their primary gear, and two derive their primary income from either fish trade or other miscellaneous business. Through the interviews conducted with eight of the 13 owners appearing among the top 20 individuals in the knowledge network, we found that none of them perceived local fisheries to be seriously threatened. In fact, on the contrary, some believed future changes in the fishery would more likely be associated with the development of new gear and fishing technology. Only two interviewed owners expressed any concern about diminishing local fish stocks, and they attributed this concern to the continued use of destructive and illegal fishing gear. Furthermore, none of the interviewed owners expressed any desire or plan to relocate as a result of declining resources. Finally, six of eight interviewed owners had ties to external actors involved in resource management.

Our last analytic step involved ordering actors according to their degree centrality in the knowledge network. The resulting patterns of data points (degree and in-degree centralities) are fairly well described by logarithmic curves (Fig. 2). However, when examining these two curves more closely, we find a number of individuals who clearly

Table 2. Cumulative probability distribution of respondent categories represented among the top 20 individuals, as ranked by degree centrality in the knowledge network.

Category	# among top 20 individuals	Total # of individuals	Cumulative probability distribution†
Owner	13	33	≥ (<0,00000)
Multi-source client	3	8	≥ (<0,032)
Client	2	39	≤ (0,23)
Isolates	2	126	≤ (0,00000)

†The probability estimate is arrived at by comparing the actual number of actors belonging to a specific category (among the top 20) with the cumulative distribution of actors of that category (that is, the distribution which would be expected if the top 20 actors had been drawn randomly from the entire population).

deviate from the overall pattern. These are listed in Table 4. Among these, we find two individuals who stand out because of their exceptional capacity to lend gear to others (top two rows). Among the persons who provide no capital to others but are considered knowledgeable, we also find two clients, both deep-sea fishers, and the village chairman, who is an isolate in the gear-exchange network. We also find three multi-source clients who lend no capital to others but have high centrality in the knowledge network. These individuals are responsible for some of the deviations from a perfect correlation between high centrality in the knowledge network and high in-degree centrality in the gear-exchange network. In the last four rows of the table, we find individuals who lend capital to others but do not seem to be influential in the local ecological-knowledge network.

DISCUSSION

Our results show that in the focus community, there are several categories of individuals based on their gear-exchange relations, and the large majority of individuals lending capital in the form of gear to others are actually fishers themselves. This is interesting for a number of reasons. First, it provides evidence of the asymmetrical distribution of capital noted even in small rural fishing communities (Béné 2003, Béné et al. 2003). Second, work in rural economics has shown patron–client type relationships to be a common feature in many rural societies (Russel 1987, Finan and Nelson 2009), particularly fishing communities (Platteau and Abraham 1987, Amarasinghe 1989, Nguinguiri 2000). However, in this literature, patrons are often described as individuals outside the fishing profession lending capital to fishers. Here, we show that a large extent of the gear exchange actually occurs among members of the fishing profession. It should be noted in this context that, in this study, many individuals categorized as owners are in fact captains, and clients are often crew members in larger fishing units. This further strengthens the argument of power as a result of high in-degree in the gear-exchange network, because not only do owners provide equipment, in some cases they even function as employers. The individuals categorized here as multi-source clients appear not to be formally linked to any fishing unit and, as such, we view them as “freelancing” fishers. In this respect, we should point out that some of the clients might also be best described as freelancers, in that they merely provide manual labor to larger fishing units. However, the multi-source clients stand out because

Table 3. List of individuals most highly ranked in the knowledge network.

Rank	Fisher category	Occupation
1	owner	deep-sea fisher
2	owner†	deep-sea fisher (retired)
3	owner†	deep sea fisher
4	owner†	beach seine fisher
5	owner	deep-sea fisher
6	owner †	middleman/fish trader
7	owner †	beach seine fisher
8	isolate†	village chairman
9	owner	deep-sea fisher
10	owner	deep-sea fisher
11	owner†	deep-sea fisher
12	client	deep-sea fisher
13	client	deep-sea fisher
14	multi-source client	gill-net fisher
15	owner	deep-sea fisher
16	owner†	local businessman/woman
17	owner	beach seine fisher
18	multi-source client	deep-sea fisher/research staff
19	multi-source client†	fisherman/ miscellaneous other occupations
20	isolate	gill-net fisher

†In-depth interview conducted.

all of them report borrowing gear from several others and, therefore, they are likely to find themselves less bound to a specific owner.

Data presented here show that people who are central in the gear-exchange network are, to a high degree, also considered knowledgeable, as shown through their centrality in the knowledge network. This demonstrates that, in this community, where the capital needed to exploit natural resources is unevenly distributed, individuals who possess such capital also enjoy an advantaged position in terms of their ability to disseminate their ecological knowledge and further their views and perceptions of the status of the natural resource. Hence, our results conform to, and support, the previously discussed literature arguing that individuals with influence in one area also tend to be influential in

Table 4. List of individuals who deviate from the correlation between knowledge and gear exchange centralities.

Deviation ID†	Gear links (+/-)‡	Gear lending category§	Occupation/type of fisher¶
1	+	owner	deep-sea fisherman
2	+	owner	beach seine fisherman
3	-	isolate	village chairman
4	-	client	deep-sea fisherman
5	-	client	deep-sea fisherman
6	-	multi-source client	fisherman and research staff
7	-	multi-source client	fisherman and research staff
8	-	multi-source client	fisherman and miscellaneous other occupations
9	-	isolate	gill-net fisherman
10	+	owner	deep-sea fisherman
11	+	owner	speargun fisherman
12	+	owner	deep-sea fisherman

† Deviation ID corresponds to the numbers in brackets in Fig. 1.

‡ Indicates whether an individual has more or less gear-exchange links than would be expected based on their position in the knowledge network.

§ Indicates which of the three categories tested in the block model each individual belongs to.

¶ Describes the occupation of each person. For fishers this refers to their primary gear type.

transmitting opinions in other areas (Marcus and Bauer 1964). Furthermore, we argue that such "opinion leaders," defined here as being centrality positioned both in the knowledge and gear-exchange networks, can play a particularly important role in community-level natural-resource governance in general, and in instigating communities to collectively transform the way they use their natural resources in particular. In attempting to understand these potential effects on resource governance, several issues of interest emerge.

First, given their high knowledge status, as revealed through their centrality in the knowledge network, opinion leaders are highly likely to engage in conversations about issues, such as movement and seasonal fluctuations of fish (Crona 2006), as well as to engage in conversations about fisheries management. Hence, it seems plausible to assume that their opinions will have a disproportionately large impact in shaping the opinions of others in the community. In addition, in our case, most of these highly influential opinion leaders had a number of communications links to fisheries officials, forestry officials, and members of other administrative

government units and relevant NGOs external to the community (see also Bodin and Crona 2008). This suggests that views expressed by these opinion leaders reach beyond the community borders to government agencies and NGOs involved in resource-management issues in the region, thus potentially amplifying their impact in shaping others' perceptions about the state of the environment. Therefore, their role in building consensus in communities appears to be instrumental and, accordingly, they are likely to have a high impact on communities' ability to self-organize and initiate collective action (c.f. Ostrom 2005). Of particular relevance in this matter is that they could also pose a significant barrier for change in communities such the one studied here that need to fundamentally transform resource management to achieve sustainability and handle various potential environmental challenges in the future.

Having shown that the identified opinion leaders are potentially highly influential in shaping ecological knowledge, and collective action within and beyond communities, we will now discuss different factors that shape their opinions about the state of the environment. First, as shown by our analysis, many of the opinion leaders listed in Table 3 belong to either the category of deep-sea fishers or seine netters. Deep-sea fishers are less dependent on, and to some degree also less aware of, the immediate ecological status of the nearby reefs and lagoon, as they themselves report (Crona 2006), and seine netters use, as their primary mode of extraction, gear that has been banned because of its destructive nature. Thus, by virtue of their gear choice, these fishers are unlikely to contribute to better/broader ecological knowledge about local reefs and lagoons, despite their favorable positions. Given the high representation of beach seiners among them, they are also unlikely to be the ones instigating collective action to reduce destructive methods (for further discussion of this topic, see Crona and Bodin 2006). Moreover, the fact that most opinion leaders identified here are fishers themselves could exert a cognitive bias. That is, their strong dependence on the fishery could make them less inclined to respond to environmental signals indicating over harvesting, as they may view that few other feasible livelihood alternatives are available.

Second, we hypothesized that those who possess significant amounts of gear, that is, enough that they are able to lend it to others, have invested capital in the current form of resource extraction, and that such sunken costs can create a certain amount of resistance to changing resource use and management practices that would interfere with this gear use. In fact, studies have shown that the greater the amount of capital that is tied up in fishing assets, the more that mobility out of fishing is reduced (Smith and McKelvey 1996). Furthermore, Bailey (1982) and Allison and Ellis (2001) have reported that full owners of fishing assets are less willing to accept occupational and geographic changes than part owners or nonowning crewmen. Our analysis shows that many of the potential opinion leaders in fact do not perceive local fisheries to be in a state warranting concern, in contrast to other reports showing that, albeit displaying fluctuations over time, in-shore fisheries in the area are experiencing a decline and showing signs of overexploitation (McClanahan and Mangi 2001, Ochiewo 2004, Maina et al. 2008). We cannot conclusively demonstrate the reason behind these perceptions, but draw attention to the fact that humans often ignore evidence that contradicts their beliefs, or tend to avoid challenging their own mental models. This has been referred to as "belief persistence" (Lord et al. 1979). Taken together, this would suggest that owners should be more reluctant than others to challenge their views of the fish resource and the effect of their gear on it. Ostrom (2005) argues that actors who are dependent on a resource will have a higher motivation to act in favor of its maintenance, and are said to have a higher salience. Relating this to our findings, it appears that the salience of potential opinion leaders is relatively low. A question that remains is whether this low salience and potential resistance to changing opinions, combined with the influential positions of these opinion leaders in the knowledge network, has hindered other fishers from perceiving the current situation of declining catches as a result of current fisheries. We do not have enough empirical support to provide a firm answer to this question; however, our results indicate that this potential intellectual inertia among opinion leaders could have contributed to the current lack of initiatives in transforming current resource use and practices.

Combating Governance Inertia in the Face of Environmental Challenges

Here, we have focused on possible factors explaining observed governance inertia in the face of ongoing environmental degradation. Many of these suggested factors link to structures of the

knowledge- and gear-exchange networks. Although we wish to make very clear that there are many other factors potentially contributing to this observed inertia, here we will elaborate on ways in which such inertia might be broken to help communities transform the way they are using natural resources, without necessarily attempting to immediately change the often rigid owner/client structures. If, as outlined above, we assume that being an owner could hamper one's ability to internalize new ecological conditions that challenges current perceptions, a plausible way forward is to identify other, presumably less bounded but still knowledgeable, individuals who could counterbalance the rigidity of the opinion leaders.

In examining the correlation between knowledge and gear-network centralities, we found a small number of individuals who deviate from this pattern (Table 4). Among these are two individuals (top two rows) who lend gear to more fishers than any others in the village. These two individuals are two of the opinion leaders we discussed. Next, we turn to an examination of the individuals who provide no gear to others but are considered knowledgeable (i.e., high LEK rank). Among these, we find four of particular interest. The first is the village chairman. He reportedly does not exchange gear with anyone in the village, but on account of his position, is someone to whom many community members turn for advice. The remaining three belong to the multi-source client fisher category, or are freelancing fishers. We believe that they are particularly noteworthy for several reasons. First of all, their LEK network centralities indicate that many of them are considered knowledgeable among community members and, therefore, they are likely to be influential in shaping others' beliefs and opinions about the state of the environment. We believe the characteristics of freelancing fishers, as they have been described here, could be potentially important for transformability of fisheries governance at the community level. On the one hand, they are considered knowledgeable. Their "unfaithful" gear-borrowing behavior indicates that they may be less tightly bound to one owner or patron (e.g., Amarasinghe 1989) and, at the same time, the fact that they have no significant capital invested in gear suggests they may also be less likely to be bound by the sunken costs of such investments and more inclined to change or try new extractive practices. Therefore, we put forth the tentative conclusion that these types of individuals may be the most well placed to initiate change. In communities that, like this one, appear to be experiencing inertia with respect to collective action for improved resource governance, efforts geared at initiating change in governance strategies could therefore benefit from identifying these types of actors. Assuming that our proposition about owners' unwillingness to change management practices as a result of invested capital is valid, interventions that also facilitate and compel owners to reallocate their capital currently invested in fishing gear could further reduce the barrier to change. However, we fully acknowledge the political, economic, and practical difficulties associated with such relocation of capital, as well as the uncertainties and unforeseen effects on livelihood opportunities that could result (Allison and Ellis 2001).

Finally, we would like to emphasis that although our current study is limited to a rural village in Kenya, we believe our results, although being largely indicative, are potentially applicable in a larger context. Small fishing communities largely dependent on direct resource extraction are a common feature of many developing countries, and we believe the relationship between informal power structures and local knowledge could well be a feature in other similar settings where fishing villages face various environmental challenges.

Responses to this article can be read online at:
http://www.ecologyandsociety.org/vol15/iss4/art32/responses/

Acknowledgments:

This work was funded in part by SIDA (Swedish International Development and Aid), and Formas Research Council in Sweden. We would like to thank all respondents for participating in this study, as well as Abdul Rashid for his assistance in the field. Gratitude is also extended to Kenya Marine and Fisheries Research Institute, to which one of the authors (B. Crona) was affiliated at the time of data collection. Furthermore, the efforts of two anonymous reviewers greatly improved the manuscript.

LITERATURE CITED

Agrawal, A. 1997. *Community in conservation: beyond enchantment and disenchantment.* Conservation and Development Forum, Gainsville, Florida, USA.

Allison, E., and F. Ellis. 2001. The livelihoods approach and management of small-scale fisheries. *Marine Policy* **25**:377–388.

Amarasinghe, O. 1989. Technical change, transforbation of risks and patronage relations in a fishing community of South Sri Lanka. *Development and Change* **20**(4):701–733.

Bailey, C. 1982. *Small-scale fisheries of San Miguel Bay, Philippines: occupational and geographic mobility.* Institute of Fisheries Development and Research, College of Fisheries, University of the Philippines in the Visayas; International Center for Living Aquatic Resources Management, Manila, Philippines; and the United Nations University, Tokyo, Japan.

Béné, C. 2003. When fishery rhymes with poverty: a first step beyond the old paradigm on poverty in small-scale fisheries. *World Development* **31** (6):949–975.

Béné, C., A. Neiland, T. Jolley, S. Ovie, O. Sule, B. Ladu, K. Mindjimba, E. Belal, F. Tiotsop, M. Baba, L. Dara, A. Zakara, and J. Quensiere. 2003. Inland fisheries, poverty, and rural livelihoods in the Lake Chad basin. *Journal of Asian and African Studies* **38**(1):17–51.

Bodin, Ö., and B. I. Crona. 2008. Management of natural resources at the community level: exploring the role of social capital and leadership in a rural fishing community. *World Development* **36** (12):2763–2779.

Bodin, Ö., and B. I. Crona. 2009. The role of social networks in natural resource governance: what relational patterns make a difference? *Global Environmental Change* **19**:366–374.

Booth, A., and N. Babchuck. 1972. Informal medical opinion leadership among the middle aged and elderly. *The Public Opinion Quarterly* **36**:87–94.

Brett, J. E., and A. Kernaleguen. 1975. Perceptual and personality variables related to opinion leadership in fashion. *Perceptional and Motor Skills* **40**:775–779.

Cinner, J. E., A. Wamukota, H. Randriamahazo, and A. Rabearisoa. 2009. Towards institutions for community-based management of inshore marine resources in the western Indian Ocean. *Marine Policy* **33**:489–496.

Cook, K. S., R. M. Emerson, and M. R. Gillmore. 1983. The distribution of power in exchange networks: theory and experimental results. *American Journal of Sociology* **89**(2):275–305.

Crona, B. I. 2006. Supporting and enhancing development of heterogeneous ecological knowledge among resource users in a Kenyan seascape. *Ecology and Society* **11**(1): 32. [online] URL: http://www.ecologyandsociety.org/vol11/iss1/art32/.

Crona, B. I., and Ö. Bodin. 2006. What you know is who you know? Patterns of communication as prerequisites for co-management. *Ecology and Society* **11**(2): 7. [online] URL: http://www.ecologyandsociety.org/vol11/iss2/art7/.

Crona, B., M. Nyström, C. Folke, and N. Jiddawi. 2010. Middlemen, a critical social–ecological link in coastal communities of Kenya and Zanzibar. *Marine Policy* **34**(4):761–771.

Degenne, A., and M. Forsé. 1999. *Introducing social networks.* Sage, London, UK.

Doreian, P., V. Batagelj, and A. Ferligoj. 2005. Positional analyses of sociometric Data. Pages 77–97 *in* P. J. Carrington, J. Scott, and S. Wasserman, editors. *Models and methods in social network analysis.* Cambridge University Press, New York, New York, USA.

Ernstson, H., Sörlin, S., Elmqvist, T. 2008. Social movements and ecosystem services—the role of social network structure in protecting and managing urban green areas in Stockholm. *Ecology and Society* **13**(2): 39. [online] URL: http://www.ecologyandsociety.org/vol13/iss2/art39/.

Farell, H. 2004. Trust, distrust and power. In R. Hardin, editor. *Distrust.* Russel Sage Foundation, New York, New York, USA.

Finan, T. J., and D. R. Nelson. 2009. Decentralized planning and climate adaptation: toward transparent

governance. Pages 335–349 in W. N. Adger, I. Lorenzoni, and K. O'Brian, editors. *Adapting to climate change: thresholds, values, governance.* Cambridge University Press, Cambridge, UK.

Focault, M. 1980. *Power/knowledge.* Pantheon, New York, New York, USA.

Government of Kenya. 2005. *Beach management regulations.* Kenya Fisheries Department, Nairobi, Kenya.

Hornborg, A. 2009. Zero-sum world: challenges in conceptualizing environmental load displacement and ecologically unequal exchange in the world-system. *International Journal of Comparative Sociology* **50**(3–4):237–262.

Inkpen, A. C., and P. W. Beamish. 1997. Knowledge, bargaining power, and the instability of international joint ventures. *Academy of Management Review* **22**:177–202.

Kadushin, C. 1968. Power, influence and social circles: a new methodology for studying opinion makers. *American Sociological Review* **33**(5):685–699.

Kingdon, J. W. 1970. Opinion leaders in the electorate. *The Public Opinion Quarterly* **34** (2):256–261.

Knight, J. 1992. Institutions and social conflict. Cambridge University Press, Cambridge, Massachusetts, USA.

Kopller, K. 1984. *Opinion leaders.* Heinrich Bauer Verlag, Hamburg, Germany.

Lord, C. G., L. Ross, and M. R. Lepper. 1979. Biased assimilation and attitude polarization: the effects of prior theories on subsequently considered evidence. *Journal of Personality Social Psychology* **37**:2098–2109.

Maina, G. W., D. Obura, H. Alidina, and B. Munywoki. 2008. Increasing catch in an over-exploited fishery: Diani-Chale, Kenya, from 1998 to 2006. Pages 309–320 *in* D. Obura, J. Tamelander, and O. Linden, editors. *Ten years after bleaching—facing the consequences of climate change in the Indian Ocean.* Coastal Oceans Research and Development in the Indian Ocean (CORDIO) status report. CORDIO/Sida-SAREC, Mombasa, Kenya.

Marcus, A. S., and R. A. Bauer. 1964. Yes: there are generalized opinion leaders. *The Public Opinion Quarterly* **28**(4):628–632.

Marsden, P. V. 1990. Network data and measurement. *Annual Review of Sociology* **16**:435–463.

McClanahan, T., and S. C. Mangi. 2001. The effect of a closed area and beach seine exclusion on coral reef fish catches. *Fisheries Management and Ecology* **8**:107–121.

Moller, H., F. Berkes, P. O'Brian Lyver, and M. Kislalioglu. 2004. Combining science and traditional ecological knowledge: monitoring populations for co-management. *Ecology and Society* **9**(3): 2. online [URL]: http://www.ecologyandsociety.org/vol9/iss3/art2/.

Nadasdy, P. 1999. The politics of TEK: power and the 'integration' of knowledge. *Arctic Anthropology* **36**(1–2):1–18.

Nguinguiri, J. C. 2000. La pêche des migrants: un modèle de criossance pour la pêche locale? A propos du dualisme des théories du développement. Pages 281–297*in* J.-P. Chauveau, E. Jul-Larsen, and C. Chaboud, editors. *Les pêches piroguières en Afrique de L'Ouest: pouvoirs, mobilités, marchés.* Karthala, Paris, France.

Ochiewo, J. 2004. Changing fisheries practices and their social implications in south coast Kenya. *Ocean and Coastal Management* **47**:389–408.

Olsson, P., C. Folke, and F. Berkes. 2004. Adaptive comanagement for building resilience in social–ecological systems. *Environmental Management* **34**(1):75–90.

Oluoch, S. J., and D. Obura. 2008. Assessment of fisherfolk organizations and beach management units (BMU) in the management of fishery resources in Diani-Chale, Southern Kenya. Pages 335–344 *in* D. Obura, J. Tamelander, and O. Linden, editors. *Ten years after bleaching—facing the consequences of climate change in the Indian Ocean*. CORDIO Status Report, Coastal Oceans

Research and Development in the Indian Ocean/ Sida-SAREC, Mombasa, Kenya.

Oskarsson, S., T. Svensson, and P. Oberg. 2009. Power, trust, and institutional constraints: individual level evidence. *Rationality and Society* **21**(2):171–195.

Ostrom, E. 2005. *Understanding institutional diversity.* Princeton University Press, Bloomington, Indiana, USA.

Platteau, J.-P., and A. Abraham. 1987. An inquiry into quasi-credit contracts: the role of reciprocal credit and interlinked deals in small-scale fishing communities. *Journal of Development Studies* **23** (4):461–490.

Robbins, P. 2006. The politics of barstool biology: environmental knowledge and power in greater northern Yellowstone. *Geoforum* **37**:185–199.

Russel, D. N. 1987. Middlemen and moneylending: relations of exchange in a highland Philippine economy. *Journal of Anthropological Research* **43** (2):139–161.

Saunders, J., M. J. Davis, and D. M. Monsees. 1974. Opinion leadership in family planning. *Journal of Health and Social Behavior* **15**:217–227.

Smith, C., and R. McKelvey. 1996. Specialist and generalist: roles for coping with variability. *North American Journal of Fisheries Management* **6**:88–99.

Wasserman, S., and K. Faust. 1994. *Social network analysis—methods and applications.* Cambride University Press, Cambridge, UK.

APPENDIX: Description of blockmodeling

As outlined under theoretical background and analysis, our assumptions about the different categories were that; each client borrows gear from one owner, multi-source clients borrow gear from more than one owner; and no other borrowing or lending links exist between or within categories. These assumptions are represented in the image matrix in Table 1. The cell representing outgoing links from owners to clients (row=2 column=1) should only contain one link per row (i.e. each client lend from one, and only one, owner). This is referred to as “row-functional”. Multi-source clients lend from more than one owner, therefore each row in cell (row=3, column=1) should contain more than one link. No other links between or among groups are allowed (thus all other cells are 0). The software Pajek (ref) was used to carry out the generalized blockmodeling does not, however, have support for this last type of relationship. Hence, we used the similar type “row-regular” where the number of links per row should be at least one, and then we manually moved any actors that showed up in this category only having one link to the client group.

Table A1.1: Image matrix for the defined three groups owners, clients and multi-source clients. Penalties to deviations are presented in parenthesis.

	Owner	Client	Multi-source client
Owner	0 (1)	0 (2)	0 (2)
Client	one 1 for each row (2)	0 (2)	0 (2)
Multi-source client	> 1 for each row (2)	0 (1)	0 (2)

Using the Pajek software, it is possible to specify if some deviations are to be considered as more sever than others. We assigned more penalties to deviations (see Table 1) when (i) clients and multi-source clients connect among themselves, (ii) a client has more/less than one owner, (iii) if clients and multi-source clients lend gear to an owner, and (iv) if a multi-source client lends gear to a client. Conversely, less penalty (1) is awarded (i) if an owner connect to another owner, or (ii) if a multi-source client borrows gear from a client. The rational behind this differentiated penalty system is that the deviations we assigned less penalty does not fundamentally challenge the key assumptions used to define the different groups, i.e. to differentiate between whether an actor depends on one (or several other) actors to get access fishing gears or not.