**Exploring the role of access regimes over stewardship behaviors of small-scale fishers**

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**Abstract:** Collective exclusive access regimes are increasingly being promoted to manage fisheries under the premise they promote local stewardship. Compliance and peer-enforcement are stewardship behaviors key to sustain resources under these access regimes. To explore stewardship behavior under formal collective access regimes, we performed a lab-in-the-field experiment with fishers who operate in a legally binding exclusive access policy in Chile. We assessed compliance and peer-enforcement decisions in a common-pool-resource game under two frames, which differed in the resource being harvested to signal two access regimes fishers face in real life: collective exclusive access and *pseudo* open access. Compliance and peer-enforcement were higher under the exclusive access frame for fishers who have experienced effective management under exclusive access in real life. These fishers sustained high compliance only under the exclusive access frame and in the presence of peer-enforcement, suggesting that formal access regimes interact with informal institutions to determine local stewardship.

**Introduction**

Local environmental stewardship is a promising pathway towards the sustainable use of common-pool natural resources (CPR) (Bennett et al. 2018). Under effective local stewardship, users protect and responsibly harvest the resources on which they depend averting “the tragedy of the commons” (Basurto 2005; Ostrom 1990). In small-scale fisheries (SSF) developing local stewardship is particularly attractive given its difficulty to establish effective central management (Costello et al. 2012). An approach increasingly applied to foster local stewardship in SSF is the establishment of formal collective exclusive access regimes (CEAR) (Defeo et al. 2016; Nguyen et al. 2017). These regimes grant legal rights to a group of fishers to exclusively access, use and manage resource stocks (Schlager & Ostrom 1992). With this, fishers are expected to become more willing to invest in stock’s sustainability and internalize their role as resource stewards compared to regimes in which weak rights or unclear stock-limits are in place (Costello et al. 2010; Fujita & Bonzon 2005; Wilen et al. 2012).

Under CEAR, fishers must comply with appropriation rules and engage in peer-enforcement to maintain catch at sustainable levels (Cox et al. 2010; Ostrom 1990). Compliance and peer-enforcement have been evidenced and proven key in several cases of traditional tenure (Basurto 2005; Gibson et al. 2005; Ostrom 1990). However, previous observations suggest mixed conclusions about the relationship between formal access regimes and local stewardship (Finkbeiner et al. 2018; Gelcich et al. 2006; Gilmour et al. 2011; Sumaila 2010).

Whether compliance and peer-enforcement behaviors are more prevalent under formal CEAR relative to open access (OA), and how this determines harvest decisions are still open questions. Exploring them associated to existing policies is crucial since the achievement of sustainable fishing via the implementation of formal CEAR relies, in part, on the assumption that fishers will engage in these behaviors. We performed a lab-in-the-field experiment to assess how stewardship behaviors of Chilean small-scale fishers differ under two access regimes they face in real life; CEAR and *pseudo* OA. To prompt the mechanisms that drive real-life behaviors under each access regime in the game, we presented the task under two frames while keeping the same monetary incentives. The wording of a task, or in this case a change in the species being managed, can affect subject’s behaviors by triggering norms, expectations and or heuristics that apply to specific contexts (Dufwenberg et al. 2011; Krupka & Weber 2013; Liberman et al. 2004).

In our experiment, some fishers were randomly assigned to play the game as the harvest of the gastropod loco (*Concholepas concholepas*) while others, from the same association, played it as the fishing of hake (*Merlucius gayi*). In real life, these fishers harvest loco under a formal CEAR, which grants fishers’ associations territorial users rights for fishing (TURFs) to harvest and manage benthic resources in a given area (Gelcich et al. 2010). The same fishers fish hake in a quota scheme that operates as a *pseudo* OA regime due to low compliance (Plotnek et al. 2016). We operationalized stewardship behaviors as quota compliance, and willingness to pay a cost associated to reporting noncompliance in the game. To address the external validity of our observations, we ran the game in two types of fishers’ associations – those that have empirically shown signs of good TURF management (high-performance associations) and those that have shown signs of relatively poor TURF management (low-performance associations). Given their real-life experience, fishers from high-performance association are more likely to have internalized mechanisms to cooperate under CEAR compared to those coming from low-performance associations. Assuming that real-life experience will permeate to the game we expect compliance and peer-enforcement to be higher under the loco frame than under the hake frame for high-performance associations, but not necessarily among members of low-performance associations.

This study assesses fishers’ internalization of stewardship behaviors under CEAR after decades operating under one of the oldest formally implemented CEAR in SSF; the Chilean TURF system. We discuss our results considering behavioral literature and comment on their implications for fisheries management.

**Methods**

**Implementation**

We selected fishers’ associations that target loco and hake and could be categorized *a priori* as high- and low-performance associations based on the variables that capture TURF management performance in the index developed by Marin et al., 2012 (Supporting Information). A total of 120 fishers from five associations, participated in our experiments. We performed two sessions (one with each frame) in each association, except for one where we conducted four sessions (two with each frame). **Table 1** displays our experimental design.

In each session, ten fishers from the same association were randomly and anonymously assembled in fixed groups of five to play the CPR game under one of the two frames (i.e. loco or hake). The game was programmed in z-Tree (Fischbacher 2007) and fishers entered their responses on individual laptops without communicating. Once the first session was completed, fishers left the room to receive their payoffs in private, and other ten participants played the game under the remaining frame.

Each session began with the monitor reading the instructions and answering questions aloud. Then, subjects played three trial rounds in which they could ask questions in private. The instructions remained the same under both frames except for the words used to describe the resource units being extracted (i.e. number of locos/kilos of hake), the action (i.e. harvesting/fishing), and the enforcement authority (i.e. the association’s board/the Undersecretary of Fisheries) (Supporting Information).

**The common pool resource game**

We adapted the CPR game implemented in Gelcich et al. (2013). It comprised 20 rounds, divided into two stages of ten rounds each.

1. Non-enforced stage:

At the beginning of each round , fishers were endowed with an individual quota of 100 units of the resource. Then, each fisher had to privately decide the number of units to harvest above their quota (i.e. overharvest). There was a negative externality to mimic the cost that overharvest imposes on other users in real life. For each unit a fisher decided to overharvest, each other member of their group lost half a unit. The unitary price of a unit was $10 CLP. Thus, the individual payoff per round was given by:

This payoff function sets a tension between the individual and the group’s interest leading to a social dilemma for which the equilibrium was a tragedy of the commons (Gelcich et al., 2013). In this stage of the game, there was no enforcement of the quota, and fishers could overharvest, in addition to the 100 quota, up to 50 units each without being punished. At the end of each round, a summary screen revealed to each fisher their total harvest, the average harvest of others in their group, and how many units they lost due to others’ overharvest.

1. Peer-enforced stage:

We introduced a peer-enforcement mechanism from the 11th round until the end of the game. The first decision node remained the same as in the non-enforced stage. Once all fishers in the group have entered their overharvest decisions, two fishers were randomly assigned as inspectors and randomly and anonymously matched with another fisher to be inspected. The overharvest of the inspected fisher was revealed to their inspector, and if there was a quota violation (i.e. ), the inspector had the opportunity to report the offender. Once an offender was reported, their harvest for the round was seized. The fifth member, who was neither inspector nor inspected, remained inactive. This mechanism mimics when fishers observe association’s members breaking rules in real life and should decide whether to report them to the authorities. To recreate the payment a fisher would earn for patrolling, we automatically added $250 CLP to a fisher’s account each time they were appointed as inspectors. Because reporting a peer bring costs in real life, each time an inspector chose to report an infraction in the game, they had to pay $250 CLP.

For the first stage, selfish behavior leads to full overharvest. For the second stage, selfishness would prevent agents to be involved in costly peer-enforcements; and the anticipation of the absence of peer-enforcement would again lead to full overharvest. .

**Statistical analysis**

We are interested in the differences in behavior between frames within each association type. Therefore, we carried on separate analyses for each association type. To test for frame effects over compliance and its erosion over the rounds of the game we ran one linear regression in each stage for each type of association. We fitted two Probit models to i) assess how the frame in each stage of the game affected the probability of a subject behaving as a complier (i.e. who chose to overharvest zero units in every round) for high- and low-performance associations; and ii) test for the effect of the frame over the probability of reporting noncompliance within each association type while controlling for the number of units overharvested by the inspected fisher. We ran our analysis in Stata v.12.0 and clustered standard errors by group in all models to account for the correlation between decisions of fishers playing in the same group.

**Results**

**Figure 1** shows the evolution of mean percent of compliance over the rounds and **Table 2** reports the results of the linear regression models in each stage for each association type. Compliance in the loco frame was almost 40% higher than compliance under the hake frame in the non-enforced stage for high-performance associations (loco frame coefficient = 39.74, p < 0.001). Yet, compliance in the loco game eroded over rounds with no enforcement mechanism, as indicated by the negative coefficient of the interaction between loco frame and round (loco x round coefficient = -2.4, p < 0.05). When peer-enforcement was allowed, differences between frames became no longer significant for high-performance communities, although compliance was stable only under the loco frame while erosion was evidenced under the hake frame (coefficient = - 0.95, p < 0.05). In the case of low-performance associations, there were no significant differences in compliance between frames for neither of the two stages.

The loco frame marginally increased the probability of subjects behaving as compliers relative to the hake frame in high-performance associations in the non-enforced stage (Loco frame coefficient = 1.07, p = 0.10, **Table 3**) while significantly increased it in the peer-enforced stage (Loco frame coefficient = 1.03, p < 0.05 , **Table 3**). The frame of the game did not affect the probability of subjects behaving as compliers in the case of low-performance associations in any of the stages of the game (**Table 3**).

**Figure 2** shows the probability of reporting noncompliance under the loco and the hake frame for each type of association. Fishers from high-performance associations playing under the loco frame reported offenders in ~70% of the total opportunities and only in ~ 32% of the total opportunities when playing under the hake frame. This difference was statistically significant (loco frame coefficient = 1.03, p < 0.001, **Table 4**). For fishers from low-performance associations differences in peer-enforcement between frames were not significant (**Table 4**).

**Discussion**

Fishers who have experienced effective management under CEAR in real life displayed higher compliance and peer-enforcement under a CPR game framed as the harvest of loco, which operates under a legally binding CEAR in real life, than in the same game framed as the fishing of hake, which operates under *pseudo* OA. We did not observe this difference among fishers belonging to associations that have shown relatively poor signs of management performance under CEAR in real life. This supports the potential of formal CEAR in generating necessary conditions to internalize stewardship behaviors and mechanisms for cooperation. It also highlights the importance of understanding informal group dynamics when pursuing behavioral changes via formal management regimes.

Members of high-performance associations presented high levels of compliance at the onset of the game under the loco frame relative to the hake frame. Yet, cooperation eroded in the absence of enforcement, as it is usually observed in repeated social dilemmas (Chaudhuri 2011). This phenomenon has been explained by the norm of conditional cooperation and how players update expectations about others’ behavior in each round (Fehr & Schurtenberger 2018; Fischbacher et al. 2001). The expectations of subjects in social dilemmas have been proved to respond to changes in the framing of the game (Dufwenberg et al. 2011). This suggests that, on average, expectations of cooperation at the beginning of the game were higher under the loco frame than under the hake frame for members of high-performance associations. These differences in expectations are likely shaped by their real-life experience harvesting loco under an effective CEAR while fishing hake under *pseudo* OA (Cárdenas & Ostrom 2004).

Engagement in costly peer-enforcement has been widely evidenced in social dilemmas (Ostrom et al. 1992; Yamagishi 1986). In our experiment, fishers engage in costly peer-enforcement independently of the frame of the game or the type of association they belong to. Yet, the frame mimicking CEAR increased the probability of reporting infractions only in high-performance associations. Costly punishment in social dilemmas has been interpreted as a sign of adherence to a social norm of cooperation (Fehr et al. 2002; Fehr & Schurtenberger 2018). Therefore, our results would suggest that high-performance associations present stronger cooperation norms in the context of harvesting loco under CEAR than when fishing hake under *pseudo* OA. By contrast, in low-performance associations cooperation norms seem weak in both contexts. CEAR provide conditions for the emergence of cooperative norms relative to OA (Ostrom 1998), but their internalization and thus our ability to observe them in the lab requires a history of success in the real world. Reasons for why only some groups would develop cooperation norms under CEAR in real life are unclear. One possibility is that the costs and benefits of enforcement vary across association types (Davis et al. 2017). Yet, a more in-depth analysis would be required to address the factors that influence the development of cooperation norms in the studied associations.

On average, the introduction of peer-enforcement increased levels of quota compliance in both types of associations, in line with previous evidence (Chaudhuri 2011; Fehr & Gächter 2000). Nonetheless, peer-enforcement was effective in sustaining high levels of compliance for high-performance associations only under the frame signaling CEAR. Hence, in the same way that peer-enforcement has proven key to maintain sustainable use in traditional tenure systems, it proves crucial in contexts of modern forms of CEAR (Gibson et al. 2005).

The fact that the loco frame increased the number of compliers only in high-performance associations also suggests differences in internalized norms across access regimes and associations. Monetary incentives cannot explain complete restraint from overharvesting. Subjects who chose to behave this way either responded to non-monetary incentives that did vary across frames or did not understand the payoffs of the game. There is no reason to believe that fishers had a better understanding of the game under a given frame since they were familiar with both fisheries. Thus, the positive effect of the loco frame over the probability of behaving as a complier suggest that non-monetary motivations to cooperate are stronger under the loco frame than in the hake frame for members of high-performance associations. These type of framing effects in social dilemmas have been attributed to social and intrinsic motivations shaped by social norms (Krupka & Weber 2013; Liberman et al. 2004; Rege & Telle 2004).

We acknowledge that the effect of the frame that we attribute to the type of access regime being signaled in the game could be confounded by other differences between the fisheries used to frame the game. For example, differences in behavior between frames could be due to particular real-life population dynamics of hake and loco. However, if only differences in resources’ characteristics were explaining changes in users’ behavior, we would have observed the same patterns in both association types. The fact that we observe differences between frames only in associations that have shown signs of high TURF-management performance indicates that access regimes are relevant to explain part of the behavioral differences we observe in the game. This is in line with previous observations showing that levels of cooperation for the same resource is associated to users’ real-life experience with different access regimes (Gelcich et al., 2013).

Our results add up to the literature supporting the external validity of lab-in-the-field experiments (Carpenter & Seki 2011; Fehr & Leibbrandt 2011; Gelcich et al. 2013; Lamba & Mace 2011; Rustagi et al. 2010). Furthermore, our observations favor the idea that framing can improve the external validity of economic experiments depending on the research question (Alekseev et al. 2017). If we would have studied both associations types only under the hake frame, we would have not identified that high-performance associations were capable of effective collective action. Properly framing a task requires a deep understanding of the real-life context of experimental subjects to anticipate subjects’ construal of the decision task. In addition, the experimenter must be cautious to avoid demand-effects and the hindering of the generalizability of the results.

**Conclusion**

The implementation of CEARs is a promising approach to respond to the current call for a sustainable and equitable blue economy (Bennett et al. 2019). Thus, it becomes crucial to evaluate whether they are generating the behavioral changes which are intended. When exclusive access is granted collectively its success relies, in part, on the engagement of fishers in collective action. We found that fishers from the same association express increased stewardship behaviors towards resources that are managed under CEAR relative to those managed under *pseudo* OA. Yet, the implementation of formal exclusive access does not seem to automatically lead to increased compliance and peer-enforcement among users. Identifying the conditions that favor stewardship under formal CEAR is crucial to guide the design of formal access regimes that promote local stewardship.

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**Figures legends**

**Figure 1.** Evolution of the mean percent of compliance over rounds under the loco frame (blue line) and the hake frame (red line) for high-performance (left panel) and low-performance associations (right panel). A 100% compliance means fishers overharvested on average zero units above their individual quota, while a 0% compliance means fishers overharvested, on average, 50 units above their individual quota.

**Figure 2.** Probability of reporting an infraction in the game for high-performance (left) and low-performance (right) associations under the loco frame (in blue) and the hake frame (in red).