Analysis

When does it pay to cooperate? Strategic information exchange in the harvest of common-pool fishery resources

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\textbf{ABSTRACT}

Harvesting common-pool fishery resources is often a competitive activity and important questions remain about the costs and benefits of engaging in cooperative behavior. Here, we link comprehensive data on fisher’s information exchange networks and economic productivity to test hypotheses about when it pays to cooperate by exchanging different types of strategic information. We find that being well connected locally in information exchange networks about both short-term topics (e.g., the location of species) and long-term topics (e.g., technical innovations) is positively associated with productivity in both the short-term (within fishing trips) and long-term (annually). In contrast, we find that exchanging both types of information across distinct social divides – a form of brokerage – is negatively associated with productivity. Our results therefore suggest that while there appears to be an economic benefit associated with cooperation across temporal scales in the harvest of common-pool fishery resources, exchanging strategic information across social divides may come at a cost – particularly under conditions of competition. We discuss our results in light of emerging research at the nexus of sociology and economics, providing key insight into the social-structural dynamics that help form the foundation for fisher decision-making and behavior.

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1. Introduction

There is a large body of theoretical and empirical research that seeks to understand the conditions that facilitate cooperation in the harvest of common-pool resources. Classic economic theory would predict that individuals, acting as rational self-interested actors, would likely choose to defect from attempts at cooperative arrangements due to the nonexcludable and rivalrous nature of common-pool resources (Gordon, 1954; Hardin, 1968; Scott, 1955). Yet many argue this conceptualization is too simplistic, and under certain conditions common-pool resource users may choose to cooperate (Gintis, 2000; Ostrom, 1990); for example, when groups are small and coercion is possible (Olson, 1965), or when cooperation is reinforced by norms, ethical codes, and institutions (Ostrom, 2000).

Information exchange among marine fishers has long been a key focus of investigations into cooperation in common-pool resource settings (Evans and Weninger, 2014; Gatewood, 1984; Haynie et al., 2009; Pollnac and Carmo, 1980; Wilson, 1990). Fishers operate in a dynamic and complex ecological environment, often covering vast spatial scales across the open ocean where spatiotemporal dynamics can change in unpredictable ways (Wilson, 1990). Decision-making in this context can be further complicated by a complex array of sociopolitical and economic processes. For example, in the U.S. pelagic fishers operate under the jurisdiction of the U.S. Magnuson-Stevens Act (NOAA, 2006), are subject to both U.S. environmental legislation and binding international conservation measures, and are governed by international fishery management organizations, regional fishery management councils, and the U.S. National Marine Fisheries Service. Adding a further layer of complexity, all commercial fishers are faced with fluctuating fish prices, market competition, and the dynamics of supply and demand in deciding when and where to land their catch (Béné, 1996; Salas and Gaertner, 2004). Marine fisheries are thus characterized by repetitive and competitive interactions among individual fishers who must determine the most strategic use of inputs over time and space to transform wild stocks of fish into catch. Fishers need to make these

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critical decisions while accommodating their activities to complex and uncertain market dynamics, socio-political processes, and the spatio-temporal fluctuations of the open ocean.

To cope with this complexity, fishers may choose to cooperate by exchanging information with others to improve their decision-making (Salas and Gaertner, 2004). Engaging in information exchanges can potentially reduce time and effort spent searching for fish aggregations (Branch et al., 2006; Gatewood, 1984), and facilitate the diffusion of technological innovations capable of enhancing vessel efficiency (Gezelius, 2007). However, decisions to engage in information exchange may be tempered by the competitive nature of fishing (Acheson, 1975; Gezelius, 2007; Wilson, 1990). Indeed, the rational actor model suggests that fishers acting in their own self-interest are unlikely to cooperate by participating in information exchanges because such exchanges can increase the efficiency of others (Gordon, 1954; Hardin, 1968; Scott, 1955). Yet existing empirical work in marine fisheries suggests that information transfer among fishers is widespread, though it does vary depending on the size, structure, and diversity of fishing communities, the biology of the fish involved, and the type and value of the information exchanged (Barnes-Mauffe et al., 2013; Branch et al., 2006; Gezelius, 2007; Wilson, 1990).

One of the most common arguments put forth is that fishers are more likely to cooperate by exchanging information with others when it is economically beneficial for them to do so (Haynie et al., 2009). Yet existing research that seeks to quantify the relationship between information exchange and economic gains in marine fisheries largely rely on simulations and other models that lack explicit data on patterns of information exchange in fishing communities (Dreyfus-Leon and Gaertner, 2006; Haynie et al., 2009; Milischer et al., 2006). When it actually pays for fishers to engage in cooperative information exchange behavior therefore remains an important empirical question. To this end, we employ comprehensive data on networks of information exchange, catch and effort, and economic cost-earnings among pelagic tuna fishers to contribute a better understanding of when it pays to cooperate in the harvest of common-pool fishery resources.

In line with the literature on the structural aspects of social capital (Borgatti et al., 2009; Burt, 2000; Lin, 1999), our empirical approach rests on the assumption that fishers’ structural position in networks of fishery-related information exchange can affect their ability to access information that can improve their decision-making. The ability to access information flowing through networks of information exchange can be exceptionally critical when dealing with aggregated and highly migratory species such as schools of tuna (Salas and Gaertner, 2004). In this case, there are two types of information that can potentially influence fisher’s productivity: (1) short-term information, such as information on the location of species that can influence fisher productivity within fishing trips, and (2) long-term information, such as information on technical innovations that can influence fisher productivity over a longer period of time (Barnes et al., 2016b; Gezelius, 2007; Mueller et al., 2008; Wilson, 1990).

To our knowledge there are no existing empirical studies examining the relationship between long-term information exchange and fisher economic outcomes, though existing research does provide insight into what we might expect regarding short-term information exchange. Specifically, fishers who work with others rather than alone and are prominently located within short-term information exchange networks (i.e., “network prominence”, see Fig. 1) have been found to be more successful, particularly when targeting highly mobile species (Barnes et al., 2016b; Dreyfus-Leon and Gaertner, 2006; Mueller et al., 2008). Network prominence refers to how central or well-connected locally one is in a social network, which tends to be associated with increased access to information and resources (Borgatti et al., 1998; Freeman, 1979) and has been positively linked to economic productivity (Abbasi et al., 2011; Greve et al., 2010). By their very nature, information exchange networks comprise information channels that can reduce the amount of time and investment needed to gather and process information (Molina-Morales and Martínez-Fernández, 2009). They can also enable learning through close contact and intensive interaction, which can foster innovation (Conley and Udry, 2010; Rogers Everett, 1995). Well-connected, centrally located individuals in such networks thus tend to have increased opportunities to capitalize on these benefits while pursuing their goals. Building on this existing theoretical and empirical foundation, here we propose and test the following hypothesis:

**H1.** Being well connected locally (i.e., network prominence) in both short-term and long-term information exchange networks will be positively associated with productivity in both the short-run (within fishing trips) and long-run (annually).

Though we expect that in general, the ability to access both types of information can provide advantages that enable fishers to be more productive, there are important differences between the exchange of short-term and long-term information that require consideration. Most notably, short-term information can almost immediately, and visibly, increase fishing success, whereas the effects of long-term information are much less immediate and tangibly visible. For example, information on the location of high-value species can reduce search effort and increase high-value catch, thereby decreasing costs while increasing revenues. The time-scale at which this occurs is almost immediate, i.e., productivity is increased within fishing trips. Perhaps more importantly, fishers are highly aware of this (Gezelius, 2007), particularly when all vessels unload their catch at a central location. Short-term information in marine fisheries is therefore known to be highly guarded, often only exchanged within small groups of trusted individuals (Gezelius, 2007; Wilson, 1990). This reflects the competitive nature of fishing and the highly visible effects of short-term information on fisher productivity, which calls into question how fishers that bridge divides between groups in the structure of short-term information exchange networks may fare.

Crossing social divides can be considered a form of bridging or brokerage (see Fig. 1), which has strong support in the literature for producing competitive advantages that lead to economic gains (e.g., Abbasi et al., 2011; Burt, 1992, 2005; Tsai and Ghoshal, 1998). This is primarily because groups that are largely disconnected in social structures often possess heterogeneous knowledge and resources – thus, people who broker across these divides have the ability to gain access to, and control

![Fig. 1. An example of network prominence (A) and brokerage (B). Network prominence can be captured by degree centrality, which corresponds to the number of direct ties one has in a network. In network A, the node with the greatest number of ties (where degree centrality = 6) is shaded in red. Brokers act as intermediaries in networks by linking isolated individuals or disparate groups. In network B, the blue shaded node is acting as a broker. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)](image-url)
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