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Analysis

External validity of artefactual field experiments: A study on cooperation, impatience and sustainability in an artisanal fishery in Colombia

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ABSTRACT

This paper contributes to the experimental analysis of sustainable behavior in artisanal fisheries and the external validity of economic experiments. We run a standard one-shot public goods experiment and two time preferences experiments with fishermen from Tasajera. It is a small fishing community located in the Caribbean coast of Colombia, which depends mainly on the fishery resources of the Ciénaga Grande de Santa Marta for its livelihood. To investigate the external validity of the experiments, we related the fishermen's individual decisions in the experiments to some indices measuring the ecological impact of fishing activities among the same group of fishermen. We found that fishermen's contributions to the public good and their levels of impatience are not robustly correlated to their real fishing behavior. We argue that the link between fishermen's behavior in the field experiments and real life could be associated to various factors, such as the specific context in which fishermen live, and the way in which cooperation in real life is measured.

1. Introduction

The conservation of common pool resources (CPRs) such as forests, pastures or fisheries, depends on several factors such as the type and the size of the resource, the characteristics of the resource users or the institutions (rules) that govern these resources (Agrawal, 2001; Baland and Platteau, 1996; Basurto et al., 2013; Basurto and Ostrom, 2009; Ostrom, 1990). There is plenty of empirical evidence that subjects do not always follow the theoretical assumption of self-interest (Hardin, 1968; Olson, 1965), and instead, they cooperate voluntarily to achieve a successful exploitation of the resources. Higher cooperation leads to more sustainable resource use (Basurto et al., 2013; Orensanz et al., 2013; Ostrom, 1990; Ostrom et al., 1999; Ostrom et al., 1992; Schlager, 1994).

Besides the ability to engage in cooperation, the level of patience or impatience of actors, in our case fishermen, is another important factor that can affect sustainability. Thus, according to standard economic theory on fisheries (Clark, 1973; Sumaila and Walters, 2005) when fishermen are impatient (i.e., they have high discount rates) and prefer to receive a smaller benefit immediately rather than to wait for a larger benefit in the future which is less certain, it is more likely that they overexploit fishery resources and behave therefore unsustainably. Only some authors argue in favor of a disinvestment hypothesis that states myopic resource users might not have the means to invest in resource technology and therefore, behave more sustainably (Farzin, 1984).

In the last decades, laboratory experiments in economics have been an important tool to study human behavior and cooperation among subjects in different settings (Falk and Heckman, 2009; Levitt and List, 2007). In particular, economic field experiments with users who share a real natural resource have increased our knowledge regarding how they make decisions and self-organize to extract those resources in a sustainable way (Cárdenas, 2000, 2011; Cárdenas and Carpenter, 2008; Cárdenas and Ostrom, 2004; Janssen and Anderies, 2011; Muradian and Cárdenas, 2015; Ostrom, 2006), thus avoiding the circumstance of being trapped in the "tragedy of the commons" (Hardin, 1968).

In fisheries, scholars have used economic field experiments to explore different factors such as communication, impatience, reciprocity, rules, and regulations affecting the likelihood of successful cooperation in the management of CPRs (Aswani et al., 2013; Castillo et al., 2011; Fehr and Leibbrandt, 2011; Lopez et al., 2012; Teh et al., 2011; Vélez and Lopez, 2013; Vélez et al., 2009, 2012).

Results from economic experiments are often used for policy recommendations. However, unless a clear link is established we cannot draw conclusions for resource governance in real life (Levitt and List, 2007; Ostrom, 2006). Nevertheless, there are only a few studies about the external validity of experiments on cooperation in commons resource management. To our knowledge, up to date, there are only six studies: four of them found evidence of external validity (Carpenter and Seki,

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2011; Fehr and Leibbrandt, 2011; Gelcich et al., 2013; Rustagi et al., 2010) and the other two studies did not (Gurven and Winking, 2008; Hill and Gurven, 2004).

In order to contribute to the experimental analysis of cooperation in artisanal fisheries and the debate on the external validity of economic experiments, we did a similar study to that of Fehr and Leibbrandt (2011). These authors examined the role of cooperativeness and impatience on the sustainable exploitation of a CPR with open access by combining laboratory experiments with field data. They found that shrimpers who were more patient and cooperated more intensively in the experiment also used more sustainable fishing instruments. Motivated by these findings and taking into account that cooperation and impatience are important factors for resource conservation, we investigate the degree to which experimental measures of cooperation and impatience are correlated to real life sustainable behavior. In case a clear correlation could be found, then those experiments could be used for the quick assessment of the sustainability or at least collective action potential of the community (Aswani et al., 2013). It also could be used as a robust tool for testing different policy alternatives (Cárdenas, 2004). However, it could also be that the link between cooperation and time preferences on the one hand and sustainable behavior on the other hand is not as straightforward. Then those experiments would have to be used with a lot more care, when linking them directly to sustainable behavior.

The study was carried out in Tasajera, a small fishing community located in the Caribbean coast of Colombia, which depends mainly on fishery resources from Ciénaga Grande de Santa Marta (CGSM) for their livelihood. For measuring the ecological impact of fishermen on the CGSM, we gained access to primary information on real fishing behavior over various years collected by a beach recorder of the Institute for Marine and Coastal Research (INVEMAR).[1] These data, together with an evaluation on the ecological impact of fishing activities in the CGSM, made by a group of experienced fishermen and scientists – either working in scientific research on CGSM's fishery or involved in its management – allowed us to build two fishing impact indices for each fisherman: one based on experienced fishermen's scores and other based on scientists' scores.

A standard one-shot public goods experiment (PGE) and two time preferences experiments (TPE) were run with the 152 fishermen whose ecological impact had been calculated by us. The first TPE was similar to the one conducted by Fehr and Leibbrandt (2011) with the only difference being that we used Coca Cola instead of chocolate pralines, which were neither common nor available. The second TPE was framed as a bonus for participating in the experiments. In this experiment, we adapted the payoff table of Harrison et al. (2002) to the context of Tasajera. Fishermen had to choose between five payoff alternatives, which had two future payment options. It allowed us to have a measure of fishermen's impatience through their propensity to discount future payoffs, which provides a more precise measurement than a dichotomous choice. Additionally, the preference for the Coca Cola could eventually be influenced by some "visceral factors" such as cravings, hunger, among others (Frederick et al., 2002).[2]

The paper is structured as follows: in the next section, we introduce Tasajera and an overview of the CGSM fishery. In Section 3, we describe the field data used in this study. In Section 4, we present our experimental design. In Section 5, we present the main results of this research and relate them to those found in the other studies on external validity of experiments on cooperation in CPRs, and finally we offer some conclusions.

2. Research Setting

Tasajera is made up of about 8000 inhabitants (SISBEN, 2012), where the majority of its members live in conditions of extreme poverty. Fishery resources from CGSM are the main source of food and income for this community. CGSM is an artisanal, multi-gear and multi-species fishery (Ibarra et al., 2014; INVEMAR, 2013), with around 3500 fishermen (Blanco et al., 2007), of which an average of 950 are active daily in the lagoon (INVEMAR-SIPEIN, 2012). Fishing in this lagoon is carried out all year round and it is done exclusively by men.

CGSM is situated in the center of a bigger region (about 4900 km^2) known as Eco-region Ciénaga Grande de Santa Marta,[3] and it is one of the most important in Colombia due to its large size (450 km^2) (Gónima et al., 1996), and its ecological and social value[4] (Vilardy and González, 2011). Given its importance, currently the protection of this lagoon resides in several government agencies. However, de facto, it is under an open-access regime since no State entity or organization nor the community itself regulates the fishery. The CGSM has seen strong fluctuations in the fishing productivity over time, with some species at risk of a critical reduction or collapse, as well as a critical deterioration in the fishermen's quality of life (Ibarra et al., 2014; INVEMAR, 2002).

3. Field Data

The conservation and sustainable use of CGSM's fishery resources largely depends on the use of appropriate fishing gear and methods. It is also important to fish in sites distant from the key nursery areas and the transit corridors of species. From our conversations with many of Tasajera's fishermen, we realized that they are aware of the negative impacts that they might have on the fishery resources by the actions mentioned above. However, several studies have found that some of the major commercial fish species of the CGSM are at risk of being over-exploited, because they are caught below their average permitted size (before they reach their sexual maturity), which is a result of fishermen using nets with small mesh sizes (Ibarra et al., 2014; Ibarra et al., 2013; Narváez et al., 2008; Rueda, 2007; Rueda and Defeo, 2003; Rueda et al., 1997).

Based on this, and taking advantage of the fact that we had reliable information that allowed us to evaluate the fishermen's fishing behavior; we built fishing impact indices for each fisherman, which gave us a measure of their cooperation for sustaining the fishery resources of CGSM over an extended time period (see Appendix A). Nevertheless, as non-biologists, we did not know what type of fisherman behavior would be considered sustainable. Therefore, we asked fishery biologists working on the CGSM, first in a qualitative and then in a standardized way, how to classify what signifies sustainable fishing behavior. This data provided us with information about what scientists understand as being sustainable fishing. However, there could be a strong misunderstanding about what signifies sustainable behavior between the scientists and the fishermen, who are actually making the decisions. If there were a strong difference between the two opinions, then comparing the experimental behavior with the scientific expert based indicator would not provide reasonable results. The fisherman would base his decisions on what he believes is sustainable. Therefore, we also asked fishermen to classify the various gear, methods and spots. We abstained from asking each individual fisherman about his opinions on sustainability, because he might have classified his own behavior as being sustainable. We observed this trend when comparing fishermen and

[1] This is an entity of mixed character (i.e. public and private). It is responsible for doing basic and applied research on the natural renewable resources in Colombia and the environment of coastal and oceanic ecosystems.

[2] According to Frederick et al. (2002) these visceral influences, which are linked to the attractiveness of the good or activity, could affect the intertemporal choice of the subjects, and can give rise to behaviors that look extremely impatient.

[3] This Eco-region includes 570 km^2 of marine area and 730 km^2 of an estuarine system of coastal lagoons, connecting creeks and mangrove swamps.

[4] The CGSM was declared as Fauna and Flora Sanctuary in 1977. Likewise, it was designated as a Ramsar site in 1998 and Biosphere reserve in 2000. Furthermore, it is the main source of both food and income for about 25,000 people who live in seven small surrounding villages, including Tasajera (SISBEN, 2007).

scientific evaluations. For the construction of these indices, we used two sources of data:

1. A database from SIPEIN (INVEMAR's Fisheries Information System). It is a system of data collection and processing of fishing information for CGSM that belongs to INVEMAR. For our study, we used data from 2006 to 2010 regarding the fishing spots, and characteristics of the fishing gear and methods used by fishermen who later participated in our experiments.
2. An evaluation of the ecological impact of fishing activities in the CGSM. For this evaluation, conducted in March 2013, we asked of 25 CGSM's experienced fishermen and 25 scientists to grade the following aspects on an impact scale from 1 (low) to 5 (high):
   a) The ecological impact caused by 13 fishing gear/methods on CGSM's main fishery resources.[5]
   b) The ecological impact of fishing on 6 fishing zones regularly visited by fishermen.[6]

There is a general trend that scientists, in comparison with experienced fishermen, value any type of behavior as being less sustainable. To evaluate whether the assessment made by experienced fishermen differed from the scientists, we compared the median scores of the six fishing zones and the thirteen types of fishing gear/methods, by using the Wilcoxon Test for paired samples. We found that there is statistically significant evidence ($\alpha = 0.01$) that experienced fishermen and scientists differ in their opinions about all fishing zones and about eight out of thirteen fishing gear types evaluated (see Fig. 1). However, refraining from the magnitude, one can see in the radar graphs in Fig. 1 that for many fishing spots and gear there is a rather substantial agreement on what is considered to be relatively sustainable or unsustainable (as additional evidence see below the high correlation coefficients between the calculated indices with the help of the experienced fishermen on the one hand and experts weights on the other).

We calculated for each fisherman two fishing impact indices (one based on experienced fishermen's scores and another one based on scientists' scores) with an identical range from (1 to 5). To build them, we first developed individual indicators for both fishing spots and fishing gear/methods, and then we aggregated them to get the indices.[7] Fig. 2 displays the distribution of these indices based on experienced fishermen's scores (Fig. 2a) and scientists' scores (Fig. 2b). Overall, the indices based on the experienced fishermen's points of view were between 1.24 and 2.56 (mean = 1.67, SD = 0.45), while the indices based on scientists' opinion were between 2.49 and 3.82 (mean = 2.87, SD = 0.31). Both indices show a significant degree of association (Spearman $r = 0.6594$ $p = 0.000$). (Appendix A provides a detailed description of the development of the individual indicators and indices).

Given the fishing characteristics of CGSM (multi-gear and multi-species), the use of these indices as a measure of Tasajera fishermen's sustainability is more suitable than taking a single indicator as used by Fehr and Leibbrandt (2011). First, the indices take into account all of the fishing gear and methods used by fishermen, instead of using only one fishing instrument. This is particularly important in our case because fishermen in Tasajera generally use more than one type of fishing gear or method throughout the year, or jointly during a normal fishing day. Also, one particular gear might have been chosen due to many reasons, for example, inheritance or current availability. Therefore, it might not indicate the general sustainability orientation of a fisherman. Examining the many choices a fisherman makes will better reflect the general trait of the individual, which is assumed to exist, similarly when analyzing his experimental behavior.

Second, to build the fishing impact indices we used real and reliable data on daily fishing habits of fishermen for a long period of time. These data included information about both fishing spots visited, as well as fishing instruments used by fishermen from 2006 to 2010. It enabled us to consider not only those aspects related to the fishery process (periods of abundance or scarcity of the species, period of the year), but also fishermen's behavior according to their needs over time. For example, a fisherman may have a particularly high need at a certain moment in time and therefore chooses a detrimental mesh size or visits a particularly high yielding spot, when otherwise he behaves more sustainably. Finally, the third advantage of using the indices in comparison to a single measure is that they take into account not only the impact of fishing instruments, but also the impact of fishing activities on certain fishing spots. This is very important to the ecological sustainability of the CGSM. Thus, to go fishing, for instance, to nursery areas or transit corridors of species can reduce the future yield, since in these areas the majority of the species are juveniles or they are in transit to spawning in safer places.

In addition to the data used to build the fishing impact indices, we got individual information for the same group of fishermen that participated in the experiments through a survey conducted in February 2013. It allowed us to get data on their socioeconomic characteristics and their perception about the CGSM's fishery resources and who should help in the conservation of this lagoon. We use these variables as control variables in our models. Table 1 presents some summary statistics of these variables. We chose these variables based on our knowledge about this community, and some studies on artisanal fishermen's behavior which demonstrate the link between those variables and sustainable behavior (Allison and Ellis, 2001; Cinner and McClanahan, 2006; Cinner and Pollnac, 2004; Silva, 2006). With respect to these variables, it is worth noting that all of our participants in the experiments were men and full-time fishermen. On average, they have 31.5 years of experience as fishermen, work 12.7 h per day, and had 4.1 years of formal education.

4. The Experiments

4.1. Experimental Procedure

We conducted four laboratory sessions in a school of Tasajera during the weekend of October 19 and 20 of 2013. We invited the 160 fishermen that we surveyed in February 2013,[8] with 40 fishermen for each session, although, some of them did not show up. Ultimately, 152 fishermen took part in three experiments: one standard PGE and two TPEs, all ran in the same session. We deliberately chose these standard experiments. We are well aware that a one-shot public goods experiment does not mimic well the cooperation environment of a dynamically evolving resource like a fish stock (Janssen et al., 2010), nor are simple time preferences experiments able to capture domain specific time preference rates (Krantz and Kunreuther, 2007). However, first, those simple and unframed experiments might be most suitable for getting at fundamental individual characteristics that underlie variation in cooperation and time preferences, and which are not confounded with other factors such as learning effects or context-specific behavior. Second, these experiments are frequently used in ways that assume relationships between game decisions and sustainable behavior.

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5 These fishing gear represent seven of the most common gear used in the CGSM. However, for the evaluation, we defined for some of the nets two different mesh sizes. The specifications of fishing gear/methods evaluated were: Cast net 1, 0.25″–2.25″; Cast net 2, 2.50″–3.00″; Seine net 1 (*Chinchorra*), 1.50″–2.50″; Seine net 2 (*Chinchorra*), 2.75″–3.50″; Seine net 1 (*Chinchorro*), 0.75″–1.00″; Seine net 2 (*Chinchorro*), 1.01″–2.00″; Fixed gill net 1, 1.25″–2.50″; Fixed gill net 2, 2.75″–4.00″; Encircling gill net 1 (*Boliche*), 1.25″–2.50″; Encircling gill net 2 (*Boliche*), 2.75″–4.00″; Shrimp net, 0.50″–1.00″; Crab traps with entrance gap of 23 cm; Long lines with hook calibers 10 to 12.

6 These zones cluster 116 fishing spots where fishermen commonly fish. The zones were defined according to their ecological characteristics and importance.

7 The indices or composite indicators are a single index, which compiles individual indicators. In addition, it may measure multidimensional concepts that cannot be captured by a single indicator (OECD and JRC, 2008).

8 We would like to point out that given we wanted to compare fishermen's behavior in real life with their decisions in the experiments, we invited only those fishermen for which we had enough information in the SIPEIN database. Therefore, we could not make a random selection of them and we have a fishermen selection bias.

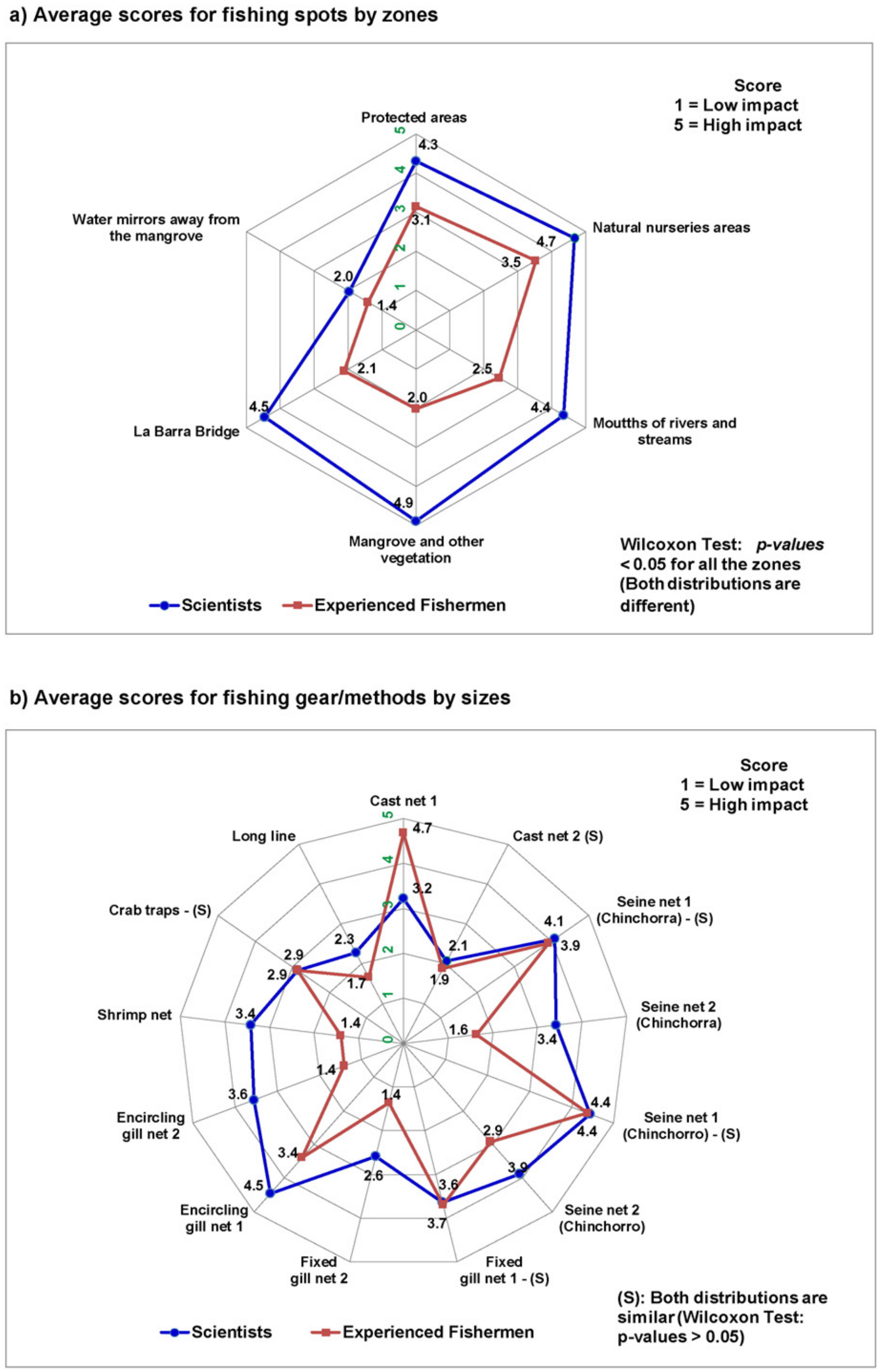

Fig. 1. Radar graphs for fishing zones and fishing gear/methods.

The first author and an assistant led two sessions with about 20 people each simultaneously in separate rooms. Instructions and order of the experiments have been the same. At the beginning of the session, we implemented the TPE with Coca Cola. Afterwards, fishermen played the PGE and finally, an additional TPE. We followed a simple design, and we used clear visual instructions to facilitate fishermen's understanding of the experiments, and the consequences of their decisions. We conducted each experimental session in the same order, and we assigned each fisherman a code for both identifying him during the session, and to ensure his anonymity. All the fishermen's questions were answered in public and communication among fishermen during the experiments was not allowed. We provided the fishermen a complimentary snack and soft drink at the end of the session.

4.2. Experimental Design

4.2.1. The Public Goods Experiment

We ran a PGE with Tasajera's fishermen. We assigned the participants of each session randomly to groups of five persons. The participants did not know to which group of five they belonged. We played the experiment for one period, which allowed us to have a measure of their voluntary cooperation without the effects that might come from repeated interaction or reputational concerns. The experiment was framed in abstract and neutral terms as a transfer of money from a private account to a group account. Each fisherman received an endowment of 10 tokens, and each token equaled 1,000 pesos (around US$ 0.50 then). Each fisherman had to individually decide how many out of 10 tokens he wanted to

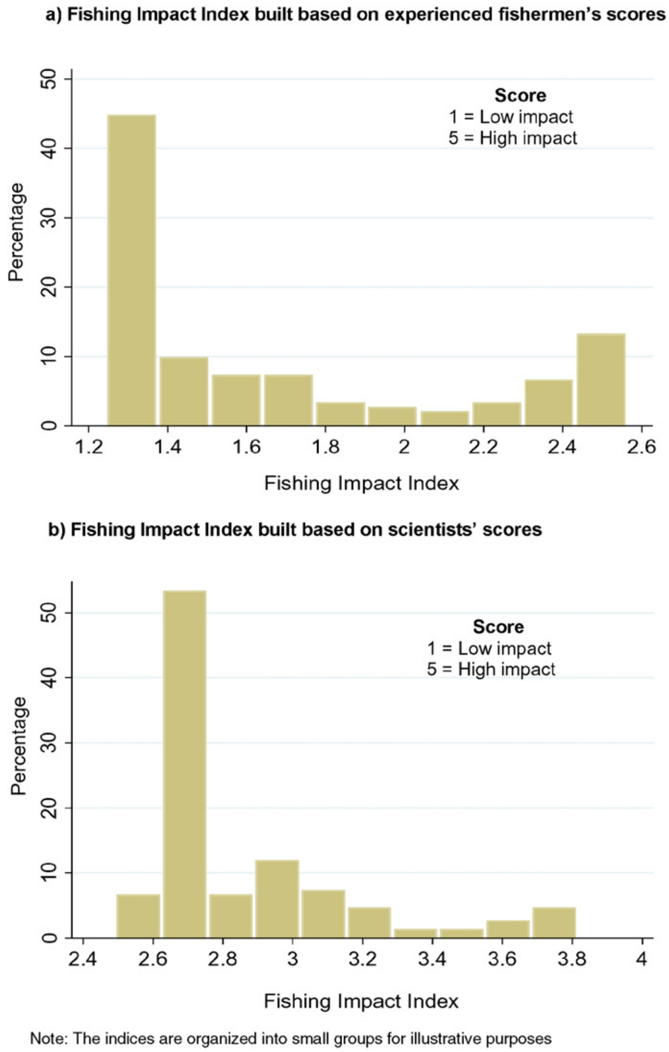

Fig. 2. Distribution of the fishing impact index.

keep for himself in his private account, and how many tokens he wanted to transfer to the group account. Tokens in the group account were multiplied by the factor 1.5 and then equally distributed among the five group members. Thus, if the five fishermen in the group contributed their 10 tokens to the group account each of them earned 15 points, but if none of them contributed, each of them only earned 10 tokens. The payoff function was:

$$\prod_i (x_i, x_j) = (10 - x_i) + \left[\left\{ 1.5 \times \left(\sum_{j \neq i} x_j + x_i \right) \right\} \Big/ 5 \right]$$

Where x_i is individual *i's* contribution to the public good, and x_j is the sum total of the other four players' contributions. At the start of the session, the experimenter read the instructions aloud and answered all the fishermen's questions in public (see instructions in Appendix B). Several examples were explained. All questions of fishermen were answered. Then control questions were asked to the group, where fishermen could raise their hands for various options. If unanimity was lacking further explanations were provided. This process was repeated if necessary. Afterwards, each fisherman received two envelopes, one marked as a private account, which contained his endowment (10 tokens), and the other marked as a group account, which was empty. Fishermen could transfer tokens from the private account to the group account. Fishermen made their decisions in private in a special place built in front of the classroom for this purpose. We did not inform the fishermen about the identity and individual contribution decisions of their group members. We paid each fisherman his earnings in private and in cash at the end of the session. Individual earnings ranged between 5,700 pesos and 18,900 pesos, with an average of 12,580 pesos (about US$ 6.71).[9]

4.2.2. The Time Preferences Experiments

4.2.2.1. The Experiment with the Coca Cola. To get a measure of the level of impatience of Tasajera's fishermen, we ran the first TPE with Coca Cola. Nevertheless, we always made sure that enough plain water was available during the session. Thus, we reduced the risk that subjects ask for the Coca Cola only because they were thirsty. Fishermen had to indicate whether they preferred one Coca Cola before starting the experimental session or two Coca Colas at the end of the session, when they would receive their earnings from the PGE.

4.2.2.2. The Experiment with the Bonus (Discount Rates). Given the TPE with Coca Cola only provides a very rough measurement of impatience, we ran a more standard TPE. For that, we adapted the payoff table of Harrison et al. (2002) to the context of Tasajera. Thus, in our case, each fisherman had to choose between payment option A and B for each of the five payoff alternatives that we had defined and then one was randomly chosen for payment (see Table 2). The question that we used to elicit individual discount rates was, do you prefer 10,000 pesos (around US$ 5) payable in one week or 10,000 pesos + $X, payable in two weeks. In our experiment the $X varied from 0 to 10,000 pesos to reflect monthly interest rates from 0% to 400%, respectively (see Table 2). We used these high interest rates because in pretests we found out that those rates are appropriate ones to allow for substantial variation.

We used two future payments in order to reduce the likelihood that fishermen perceive differences between the payments regarding the transaction costs and the risk associated with future payment (Harrison et al., 2002). In addition, we described the payment as a bonus (show up fee) to participate in the experimental session (see instructions in Appendix B), which would be paid in the next weeks directly in their houses by the experimenter.

To assure that the fishermen understood the experiment, we explained it individually and we read each of the payment alternatives, instead of providing a payoff table. Once the experimenter was sure the fisherman had understood the experiment, he made his decision. The first author and three field assistants collected fishermen's decisions simultaneously using different classrooms to guarantee confidentiality of the fishermen's decisions. We calculated the fishermen's discount rates by finding the point at which they switch from choosing the sooner to the later payment.

5. Results and Discussion

In this section, we first examine the correlation between the results of the field experiments and individual levels of exploitation of CGSM's fishery resources, measured through the indices. Then, we discuss our findings in light of other studies that compare real life behavioral data with experimental data. Similar to Fehr and Leibbrandt (2011), we used the outcomes of the PGE and the two TPEs to predict fishermen's cooperativeness in maintaining the CGSM fishery. Based on this, we hypothesize (1) that fishermen who contribute more in the PGE and therefore show a higher level of cooperation while exerting a lower impact on the CGSM (i.e., the value of their fishing impact indices are low), and (2) that fishermen who are impatient in the TPEs (Coca Cola & Bonus) have higher impacts on the CGSM (i.e., the value of their fishing impact indices are high).

[9] A day's wage in this zone varied between 15,000–20,000 pesos (US$7.98–US$10.64) at the time of the experiments.

Table 1
Summary of variables used in the estimations.

Variable name	Explanation	Mean/Prop	SD	N
Fishing impact index estimated with experienced fishermen's opinion	1 (lowest impact) – 5 (highest impact)	1.67	0.45	152
Fishing impact index estimated with scientists' opinion	1 (lowest impact) – 5 (highest impact)	2.87	0.31	152
Contribution in PGE (in tokens)	0 (lowest) -10 (highest)	4.93	3.14	152
Impatience (Coca Cola Dummy)	0 = prefers one Coca Cola immediately 1 = prefers two Coca Colas approximately 3 h later	0.73		152
Impatience (Bonus %)	Discount rate calculated for each fisherman based on his decision in the experiment: 25%, 50%, 75%, 100%, >100%	0.67	0.32	134
Years of schooling	Number of years of formal education	4.10	3.96	152
People who fisherman supports	Number of people who depend economically on the fisherman in his home.	4.14	2.32	152
Fisherman shares in paying for household expenses (Dummy)	Other family members help fisherman with household expenses 0 = fisherman does not share in paying for household expenses 1 = fisherman shares in paying for household expenses	0.41		152
Average daily hours fishing	Average daily work time (Including time to sell)	12.72	2.85	152
Years in occupation	Years fishing professionally	31.54	11.57	152
Fisherman is paying a loan (Dummy)	Fisherman is paying a loan 0 = fisherman is not paying a loan 1 = fisherman is paying a loan	0.33		152
Fisherman has job alternatives (Dummy)	Fisherman has job alternatives 0 = fisherman does not has job alternatives 1 = fisherman has job alternatives	0.35		152
Fishery resources are scarce (Dummy)	Perception about fishery resources 0 = fishermen perceive there are many resources for all. 1 = fishermen perceive resources have always been scarce or they are beginning to become scarce.	0.84		152
Government should help in the conservation of CGSM (Dummy)	Perception about who should help in the conservation of the lagoon 0 = fishermen believe they should help conserve the CGSM 1 = fishermen believe the government and other users of the CGSM (different from the fishermen) should help with the conservation of the lagoon.	0.45		152

SD = Standard deviation. N = Number of responses.

5.1. Predicting Fishermen's Sustainable Behavior with the Public Goods Experiment

According to our results, only a small group of fishermen behaved selfishly and did not contribute (9.2%), or contribute only one token (4.6%) to the public good, while 21.7% contribute five tokens, and 34.2% contribute more than five tokens (see Fig. 3). These results contrast with shrimpers' contributions analyzed by Fehr and Leibbrandt (2011) in Brazil. In their case, 15.8% of shrimpers did not contribute to the public good, 11.4% contributed only one unit, 21.1% contributed five units (tokens), and only 18.4% contributed more than five units.

Table 2
Payoff table for the two-week time horizon.

Payoff alternative	Payment option A (1 week)	Payment option B (2 weeks)	Weekly interest rate	Monthly interest rate
1	10,000 pesos	10,000 pesos	0%	0%
2	10,000 pesos	12,500 pesos	25%	100%
3	10,000 pesos	15,000 pesos	50%	200%
4	10,000 pesos	17,500 pesos	75%	300%
5	10,000 pesos	20,000 pesos	100%	400%

Overall, the mean contribution to the group account was in our PGE 4.93 tokens (SD = 3.14), while in the case of shrimpers it was 3.63 tokens (SD = 2.69). Comparing the contribution in our PGE

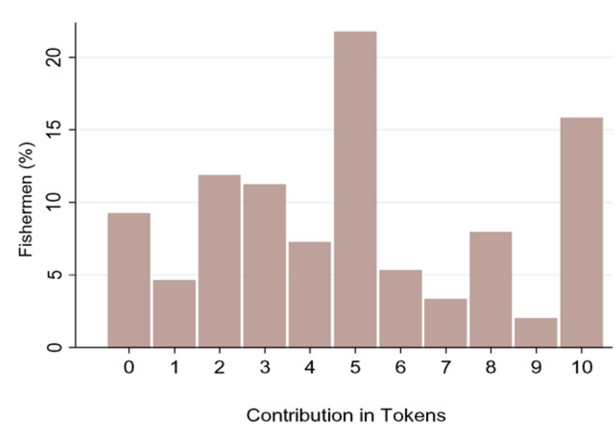

Fig. 3. Distribution of contributions in the Public Goods Experiment. Total fishermen: 152.

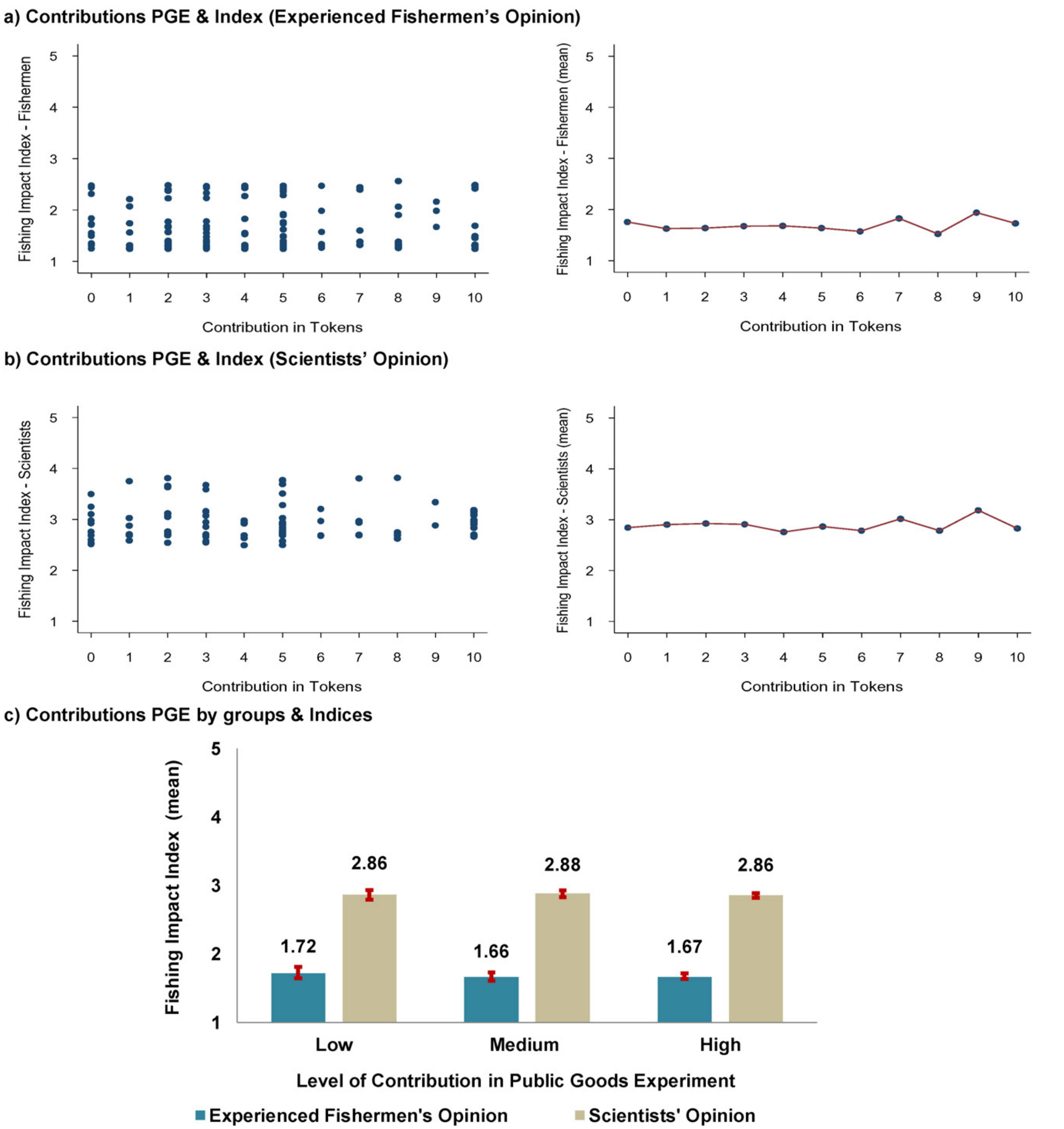

Fig. 4. Contribution to the Public Goods Experiment (PGE) and Fishing Impact Indices. Level of contributions: Low = 0–1 Tokens; Medium: 2–4 Tokens; High: 5–10 Tokens. Fishing impact index: 1 = Low impact; 5 = High impact. Red bars represent the standard error of the mean (95% Confidence interval).

with other studies in comparable settings we observe similar levels of contribution (Coleman and Lopez, 2013; Hill and Gurven, 2004; Hopfensitz and Miquel-Florensa, 2014). This is remarkable, as in Tasajera no form of collective action and cooperation takes place, at least when it comes to the regulation and governance of fisheries (Torres-Guevara et al., 2016).

Fig. 4, shows the relationship between contributions to the PGE and the average of the fishing impact indices calculated based on the opinion of experienced fishermen (Fig. 4a) and scientists (Fig. 4b). As we can see, independently of the index used, the relationship between the indices and their contributions to the PGE is almost null. Likewise, if we grouped fishermen according to their contributions to the public good in low (0–1 token, N = 21), medium (2–4 tokens, N = 46) and high level (5–10 tokens, N = 85),[10] we obtain similar results (Fig. 4c). Pearson correlation analysis between contributions in PGE (0,1,…,10) and the indices confirmed these results (fishermen's opinion: $r = 0.0128$ $p = 0.8758$ and scientists' opinion: $r = -0.0379$ $p = 0.6430$).

We also investigated whether contributions in the PGE can predict the level of impact that fishermen cause on the fishery resources of

[10] We used the same categories by Fehr and Leibbrandt (2011) to made the groups.

Table 3
Determinants of fishermen's fishing behavior (OLS) based on experienced fishermen's opinion.

Dependent variable	**Fishing impact index estimated with experienced fishermen's opinion**							
Models	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Contribution in PGE (in tokens)	0.0018			0.0000			0.0014	-0.0070
	(0.0124)			(0.0110)			(0.0110)	(0.0116)
Impatience (Coca Cola Dummy)		0.0728			0.1112		0.1121	
		(0.0843)			(0.0735)		(0.0735)	
Impatience (Bonus %)			-0.0788			-0.0915		-0.0824
			(0.1197)			(0.1115)		(0.1151)
Years of schooling				-0.0203 **	-0.0220 ***	-0.0209 **	-0.0220 ***	-0.0205 **
				(0.0082)	(0.0082)	(0.0098)	(0.0084)	(0.0099)
People who fisherman supports				-0.0124	-0.0132	-0.0094	-0.0131	-0.0100
				(0.0149)	(0.0144)	(0.0164)	(0.0145)	(0.0165)
Fisherman shares in paying for household expenses (Dummy)				-0.2169 ***	-0.2210 ***	-0.2181 ***	-0.2220 ***	-0.2140 ***
				(0.0678)	(0.0667)	(0.0732)	(0.0678)	(0.0738)
Average daily hours fishing				-0.0555 ***	-0.0576 ***	-0.0499 ***	-0.0575 ***	-0.0506 ***
				(0.0136)	(0.0136)	(0.0162)	(0.0135)	(0.0160)
Years in occupation				0.0012	0.0005	0.0007	0.0005	0.0007
				(0.0031)	(0.0031)	(0.0032)	(0.0031)	(0.0032)
Fisherman is paying a loan (Dummy)				0.1687 **	0.1601 **	0.1701 **	0.1600 **	0.1697 **
				(0.0718)	(0.0711)	(0.0786)	(0.0716)	(0.0786)
Fisherman has job alternatives (Dummy)				-0.0549	-0.0469	-0.0843	-0.0467	-0.0852
				(0.0654)	(0.0660)	(0.0672)	(0.0661)	(0.0670)
Fishery resources are scarce (Dummy)				-0.0219	-0.0278	-0.0535	-0.0278	-0.0535
				(0.0845)	(0.0848)	(0.0901)	(0.0851)	(0.0909)
Government should help in the conservation of CGSM (Dummy)				0.2168 ***	0.2151 ***	0.1984 ***	0.2146 ***	0.2017 ***
				(0.0646)	(0.0641)	(0.0694)	(0.0643)	(0.0690)
Constant	1.6627 ***	1.6182 ***	1.6964 ***	2.4447 ***	2.4295 ***	2.4620 ***	2.4214 ***	2.4959 ***
	0.0679	0.0729	0.0934	(0.2141)	(0.2144)	(0.2876)	(0.2115)	(0.2768)
Observations	**152**	**152**	**134**	**152**	**152**	**134**	**152**	**134**
R^2	0.0002	0.0051	0.0033	0.2926	0.3038	0.2548	0.3039	0.2572

Notes: *** 99% significance ** 95% significance * 90% significance. Robust standard errors are in parentheses.

CGSM, using Ordinary Least Squares (OLS) regressions. To analyze these correlations we used the fishing impact indices calculated based on the experienced fishermen's scores (Table 3) and scientists' scores (Table 4) as dependent variables in the models. We found that independent of the index, the contributions in the PGE fail to predict the level of impact that fishermen exert on this ecosystem (Table 3, Model 1: $t = 0.15$, $p = 0.883$; Table 4, Model 1: $t = -0.51$, $p = 0.610$). We tested if these results were robust to the inclusion of several control variables such as years of schooling, number of people that fisherman supports or average daily hours fishing and

Table 4
Determinants of fishermen's fishing behavior (OLS) based on scientists' opinion.

Dependent variable	**Fishing impact index estimated with scientists' opinion**							
Models	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Contribution in PGE (in tokens)	-0.0037			-0.0045			-0.0034	-0.0094
	(0.0073)			(0.0069)			(0.0069)	(0.0072)
Impatience (Coca Cola Dummy)		0.0718			0.0878 *		0.0856 *	
		(0.0525)			(0.0490)		(0.0495)	
Impatience (Bonus %)			0.0070			0.0272		0.0395
			(0.0747)			(0.0663)		(0.0661)
Years of schooling				-0.0103 **	-0.0118 **	-0.0107 **	-0.0116 **	-0.0101 *
				(0.0048)	(0.0047)	(0.0055)	(0.0048)	(0.0055)
People who fisherman supports				0.0128	0.0126	0.0188	0.0123	0.0181
				(0.0113)	(0.0109)	(0.0120)	(0.0110)	(0.0121)
Fisherman shares in paying for household expenses (Dummy)				-0.1267 ***	-0.1330 ***	-0.1172 **	-0.1306 ***	-0.1117 **
				(0.0470)	(0.0466)	(0.0497)	(0.0472)	(0.0498)
Average daily hours fishing				-0.0354 ***	-0.0367 ***	-0.0340 ***	-0.0369 ***	-0.0350 ***
				(0.0090)	(0.0087)	(0.0105)	(0.0087)	(0.0107)
Years in occupation				0.0007	0.0001	0.0005	0.0001	0.0005
				(0.0021)	(0.0020)	(0.0022)	(0.0020)	(0.0023)
Fisherman is paying a loan (Dummy)				0.0906 *	0.0837	0.0535	0.0840	0.0529
				(0.0522)	(0.0530)	(0.0546)	(0.0531)	(0.0542)
Fisherman has job alternatives (Dummy)				-0.0816 *	-0.0748 *	-0.0845 *	-0.0753 *	-0.0857 *
				(0.0451)	(0.0450)	(0.0471)	(0.0448)	(0.0466)
Fishery resources are scarce				0.0721	0.0677	0.0436	0.0677	0.0437
				(0.0542)	(0.0543)	(0.0541)	(0.0543)	(0.0543)
Government should help in the conservation of CGSM (Dummy)				0.1704 ***	0.1674 ***	0.1252 ***	0.1687 ***	0.1296 ***
				(0.0450)	(0.0445)	(0.0464)	(0.0444)	(0.0461)
Constant	2.8832 ***	2.8118 ***	2.8402 ***	3.2162 ***	3.1790 ***	3.1768 ***	3.1984 ***	3.2223 ***
	(0.0480)	(0.0428)	(0.0537)	(0.1649)	(0.1476)	(0.1811)	(0.1598)	(0.1956)
Observations	**152**	**152**	**134**	**152**	**152**	**134**	**152**	**134**
R^2	0.0014	0.0105	0.0001	0.2866	0.2994	0.2503	0.3005	0.2600

Notes: *** 99% significance ** 95% significance * 90% significance. Robust standard errors are in parentheses.

we got similar results (Table 3, Model 4: t = 0.00, p = 1.000; Table 4, Model 4: t = − 0.65, p = 0.515). In Models 7 and 8 in Tables 3 and 4, we added the impatience measured by the TPE with Coca Cola (Models 7) and the TPE with the bonus (Models 8) as other control variables. However, these do not affect the significance of the contributions in the PGE. Therefore, the results remain insignificant. We also tested if using an index constructed on fishing spots or fishing gear/methods alone, or an index using just data points from one year out of the SIPEIN data base would provide any significant correlation, but the results remained insignificant.

Overall, in contrast to the findings of Fehr and Leibbrandt (2011), we did not find evidence to confirm our hypothesis that fishermen who contributed less to the public good exert higher impacts on the CGSM and fishermen who contribute more have lower impacts on this lagoon. One explanation of this lack of correspondence between the behavior in the experiment and the real fishing behavior of fishermen is the use of the index. Thus, while Fehr and Leibbrandt (2011) used the hole size of the shrimp traps, our index included several aspects of fishing activity. In Section 5.3, where we discuss our findings in light of other studies, we analyze this aspect in more detail.

5.2. Predicting Fishermen's Sustainable Behavior with the Time Preferences Experiments

As we mentioned earlier, we used two TPEs (Coca Cola & Bonus) to get an individual measure of fishermen's impatience. Fig. 5 displays the fishermen's preference for Coca Cola (Fig. 5a) and the distribution of estimated discount rates (Fig. 5b). It can be seen that 74% of fishermen in our study were patient and preferred two Coca Colas at the end of the session, which is similar to the findings of Fehr and Leibbrandt (2011) who found that 61% of shrimpers were patient and preferred three pralines at the end of the experimental session. Fig. 5b shows, apart from the results of the TPE with the bonus, also how many patient and impatient people we found in the Coca Cola experiment for each category in the TPE with the bonus. This indicates that there is not a clear relationship between the fishermen behavior in both experiments. Additionally we calculated Chi^2, which indicates that there is a no significant relationship between the results of the Coca Cola experiment and the TPE with bonus (Pearson Chi^2 (4) = 4.7787 p = 0.311). From those results we cannot infer which of the two TPEs provides a more realistic representation of people's time preferences. However, the TPE with bonus is the standard method of assessment of time preferences. The Coca Cola experiment probably rather tests self control than time preferences, as it is very similar to the Standford Marshmallow experiment, where children have to choose if they prefer one Marshmallow in comparison to two later (Mischel et al., 1972).

Fig. 6 shows a first insight into the relationship between fishermen's impatience and the level of impact that they cause on the CGSM. As we can observe in Fig. 6a, the average scores of indices from fishermen who are impatient and prefer one Coca Cola immediately are similar to the average scores of indices from fishermen who are patient and prefer two Coca Colas at the end of the experimental session. Fig. 6b shows similar results: fishermen with the lowest discount rates (i.e., patient fishermen) have almost the same average scores of indices than fishermen who have the highest discount rates (i.e., impatient fishermen).

We also used OLS regressions to analyze the relationship between impatience and the scores of fishing impact indices calculated based on the experienced fishermen's scores (Table 3) and scientists' scores (Table 4). For the regressions, the variable *Impatience* (*Coca Cola*) was

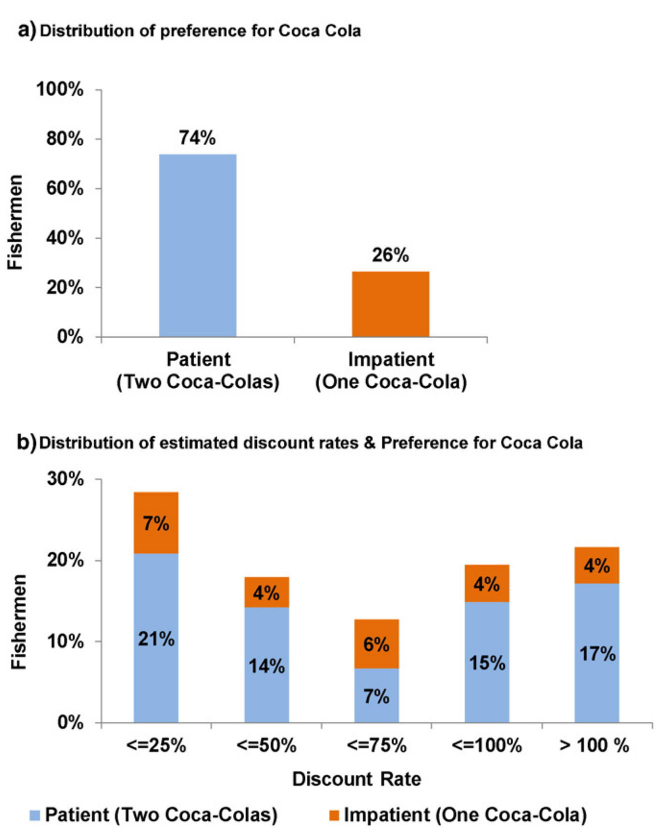

Fig. 5. Fishermen's preferences in the experiments. Total fishermen : 152 for the TPE with Coca Cola (Fig. 5a). In the case of TPE with the bonus (Fig. 5b), the final sample consists of 134 observations. 18 subjects gave inconsistent responses, so we did not include these observations.

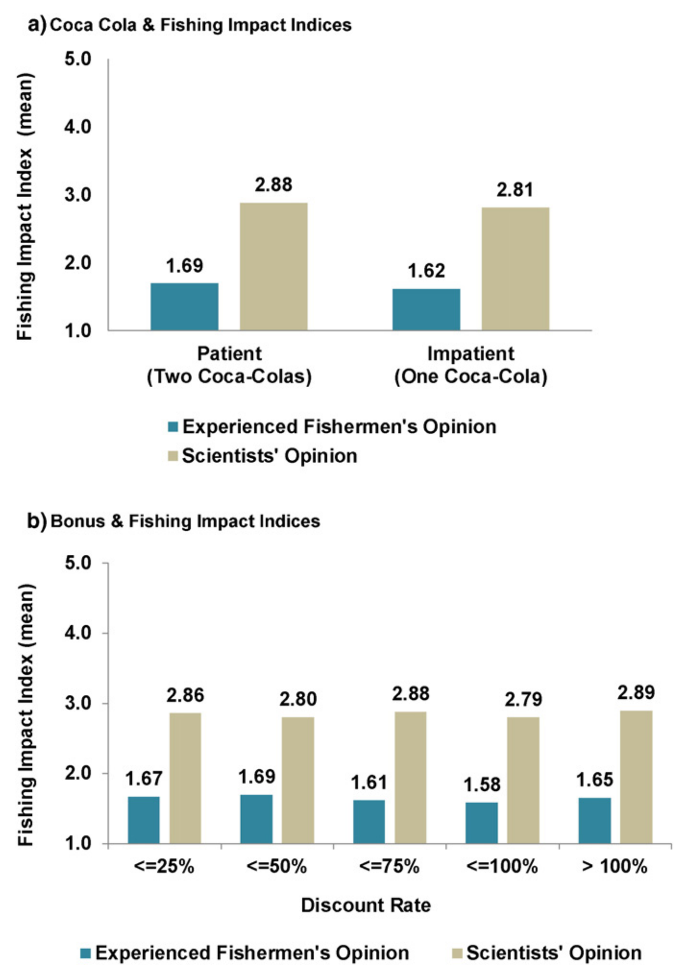

Fig. 6. Impatience and fishing impact indices. Fishing impact index: 1 = Low impact, 5 = High impact.

Table 5
Determinants of laboratory behavior (OLS).

Dependent variable	**Contibution to the public good**			
Models	**1**	**2**	**3**	**4**
Impatience (Coca Cola Dummy)	-0.6071 (0.6286)		-0.6551 (0.6324)	
Impatience (Bonus %)		1.3653 * (0.7963)		1.3015 (0.8177)
Years of schooling			0.0518 (0.0668)	0.0619 (0.0825)
People who fisherman supports			-0.0954 (0.0978)	-0.0781 (0.1050)
Fisherman shares in paying for household expenses (Dummy)			0.7008 (0.5380)	0.5832 (0.5690)
Average daily hours fishing			-0.0496 (0.0937)	-0.1017 (0.1047)
Years in occupation			0.0031 (0.0246)	0.0006 (0.0276)
Fisherman is paying a loan (Dummy)			0.0869 (0.5441)	-0.0637 (0.5671)
Fisherman has job alternatives (Dummy)			-0.1532 (0.5533)	-0.1276 (0.5840)
Fishery resources are scarce (Dummy)			-0.0239 (0.7944)	0.0081 (0.8366)
Government should help in the conservation of CGSM (Dummy)			0.3950 (0.5211)	0.4666 (0.5551)
Constant	5.3750 *** (0.5624)	3.7966 *** (0.5786)	5.7058 *** (1.8028)	4.8296 ** (2.3262)
Observations	**152**	**134**	**152**	**134**
R^2	0.0073	0.0197	0.0345	0.0487

Notes: *** 99% significance ** 95% significance * 90% significance. Robust standard errors are in parentheses.

coded as a dummy variable (0 = Prefers one Coca Cola immediately and 1 = Prefers two Coca Colas after). The variable *Impatience* (*bonus*) was coded as a percentage, and corresponds to the discount rate calculated for each fisherman.

In Models 2 and 3 of Tables 3 and 4, we investigated whether the impatience in the TPE with Coca Cola (Models 2) and the TPE with the bonus (Models 3) have any effect on the scores of the fishing impact indices. We found no effect of the impatience on the scores of the indices. Nevertheless, when we added control variables, Models 5 and 6 in the same Tables (3 and 4), we observe that there is a small significant positive relationship ($\alpha = 0.10$) between fishermen who are patient and prefer two Coca Colas after the session and the fishing impact index calculated based on scientists' opinion (Table 4, Model 5). Thus, fishermen who are patient have a higher fishing impact index (coefficient = 0.0878 points, t = 1.79, p = 0.075) than fishermen who are impatient and prefer one Coca Cola immediately. This result continues being significant ($\alpha = 0.10$) and robust to the inclusion of the contributions in the PGE as a control variable (coefficient = 0.0856 points, t = 1.73, p = 0.086) in the Model 7 of Table 4. This finding could be explained by the disinvestment effect (Farzin, 1984). More patient fishermen have the means to invest in fishing gear with a higher extraction potential, which normally are more expensive and need savings. However, due to their higher extraction rate, they are less sustainable. In Model 8 of Tables 3 and 4, which focuses on the TPE with bonus, where we added the contribution to the PGE and other control variables, we still find no correlation between the level of impatience for the bonus and the scores of the fishing impact indices.[11] The fact that we conducted a number of independent analyses using relatively statistically uncorrelated predictors increases the likelihood of making a type I error, particularly using an α level of 0.10. All this indicates that the relationship between the behavior in the various experiments and sustainable behavior in real life according to the index is rather weak.

In addition, we examined in Table 5, if the impatience in the TPE with Coca Cola (Models 1 and 3) and the TPE with the bonus (Models 2 and 4) predicts fishermen's cooperativeness in the PGE. We found that only in Model 2, the impatience of the TPE with bonus and without using any controls leads to a significant result (coefficient = 1.3653 points, t = 1.71, p = 0.089). Nevertheless, when we added controls (Model 4) it becomes insignificant, indicating the lack of robustness of this result. Besides this model, the results for the other three Models (1, 3 and 4) show that impatience is not a predictor of contributions in the public good. Furthermore, as we played an unframed PGE, we would have expected that the behavior in the PGE is only influenced by the cooperative orientation of the players or their expectations about the cooperativeness of the other group members and not by time preferences.

5.3. Discussing the Results in the Light of Other Studies

As stated in the introduction, only some studies have found evidence of external validity of economic experiments, measured as the correspondence between the behavior in the experiment and the behavior in real life, while others have not. Table 6 shows a summary of the main characteristics of these studies.

Regarding studies with external validity, Rustagi et al. (2010) combined experimental measures of conditional cooperation and survey measures on costly monitoring with forest growth data for 49 forest user groups in Ethiopia. They found that groups with larger proportion of conditional cooperation had more productive forests and they were more likely to invest in forest patrols in order to promote cooperation by sanctioning free riders. Carpenter and Seki (2011) examined two groups of artisanal shrimpers in Japan, where one of the groups pooled their income and operating costs and the other group did not. They compared cooperation of poolers and non-poolers in a public goods experiment with a voluntary contribution mechanism and payment to show disapproval with the contribution of the other members of the group. They found that poolers had higher levels of cooperation than non-poolers.

Fehr and Leibbrandt (2011) conducted laboratory experiments and field observations of shrimpers and fishermen in Brazil. They found that subjects who were more cooperative and patient in the experiments were less likely to overexploit the CPR. Gelcich et al. (2013) investigated two groups of artisanal fishermen in Chile, comparing

[11] We also investigated which of the socioeconomic and perception variables predicted fishermen's decisions in both TPEs. We observed that *years in occupation* and *fishery resources are scarce* were the only variables that significantly ($\alpha = 0.05$) predict decisions in the experiments with Coca Cola and the bonus, respectively.

Table 6
Summary of main characteristics of the studies on external validity of experiments on cooperation in CPRs.

	Hill & Gurven (2004)	Gurven & Winking (2008)	Rustagi et al. (2010)	Carpenter and Seki (2011)	Fehr & Liebbrandt (2011)	Gelcich et al. (2013)	Torres Guevara & Schlüter (2016)
Subjects	Ache Indians: hunters and gathers	Tsimane forager-horticulturalists	Forest users	Artisanal shrimpers	Artisanal shrimpers and fishers	Artisanal benthic fishers	Artisanal fishermen
Place	Forest areas of Eastern of Paraguay	Lowlands of Bolivia	Bale region of Ethiopia	Toyama Bay in the west coast of the Honsyou Island, Japan	Northeastern Brazil	Coast of Chile	Caribbean Coast of Colombia
Property regime	Forest reservations with legal land access	Indigenous territory with Collective property rights.	Secure tenure rights to use and manage the forests as a common property	Collective property rights through Fishery Cooperative Associations	Lake under open access regime	Unionized fishers: Territorial user rights areas on the coast Non-unionized fishers: open access areas	Coastal lagoon under a *de facto* open access regime
Type of analysis	Individual behavior	Individual behavior	Group behavior: - 49 Forest user groups	Group behavior: - Poolers - Non-poolers	Individual behavior	Group behavior: - High performance unions - Low performance unions - Non-unionized fishers	Individual behavior
Experiments	**PGE** - Round 1: anonymous - Round 2: public - Framed as a play money **UG** - Round 1: anonymous - Round 2: public	**DG** - One-shot **UG** - One-shot **TPPG** - One-shot	**PGE** - One-shot with conditional cooperation - No frame	**PGE - VCM** - Rounds 1 to 5: VCM - Round 6-10: VCM + Social disapproval - Framed as a fishery situation	**PGE** - One-shot - No Frame **TPE** - Chocolate bonbons	**CPRE** - 20 rounds - Framed as a fishery situation	**PGE** - One-shot - No Frame **TPE1** - Coca Cola **TPE2** - Discount rates - Framed as a bonus to participate
Real life indicator	- Observations of food production and sharing patterns	- Observations of prosocial behavior in everyday life: well labor contribution, time spent in social visitation and social group size, food sharing, beer provision and consumption and contribution to a village fest	- Survey measures on costly monitoring - Number of young trees per hectare	- Fishing productivity	- Size of holes of shrimp traps	- Membership of a fishers' union - Union's performance in comanagement: high and low. - Co-management performance index: indirect measure of cooperation.	- Fishing impact indices
Evidence of external validity	No	No	Yes	Yes	Yes	Yes	No

PGE: Public Goods Experiment / UG: Ultimatum game / DG: Dictator game / TPPG: Third Party Punishment Game / TPE: Time Preferences Experiment / PGE-VCM: Public Goods Experiment with Voluntary Contribution Mechanism / CPRE: Common Pool Resources Experiment

nonunionized fishermen's behavior and the performance of unionized's fishermen with their behavior in the experiments. They found that fishermen of high-performance unions were more cooperative among them, while fishermen of low-performance unions were less cooperative. Likewise, they found that fishermen that were not unionized did no cooperate at all.

The two studies that did not find evidence of external validity were carried out with indigenous communities in South America. One of them was done by Hill and Gurven (2004). They related measures of real life cooperativeness with experimental measures of the Ache Indians, a tribal group that lives in the forested areas of Paraguay and has a well-known tradition of extensive food sharing, as well as high levels of cooperative food acquisition. Nevertheless, there was no correlation between subjects' behavior in the experiments and their behavior in real life. The second study was developed by Gurven and Winking (2008). They studied the Tsimane, an indigenous group of forager-horticulturalists of lowland Bolivia. They compared the subjects' behavior in various experiments with their prosocial behavior in their daily life. They found that there was no correlation between their real-life forms of cooperation and their levels of contribution in the experiments.

There are two main reasons that in our opinion, might explain why some studies have found a relationship between subject's behavior in the experiments on cooperation in CPRs and their actions in real life, and other studies did not. The first reason is related to the experimental setup. As shown in Table 6, two of the studies with evidence of external validity (Carpenter and Seki, 2011; Gelcich et al., 2013) compared the behavior between groups of resource users, not of individuals. In these experiments, cooperators and non-cooperators played the game separately. Therefore, there was a clear signaling to all participants about the cooperativeness of their fellow players. In addition, fishermen have been associated in cooperatives for several years, which have allowed them to establish not only patterns of understanding, but also to develop a group identity. In the case of Rustagi et al. (2010), the experiments were done with subjects that are part of a participatory forest management program and have been organized in small forest user groups since 2000, which have formal rights to manage their forests blocks as commons. Therefore, they know more or less what to expect from their group members. This should have influenced subjects' decisions in the experiment, in particular to the conditional cooperators within the groups.

In contrast, Hill and Gurven (2004) and Gurven and Winking (2008) – who did not find evidence of external validity – compared the contributions of each individual, and cooperators and non-cooperators played the game together. Therefore, conditional cooperators could not anticipate either high or low contribution levels, due to group composition and previous experience with those group members. In our experiment, cooperators and non-cooperators played together, similar to Hill and Gurven (2004).

The second reason is the indicator that is used to measure cooperation in real life. Carpenter and Seki (2011) use people's preferences to solve problems collectively or individually as a real life indicator. Thus, according to these authors, fishermen established the pooling arrangement since 1960 as response to several economic problems that they were facing in that moment. Gelcich et al. (2013) take as a proxy if people are living in a cooperative or non-cooperative environment. Thus, one group was formed by subjects from fishermen's unions with territorial user rights areas and a comanagement system since 1997. The other group was formed by nonunionized fishermen who fished exclusively in open-access areas, and they did not participate in the comanagement system. Both studies find a significant relationship, namely, both real life measurements assess cooperation behavior directly.

The studies of Rustagi et al. (2010); Fehr and Leibbrandt (2011), and our study instead observed sustainable resource use as an indicator of cooperation. Nevertheless, we must stress that while these studies use only one feature as a measure of sustainability and associated it with cooperation, we use an index that includes several components related to the fishing activity for five years. In fact, Rustagi et al. (2010) use the number of young trees per hectare that each group had in their forest blocks in 2005. The data was obtained from an assessment that is carried out once every five years by the forest administration.

Fehr and Leibbrandt (2011) use the hole size of the shrimp traps as an indicator of cooperation, which are manufactured by the fishermen making holes in used PET bottles. To get the data, they measured five to ten holes in one to two bottles that fishermen brought to a meeting in which they participated, and then they estimated an average hole size for each fisherman. Nevertheless, this measure of cooperativeness could be biased not only due to the reduced number of hole sizes measured – as these authors state – but also because fishermen could have inherited the traps from somebody, or asked someone else to make the holes in the bottles, or brought the only available bottles that they had in that moment to the meetings. In our case, we built two fishing impact indices, which evaluate fishermen's fishing behavior for five years based on the different fishing gear and methods used, and the fishing spots visited.

In contrast, Hill and Gurven (2004) use data about the food production and sharing patterns for five months, and Gurven and Winking (2008) use food production, food-sharing patterns, social visitation, and participation in some communal activities carried out for the community for eleven months. Overall, all those indicators are influenced by many factors (as our regression results show) and cooperative behavior as a trait might be just one of them. System knowledge, environmental awareness, income, or sense of responsibility definitely might also influence sustainable behavior. In fact, for instance, some studies have found that artisanal fishermen who are older, with higher levels of education, and higher asset wealth are less likely to use destructive fishing gear (Cinner, 2010; Silva, 2006). Therefore, it is not wholly surprising that the relationship between experimental behavior and sustainable behavior in real life is not as strong as if we measure cooperation in real life more directly.

6. Conclusions

In this study, we did a similar study to that of Fehr and Leibbrandt (2011) in Tasajera, a fishing community located in the Caribbean Coast of Colombia. In addition, we ran a standard TPE following a "multiple price list" format, similar to that of Harrison et al. (2002). We ran a one-shot PGE and two TPEs with 152 fishermen that exploit the fishery resources of the CGSM. The most important findings of our study are as follows: First, we find no correlation between the fishermen's contributions in the PGE and the fishing impact indices. This finding contrasts with the results of Fehr and Leibbrandt (2011), who showed that shrimpers who contribute more to the public good use shrimp traps with bigger holes, allowing the small and infertile shrimps to escape. Nevertheless, we also find that a large group of fishermen contribute to the PGE.

Second, the evidence about the effect of the impatience on the fishing impact indices is weak. Only when we use the fishing impact indices estimated based on scientists' scores, the TPE with Coca Cola is positive and significant, which suggests that patient fishermen have higher impacts on the CGSM. We cannot conclude that there is a relationship between fishermen's behavior in their real life and their behavior in the experiments. Our results are different to the findings of Fehr and Leibbrandt (2011), who found a strong correlation between shrimpers' impatience (measured by preferences for pralines) and the size of the holes in their shrimp traps.

In our view, the fact that some studies find evidence of external validity of economic experiments and others do not, might be associated to diverse factors such as the context in which fishermen live, or the way in which the cooperation in real life is measured. Thus, based on the findings of these studies, we can state that there is a strong link between cooperation in real life and field experiments if real life measures are closely linked to cooperative behavior (Carpenter and Seki, 2011; Gelcich et al., 2013). In the case of a real life measure that is only partially showing cooperative behavior, the link might be much weaker. Food sharing (Gurven and Winking, 2008; Hill and Gurven, 2004), might be influenced, for example, by cooking abilities or income. Sustainable behavior (Fehr and Leibbrandt, 2011; Rustagi et al., 2010), for example, might not only be influenced by cooperative behavior, but also by time preferences, environmental awareness, resource dependence, among others. If cooperation and impatience increase sustainable behavior, it is very much context dependent, and the relationship might even be the other way around. Therefore, the observation of a rather low relationship between the experimental behavior in a PGE, the TPEs and sustainable behavior in real life might not put into question the external validity of experiments as such. However, the findings imply that we should be more careful, when linking experimental behavior in those standard experiments with overall sustainable behavior. As certain studies show, experimental behavior might correspond well to cooperation levels or time preferences in real life, but not to the more complex phenomenon of sustainable behavior. This indicates that caution is necessary, if we are to draw policy conclusions on sustainable behavior from experimental results.

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Appendix A. Fishing Impact Indices

A.1. Methodology to Build the Indices Evaluating Fishing Ecological Impact in Cienaga Grande de Santa Marta (CGSM)[12]

To build the fishing impact indices we used two sources of data:

1. A database with individual data on fishing spots visited and fishing gear/methods used from 2006 to 2010 for the same group of fishermen that participated in the experiments. We got this data from SIPEIN (INVEMAR's Fisheries Information System).
2. An evaluation of the ecological impact of fishing in CGSM made by 25 experienced CGSM's fishermen and 25 scientists with an in-depth knowledge of CGSM fishery.

SIPEIN is a system of data collection and processing of fishing information that belongs to the Institute for Marine and Coastal Research –

[12] The information about the evaluation and the construction of the indices is nearly the same as the one provided in Torres-Guevara et al. (Under review) in *Sustainability*. Understanding artisanal fishermen's behavior: the case of Ciénaga Grande de Santa Marta, Colombia.

INVEMAR. It is the institute responsible in Colombia for conducting basic and applied research on the natural renewable resources and the environment of coastal and oceanic ecosystems. This Institute has been collecting fishing information on the CGSM since 1993. The data are collected five days a week in five fish landing sites where sell their fish. At each site, the information is collected by a resident trained by INVEMAR for this job. The fishermen to be assessed are selected unsystematically, depending on availability. In three out of five days, information on the fishing unit (vessel and crew) and fishing effort, fishing spots visited, characteristics of the fishing gear and methods, and landed catch is gathered. In the other two days, they collect data on the size frequency for the landed catch, fish prices, and fishing expenses, among other data. Due to this way of data collection, there is not a daily monitoring of each fisherman registered in SIPEIN and therefore each fisherman had different number of data entries for the period evaluated. For this study we only used the data on the fishing spots visited and the fishing gear and methods used by fishermen sampled from 2006 to 2010.

The evaluation of ecological impact of fishing in CGSM consisted of four stages. In the first stage, we elaborated a list of all fishing spots and gear (with their respective methods) registered in SIPEIN database. In total we identified 116 fishing spots where fishermen fish. Additionally, we found seven different gear, namely, five types of nets, long lines, and crab traps. One of the nets, the gill net, is used with two methods—encircling and fixed—thus we established eight different fishing methods. For the nets, we identified 36 different mesh sizes.

In stage two, we defined six fishing zones within CGSM according to their ecological characteristics and importance with support of a few scholars with an in-depth knowledge of the region, namely, protected areas, natural nursery areas, mouths of rivers and streams, mangrove roots and other vegetation, Boca de la Barra, and water mirrors away from the mangrove. Then, with the help of the scholars and several experienced fishermen, we classified all 116 fishing spots identified in stage one into one of these six zones.

Afterward, with support of the scholars in addition to fishing literature (Bjordal, 2009; Blaber et al., 2000; Rueda and Defeo, 2003), we chose three criteria normally used to evaluate the ecological impact of fishing gear/methods on the ecosystem, namely, impact on the habitat, efficiency,[13] and selectivity[14] of fishing gear and target species impact. To reduce the number of fishing nets to be evaluated, based on literature (INVEMAR, 2002; López et al., 2001; Narváez et al., 2008; Rueda and Defeo, 2003; Santos-Martínez et al., 1998) and scholars' knowledge, we defined two groups of mesh sizes for each method: ecologically unsustainable (nets with the smaller mesh size) and ecologically sustainable (nets with the larger mesh size). For the shrimp nets, we defined only one group since shrimps inside CGSM are juveniles and therefore it is unsustainable to catch them (López et al., 2001). Additionally, for each fishing gear, we evaluated jointly two aspects (1) fishing method and (2) the dimension of the fishing gear. For the latter we evaluated the mesh size of the nets, the caliber of hooks for the long lines, and the size of the entrance gap for the crab traps.

Due to the diversity of fishing resources in CGSM, we considered only the main fishing resources extracted for the evaluation. Thus, in the third stage, we selected five types of fish and three invertebrates[15] based on CGSM's fishing reports (Cadavid et al., 2012; INVEMAR, 2012) and scientists' knowledge.

Using the information gleaned in the preceding three stages, we created two questionnaires that would allow us to collect experienced fishermen's and scientists' opinions on the ecological impact of fishing on CGSM's main fishery resources and its habitat. These questionnaires included questions for each of the fishing zones as well as questions regarding the different fishing gear and methods identified earlier. The first author conducted workshops and interviews with experienced fishermen and scientists in Tasajera and Santa Marta in March 2013. She collected data from 25 experienced fishermen[16] and 25 scientists,[17] both groups selected using convenience and snowball sampling. Both experienced fishermen and scientists graded on a scale from 1 to 5, where 1 meant low impact and 5 meant high impact, (a) ecological impact of fishing in each fishing spot (graded by fishermen) or zone identified previously (graded by scientists), and (b) ecological impact caused by the fishing gear/methods on CGSM's main fishery resources defined previously. The first difference we identified between fishermen and scientists is that fishermen had a much more nuanced understanding of the area and thus were able to evaluate the 116 fishing spots. Scientists had to evaluate only the six fishing zones in which the 116 spots were clustered.

Based on the results of the evaluation done by experienced fishermen and scientists, we first built individual indicators for fishing spots and fishing gear/methods and then composite indicators (Indices).

To build the individual indicators based on scientists' opinion, firstly, we computed a simple average with the scores the scientists provided for each fishing zone (6). Then we repeated the same procedure for each fishing gear/method evaluated (13). To build the individual indicators based on experienced fishermen's opinion, we repeated the same process with their scores. Secondly, we evaluated the individual fishermen's behavior. To do that, we merged the information about the fishing spots visited and the fishing gear/methods used by fishermen from 2006 to 2010 with the average scores obtained from scientists' or experienced fishermen assessment. Thirdly, since each fisherman had different amounts of data entries for the whole period analyzed, we computed average scores (individual indicators) for each fisherman and for four different issues: two relating to fishing spots — one based on experienced fishermen's scores and the other based on scientists scores — and two for fishing gear/methods — one based on experienced fishermen's scores and the other one based on scientists scores.

To build the composite indicators (indices), we first assigned to each individual indicator (fishing spot and fishing gear/method) a weight using the equal weighing method (OECD and JRC, 2008).[18] Then we aggregated them using the linear aggregation method (OECD and JRC, 2008).[19] We got two composite indicators for each fisherman, one based on experienced fishermen's opinions and the other based on scientists' opinions.

Appendix B. Supplementary Data

Supplementary data to this article can be found online at http://dx.doi.org/10.1016/j.ecolecon.2016.04.022.

References

Agrawal, A., 2001. Common property institutions and sustainable governance of resources. World Dev. 29, 1649–1672.

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

[13] Gear efficiency or catchability refers to “fish caught per fish available per effort unit and per time unit” (Jul Larsen et al., 2003).

[14] Gear selectivity refers to a “fishing method's ability to target and capture organisms by size and species during the fishing operation allowing non-targets to be avoided or released unharmed” (FAO, 2005).

[15] The CGSM fishery is multi-species; we did not evaluate the impact of the fishing on each species in particular. Instead, we asked fishermen and scientists who participated in the evaluation to consider all the species jointly.

[16] The first author has been working with CGSM's fishermen since 2011; therefore, she had identified previously this group of fishermen. It is important to note that some of the fishermen who participated in this evaluation had also participated in the survey.

[17] These scientists have an in-depth knowledge in different topics related to CGSM fishery (e.g. population dynamics, fishing gear and practices). They were identified with the help of INVEMAR's researchers working in the region.

[18] We used this method because we did not have information that allowed us to determine which of the components—fishing spot or fishing gear/method—was more important.

[19] This method consists of the summation of the weighted individual indicators, and according to OECD and JRC (2008) it is the most appropriate when the individual indicators have the same measurement unit.

Aswani, S., Gurney, G.G., Mulville, S., Matera, J., Gurven, M., 2013. Insights from experimental economics on local cooperation in a small-scale fishery management system. Glob. Environ. Chang. 23, 1402–1409.
Baland, J.M., Platteau, J.P., 1996. Halting Degradation of Natural Resources: Is There a Role for Rural Communities? Food and Agriculture Organization of the United Nations, Rome
Basurto, X., Ostrom, E., 2009. Beyond the Tragedy of the Commons. Economia Delle Fonti Di Energia e Dell Ambiente Vol. 52, pp. 35–60.
Basurto, X., Gelcich, S., Ostrom, E., 2013. The social–ecological system framework as a knowledge classificatory system for benthic small-scale fisheries. Glob. Environ. Chang. 23, 1366–1380.
Bjordal, Å., 2009. Regulation of fishing gear and methods. In: Cochrane, K.L., Garcia, S.M. (Eds.), A Fishery Manager's Guidebook, 2 ed. The Food and Agriculture Organization of the United Nations and Wiley-Blackwell, Singapore, pp. 167–196.
Blaber, S.J.M., Cyrus, D.P., Albaret, J.J., Ching, C.V., Day, J.W., Elliott, M., Fonseca, M.S., Hoss, D.E., Orensanz, J., Potter, I.C., Silvert, W., 2000. Effects of fishing on the structure and functioning of estuarine and nearshore ecosystems. ICES J. Mar. Sci. 57, 590–602.
Blanco, J.A., Narváez, J.C., Viloria, E.A., 2007. ENSO and the rise and fall of a tilapia fishery in northern Colombia. Fish. Res. 88, 100–108.
Cadavid, B.C., Bautista, P.A., Espinosa, L.F., Hoyos, A.J., Malagón, A.M., Mármol, D., Orjuela, A.M., Parra, J.P., Perdomo, L.V., Rueda, M., Villamil, C.A., Viloria, E.A., 2012. Monitoreo de las condiciones ambientales y los cambios estructurales y funcionales de las comunidades vegetales y de los recursos pesqueros durante la rehabilitación de la Ciénaga Grande de Santa Marta. Informe Técnico Final 2011. Instituto de Investigaciones Marinas y Costeras "José Benito Vives de Andréis" - INVEMAR, Santa Marta, Colombia.
Cárdenas, J.C., 2000. How do groups solve local commons dilemmas? Lessons from experimental economics in the field. Environ. Dev. Sustain. 2, 305–322.
Cárdenas, J.C., 2004. Groups, Commons and Regulations: Experiments with Villagers and Students in Colombia. CEDE, Universidad de los Andes, Bogotá D.C., Colombia.
Cárdenas, J.C., 2011. Social norms and behavior in the local commons as seen through the lens of field experiments. Environ. Resour. Econ. 48, 451–485.
Cárdenas, J.C., Carpenter, J., 2008. Behavioural development economics: lessons from field labs in the developing world. J. Dev. Stud. 44, 311–338.
Cárdenas, J.C., Ostrom, E., 2004. What do people bring into the game? Experiments in the field about cooperation in the commons. Agric. Syst. 82, 307–326.
Carpenter, J., Seki, E., 2011. Do social preferences increase productivity? Field experimental evidence from fishermen in Toyama Bay. Econ. Inq. 49, 612–630.
Castillo, D., Bousquet, F., Janssen, M.A., Worrapimphong, K., Cárdenas, J.C., 2011. Context matters to explain field experiments: results from Colombian and Thai fishing villages. Ecol. Econ. 70, 1609–1620.
Cinner, J.E., 2010. Poverty and the use of destructive fishing gear near east african marine protected areas. Environ. Conserv. 36, 321–326.
Cinner, J.E., McClanahan, T.R., 2006. Socioeconomic factors that lead to overfishing in small-scale coral reef fisheries of Papua New Guinea. Environ. Conserv. 33, 73–80.
Cinner, J.E., Pollnac, R.B., 2004. Poverty, perceptions and planning: why socioeconomics matter in the management of Mexican reefs. Ocean Coast. Manag. 47, 479–493.
Clark, C.W., 1973. The economics of overexploitation. Science 181, 630–634.
Coleman, E.A., Lopez, M.C., 2013. Reconstructing cooperation from civil conflict: experimental evidence from Colombian development policy. (Unpublished manuscript).
Falk, A., Heckman, J.J., 2009. Lab experiments are a major source of knowledge in the social sciences. Science 326, 535–538.
FAO, 2005. World inventory of fisheries. Selectivity of gear. Issues fact sheets. Text by John Willy Valdemarsen, Fisheries and Aquaculture Department [online], Rome. (Updated 27 May 2005. Cited 16 September 2015) http://www.fao.org/fishery/topic/12282/en.
Farzin, Y.H., 1984. The effect of the discount rate on depletion of exhaustible resources. J. Polit. Econ. 92, 841–851.
Fehr, E., Leibbrandt, A., 2011. A field study on cooperativeness and impatience in the tragedy of the commons. J. Public Econ. 95, 1144–1155.
Frederick, S., Loewenstein, G., O'Donoghue, T., 2002. Time discounting and time preference: a critical review. J. Econ. Lit. 40, 351–401.
Gelcich, S., Guzman, R., Rodríguez-Sickert, C., Castilla, J.C., Cárdenas, J.C., 2013. Exploring external validity of common pool resource experiments: insights from artisanal benthic fisheries in Chile. Ecol. Soc. 18 (3), 2.
Gónima, L., Mancera, J.E., Botero, L., 1996. Análisis e interpretación de imagenes de satélite para estudios de vegetación, suelos y aguas en la Ciénaga Grande de Santa Marta. Informe Final. Universidad Nacional de Colombia e INVEMAR, Santa Marta, Colombia.
Gurven, M., Winking, J., 2008. Collective action in action: prosocial behavior in and out of the laboratory. Am. Anthropol. 110, 179–190.
Hardin, R., 1968. The tragedy of the commons. Science 162, 1243–1248.
Harrison, G.W., Lau, M.I., Williams, M.B., 2002. Estimating individual discount rates in Denmark: a field experiment. Am. Econ. Rev. 92, 1606–1617.
Hill, K., Gurven, M., 2004. Economic experiments to examine fairness and cooperation among the Ache Indians of Paraguay. In: Henrich, J., Boyd, R., Bowles, S., Camerer, C., Fehr, E., Gintis, H. (Eds.), Foundations of Human Sociality: Economic Experiments and Ethnographic Evidence from Fifteen Small-Scale Societies. Oxford University Press, Oxford, UK, pp. 382–412.
Hopfensitz, A., Miquel-Florensa, J., 2014. Investigating Social Capital in Colombia: Conflict and Public Good Contributions. Working paper. Toulouse School of Economics (TSE).
Ibarra, K.P., Villamil, C.A., Viloria, E.A., Vega, D., Bautista, P.A., Cadavid, B.C., Parra, J.P., Espinosa, L.F., Gómez, M.C., Agudelo, C.M., Perdomo, L.V., Mármol, D., Rueda., M., 2013. Monitoreo de las condiciones ambientales y los cambios estructurales y funcionales de las comunidades vegetales y de los recursos pesqueros durante la rehabilitación de la Ciénaga Grande de Santa Marta. Informe Técnico Final 2012. Instituto de Investigaciones Marinas y Costeras "José Benito Vives de Andréis" - INVEMAR, Santa Marta, Colombia.
Ibarra, K.P., Gómez, M.C., Viloria, E.A., Arteaga, E., Quintero, M., Cuadrado, I., Rodríguez, J.A., Licero, L., Perdomo, L.V., Rueda., M., 2014. Monitoreo de las condiciones ambientales y los cambios estructurales y funcionales de las comunidades vegetales y de los recursos pesqueros durante la rehabilitación de la Ciénaga Grande de Santa Marta. Informe Técnico Final 2013. Instituto de Investigaciones Marinas y Costeras "José Benito Vives de Andréis" - INVEMAR, Santa Marta, Colombia.
INVEMAR, 2002. Monitoreo de las condiciones ambientales y los cambios estructurales y funcionales de las comunidades vegetales y de los recursos pesqueros durante la rehabilitación de la Ciénaga Grande de Santa Marta: un enfoque de manejo adaptativo. Informe Técnico Final 1999–2002. Convenio MMA-BID-INVEMAR. Instituto de Investigaciones Marinas y Costeras "José Benito Vives de Andréis" - INVEMAR, Santa Marta, Colombia.
INVEMAR, 2012. Informe del estado de los ambientes y recursos marinos y costeros en Colombia: año 2011. Serie de Publicaciones Periódicas No. 8. INVEMAR, Santa Marta, Colombia.
INVEMAR, 2013. Informe del estado de los ambientes y recursos marinos y costeros en Colombia: año 2012. Serie de Publicaciones Periódicas No. 8. INVEMAR, Santa Marta, Colombia.
INVEMAR-SIPEIN, 2012. Sistema de Información Pesquera del INVEMAR - SIPEIN. INVEMAR - Programa Valoración y Aprovechamiento de Recursos Marinos y Costero, Santa Marta.
Janssen, M.A., Anderies, J.M., 2011. Governing the commons: learning from field and laboratory experiments. Ecol. Econ. 70, 1569–1570.
Janssen, M.A., Holahan, R., Lee, A., Ostrom, E., 2010. Lab experiments for the study of social–ecological systems. Science 328, 613–617.
Jul-Larsen, E., Kolding, J., Overå, R., J., R.N., Zwieten, P.A.M.v., 2003. Management, Co-management or No Management? Major Dilemmas in Southern African Freshwater Fisheries. Synthesis report. FAO Fisheries Technical Paper. No. 426/1. Rome.
Krantz, D.H., Kunreuther, H.C., 2007. Goals and plans in decision making. Judgment Decis. Mak. 2, 137–168.
Levitt, S.D., List, J.A., 2007. What do laboratory experiments measuring social preferences reveal about the real world? J. Econ. Perspect. 21, 153–174.
López, A.C., Criales, M.M., García, C.B., 2001. Postlarvas y juveniles de camarones *farfantepenaeus spp* y *Xiphopenaeus kroyeri* en la Boca de la Barra (Ciénaga Grande de Santa Marta), Caribe colombiano. Bol. Invest. Mar. Cost. INVEMAR 30, 177–198.
Lopez, M.C., Murphy, J.J., Spraggon, J., Stranlund, J.K., 2012. Comparing the effectiveness of regulation and pro-social emotions to enhance cooperation: experimental evidence from fishing communities in Colombia. Econ. Inq. 50, 131–142.
Mischel, W., Ebbesen, E.B., Raskoff Zeiss, A., 1972. Cognitive and attentional mechanisms in delay of gratification. J. Pers. Soc. Psychol. 21, 204.
Muradian, R., Cárdenas, J.C., 2015. From market failures to collective action dilemmas: reframing environmental governance challenges in Latin America and beyond. Ecol. Econ. 120, 358–365.
Narváez, B.,J.C., Herrera, P.,F.A., Blanco, R.,J., 2008. Efecto de los artes de pesca sobre el tamaño de los peces en una pesquería artesanal del caribe colombiano. Bol. Invest. Mar. Cost. INVEMAR 37, 163–187.
OECD, JRC, 2008. Handbook on Constructing Composite Indicators: Methodology and User Guide. Organisation for Economic Co-operation and Development (OECD) and JRC (Joint Research Centre), Paris, France.
Olson, M., 1965. The Logic of Collective Action. Public Goods and the Theory of Groups. Harvard University Press, Cambridge, Massachusetts.
Orensanz, J.M., Cinti, A., Parma, A.M., Burotto, L., Espinosa-Guerrero, S., Sosa-Cordero, E., Sepúlveda, C., Toral-Granda, V., 2013. Latin-American Rights-based Fisheries Targeting Sedentary Resources. In: Orensanz, J.M., Seijo, J.C. (Eds.), Rights-Based Management in Latin American Fisheries. FAO, Fisheries and Aquaculture Technical Paper, No. 582, Rome.
Ostrom, E., 1990. Governing the Commons. The Evolution of Institutions for Collective Action. Cambridge University Press, New York.
Ostrom, E., 2006. The value-added of laboratory experiments for the study of institutions and common-pool resources. J. Econ. Behav. Organ. 61 (2), 149–163.
Ostrom, E., Walker, J., Gardner, R., 1992. Covenants with and without a sword: self-governance is possible. Am. Polit. Sci. Rev. 86, 404–417.
Ostrom, E., Burger, J., Field, C.B., Norgaard, R.B., Policansky, D., 1999. Revisiting the commons: local lessons, global challenges. Science 284, 278–282.
Rueda, M., 2007. Evaluating the selective performance of the encircling gillnet used in tropical estuarine fisheries from Colombia. Fish. Res. 87, 28–34.
Rueda, M., Defeo, O., 2003. Linking fishery management and conservation in a tropical estuarine lagoon: biological and physical effects of an artisanal fishing gear. Estuar. Coast. Shelf Sci. 56, 935–942.
Rueda, M.E., Mancera, J.E., Mendo, J.H., 1997. Estimación del factor de retención de la red bolichera empleada en pesquería en la Ciénaga Grande de Santa Marta, Caribe colombiano. Acad. Colomb. Cien. Exactas Físicas Nat. 21, 487–495.
Rustagi, D., Engel, S., Kosfeld, M., 2010. Conditional cooperation and costly monitoring explain success in forest commons management. Science 330, 961–965.
Santos-Martínez, A., Viloria, E., Sánchez, C., Rueda, M., Tíjaro, R., Grijalba, M., Narváez., J.C., 1998. Evaluación de los principales recursos pesqueros de la Ciénaga Grande de Santa Marta y Complejo Pajarales, Caribe Colombiano. Informe Final. COLCIENCIAS, INVEMAR y GTZ-PROCIENAGA, Santa Marta, Colombia.
Schlager, E., 1994. Fishers' Institutional Responses to Common Pool Resources Dilemmas. In: Ostrom, E., Gardner, R., Walker, J. (Eds.), Rules, Games & Common-Pool Resources. The University of Michigan Press, Ann Arbor, pp. 246–266.
Silva, P., 2006. Exploring the Linkages Between Poverty, Marine Protected Area Management, and the Use of Destructive Fishing Gear in Tanzania, World Bank policy research working paper 3831. World Bank, Washington D.C., USA.
SISBEN, 2007. Base Certificada Nacional del Sistema de Identificación de Potenciales Beneficiarios de Programas Sociales (SISBEN). Departamento Nacional de Planeación Colombia.

SISBEN, 2012. Base Certificada Nacional del Sistema de Identificación de Potenciales Beneficiarios de Programas Sociales (SISBEN). Departamento Nacional de Planeación Colombia.
Sumaila, U.R., Walters, C., 2005. Intergenerational discounting: a new intuitive approach. Ecol. Econ. 52, 135–142.
Teh, L.S.L., Teh, L.C.L., Sumaila, U.R., 2011. Low discounting behavior among small-scale fishers in Fiji and Sabah, Malaysia. Sustainability 3, 897–913.
Torres-Guevara, L.E., Schlüter, A., Lopez, M.C., 2016. Collective action in a tropical estuarine lagoon: adapting Ostrom's SES framework to Ciénaga Grande de Santa Marta, Colombia. Int. J. Commons 10 (1).
Vélez, M.A., Lopez, M.C., 2013. Rules compliance and age: experimental evidence with fishers from the Amazon River. Ecol. Soc. 18.
Vélez, M.A., Stranlund, J.K., Murphy, J.J., 2009. What motivates common pool resource users? Experimental evidence from the field. J. Econ. Behav. Organ. 70, 485–497.
Vélez, M.A., Stranlund, J.K., Murphy, J.J., 2012. Preferences for government enforcement of a common pool harvest quota: theory and experimental evidence from fishing communities in Colombia. Ecol. Econ. 77, 185–192.
Vilardy, S.P., González, J.A., 2011. Repensando la Ciénaga: nuevas miradas y estrategias para la sostenibilidad en la Ciénaga Grande de Santa Marta. Universidad de Magdalena/Universidad Autónoma de Madrid, Editorial Gente Nueva, Santa Marta, Colombia.