COOPERATIVENESS AND IMPATIENCE IN THE TRAGEDY OF THE COMMONS[1]

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Abstract: This paper examines the role of cooperativeness and impatience in the exploitation of common pool resources (CPRs) by combining laboratory experiments with field data. We study fishermen whose main, and often only, source of income stems from the use of fishing grounds with open access. The exploitation of a CPR involves a negative interpersonal and inter-temporal externality because individuals who exploit the CPR reduce the current and the future yield for both others and themselves. Accordingly, economic theory – which assumes the existence of general across-situational traits – predicts that fishermen who exhibit more cooperative and less impatient behavior in the laboratory should be less likely to exploit the CPR. This is what we find. Thus we corroborate economic theory and extend the scope of other-regarding preference theories to crucial economic decisions with lasting consequences for the people involved. In addition, we establish cooperativeness and impatience as two distinct traits related to resource conservation in the field and validate laboratory preference measures.

Keywords: cooperation, common pool resource, experiments, generalizability, impatience, methodology

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Economic theory hypothesizes that there is little cooperation in sustaining common pool resources (CPRs) where individual and collective interests are in conflict. The standard assumption of pure self-interest implies that natural resources like fishing grounds or rain forests are overexploited, and that we are often trapped in an inevitable process that ends in the "Tragedy of the Commons" (Hardin, 1968). An additional aggravating factor for resource conservation is the propensity to discount future outcomes. The more impatient resource users are, the more they exploit natural resources.[2] Interestingly, observations from the laboratory paint a more optimistic picture regarding the occurrence of cooperation in social dilemmas. Considerable evidence now shows that some individuals are cooperative and voluntarily sustain CPRs or public goods in the laboratory (Walker, Gardner, Ostrom., 1990; Ostrom, Walker, Gardner, 1992; Andreoni, 1995; Ledyard, 1995; Cardenas, 2000; Casari and Plott, 2003; Croson, 2008; Charness and Villeval, forthcoming), suggesting that some individuals have other-regarding preferences (Andreoni, 1990; Rabin, 1993; Fehr and Schmidt, 1999; Bolton and Ockenfels, 2000; Charness and Rabin, 2002; Dufwenberg and Kirchsteiger, 2004; Sobel, 2005; Falk and Fischbacher, 2006; Segal and Sobel, 2007). There is also laboratory evidence that individuals differ with regard to their degree of impatience (Benzion, Rapoport, Yagil, 1989; Ashraf, Karlan, Wesley, 2006).

In view of the key role that economic theory assigns to individuals' preferences in the exploitation of CPRs, we examine whether laboratory other-regarding and time preference measures predict fishermen's propensity to exploit a CPR that constitutes their main, and often only, source of income. This is a nontrivial task because it requires both laboratory preference measures and field data from the same group of fishermen. The problem is that field measures of preferences are often confounded by all sorts of factors – such as

[2] Farzin (1984) shows that this statement holds as long as capital requirements for exploiting natural resources are low. If capital requirements are high, however, impatient individuals might shy away from investing in technology that facilitates the exploitation of natural resources and thus be less likely to exploit natural resources. Capital requirements are very low in our setting.

reputational incentives, budget or information constraints – while laboratory behavior may be influenced by several factors that are specific to the laboratory environment but that are not present in naturally occurring situations (Levitt and List, 2007). Moreover, prominent scholars have suggested that preferences are "constructed" and highly context-specific (e.g. Kahneman et al., 1993; Loewenstein and Issacharoff, 1994; Schkade and Payne, 1994; Slovic, 1995; Kahneman, 1996; Hoeffler and Ariely, 1999; Frederick, Loewenstein, O'Donoghue, 2002). To quote Tversky and Thaler (1990, p. 210): "*People do not possess a set of pre-defined preferences for every contingency. Rather, preferences are constructed in the process of making a choice or judgment. Second, the context and procedures involved in making choices or judgments influence the preferences that are implied by the elicited responses. In practical terms, this implies that behavior is likely to vary across situations that economists consider identical*."[3]

Therefore, if we can show that laboratory measures of other-regarding and time preferences are nevertheless significantly predictive of fishermen's behavior in the field, we can kill several birds with one stone. First, we corroborate economic theories which predict the relevance of individuals' preferences for the exploitation of CPRs. Second, we extend the scope of other-regarding preference theories to crucial economic decisions with lasting consequences for the people involved. Third, we identify – with cooperativeness and impatience – two distinct traits related to resource conservation in the field. And finally, we demonstrate the value of laboratory preference measures for a better understanding of field behavior.

We achieve these goals with the help of two unique data sets that relate individual laboratory behavior with the fishermen's individual decisions pertaining to the use of certain

[3] Beliefs in the context-dependence of preferences have been fueled by the observation of preference reversals across different elicitation methods. For an examination of the preference reversal phenomenon see, e. g., Plott and Grether (1979).

fishing instruments. Our study takes place in Brazil and involves fishermen who live off shrimp or fish caught from a lake. As there is free access to the lake, they face a CPR dilemma in their daily lives. There is suggestive evidence that fishermen in this setting differ in their level of cooperation for sustaining fishing grounds, i.e. they use different fishing instruments that allow them to influence the proportion of the catch consisting of small shrimp/fish which have not yet reached fertility (Cavalcanti, 2003). We have data from fishermen who catch shrimp (collected 2008) and fish (collected 2006), and both include information about *the extent to which the fishermen's chosen fishing instruments exploit the CPR*, as well as the fishermen's decisions in two laboratory experiments: a public goods experiment where free-riding is the dominant strategy, and a time preference experiment.

Economic theories of other-regarding preferences predict that individuals who exhibit a higher propensity to cooperate in the public goods experiment in the laboratory (i.e. those who demonstrate cooperativeness), and those who show more patience in the time preference experiment, should use fishing instruments which exploit the CPR less for the following reasons: (i) a higher current exploitation reduces the current yield of other fishermen. Thus, ceteris paribus, other-regarding fishermen will impose fewer current negative externalities on others; and (ii) a higher current exploitation (in terms of small shrimp/ fish that have not yet reached fertility) also reduces the future yield for both others and themselves.[4] Therefore, more cooperative and less impatient individuals will impose fewer (current and future) negative externalities on others and themselves.

To provide a rigorous test of whether cooperativeness and impatience are relevant in the field, we use laboratory preference measures that differ in important ways from the field context. *First*, the fishermen face a CPR problem in the field, while subjects play a public

[4] Individual fishermen tend to fish the same spots over extended periods of time, and the fishermen seem to respect this allocation of spots to individuals. This means that they are able to establish weak property rights, implying that they also harm themselves in the future if they catch infertile animals. However, due to the mobility of fish and shrimps throughout the fishing grounds, they obviously also harm other fishermen.

goods game in the laboratory – a difference that is likely to weaken the behavioral link between the two situations (Andreoni, 1995).[5] *Second*, the cooperation problem in the field is embedded in the natural frame of the environment the subjects face every day, while the public goods game was played one-shot and framed in an *abstract* way as a transfer of money from a private account to a group account. This makes it more difficult for the subjects to behave according to their pre-existing preferences because subjects may not fully grasp the prevailing incentives in novel situations (Plott, 1996).[6] *Third*, our experimental time preference measure is related to time preferences within a day, while the time preferences involved in the common pool resource problem relate to months, years, or even decades. *Fourth*, our time preference measure is based on inter-temporal choices about chocolate and mineral water, while the inter-temporal trade off in the CPR problem concerns current versus future yield of shrimp and fish.

Despite these widely different contexts we find that these laboratory measures of other-regarding and time preference in both data sets are important predictors of individual behavior in real world CPRs. In line with the predictions we observe that more cooperative and patient shrimp fishermen use shrimp traps with bigger holes where small shrimps – which have not yet reached reproductive maturity (i.e., "infertile" shrimps) – can escape (see Figure a in the appendix), and more cooperative and patient fishermen who catch fish use fishnets with larger mesh sizes in which only bigger fish are caught (see Figures b and c in the appendix). Thus we provide evidence that cooperativeness and impatience are traits that are not so strongly context dependent as to render the typical economic preference approach meaningless whose merit it is to assume the existence of general across-situational traits.

[5] For evidence in support of Andreoni's finding see e.g. Anderson et al. (2008).

[6] Plott (1996) proposes the "discovered preference hypothesis" as an alternative to the "constructed preference hypothesis". Plott defends the economic view of stable preferences across contexts and argues that subjects only need to "discover" their pre-existing preferences through experience. For this reason, Plott favors stationary replication of experimental situations because this provides the best chance for subjects to discover their preferences in the course of an experimental session.

Note that the behavior in the laboratory public goods and time preference experiments is predicted to be independent because time preferences can play no role in the public goods experiment. We indeed find that fishermen who are impatient in the time preference experiments are neither more nor less likely to cooperate in the public goods experiments. Therefore, our study identifies that *both* cooperativeness and impatience are independently related to resource conversation in a naturally occurring field situation. In addition, we find that fishermen are less likely to exploit fishing grounds if, (i) they perceive the risk of the depletion of the fishing grounds to be higher, and (ii) they believe that other fishermen are also less likely to exploit the fishing grounds.

There are several field studies in which the observed behavioral patterns are consistent with the existence of cooperativeness (e.g. Feeny et al., 1990; Sneath, 1998; Ostrom, 1999; Bandiera, Barankay, Rasul, 2005; Ostrom and Nagendra, 2006; Mas and Moretti, forthcoming). However, these studies do not show a direct link between cooperativeness and the observed field behavior. In fact, they cannot exclude the possibility that cooperation behavior in the field is exclusively driven by social pressure or reputation effects (Kandori, 1991). Bandiera, Barankay, Rasul (2005), for example, find that fruit-pickers work less if their effort has negative externalities on their co-workers, but only in fruit fields where their co-workers can monitor them. Similarly, Mas and Moretti (forthcoming) find that cashiers work faster if a harder-working colleague can observe them, but not if the harder-working colleague cannot observe their work speed. In addition, the field experiments by Landry et al. (2006) and DellaVigna, List, Malmendier (2009) suggests that charitable donations are not necessarily a consequence of altruism, but are often motivated by status concerns or social pressure.

Only a few studies combine laboratory experiments with field observations for better understanding of cooperation behavior in the field (Karlan, 2005; Carpenter and Seki, 2005;

List, 2004a, 2004b, 2006; Laury and Taylor, 08; Benz and Meier, 2008). Karlan (2005) conducted economic experiments with borrowers in a Peruvian microcredit program and reports that the behavior in a trust game predicts loan repayment. Individuals who transfer less money back to their trustor in a trust game are also more likely to drop out of the program and to defaults on their loans. This study shows that behavior in laboratory experiments can predict field behavior. However, since many trustors knew their trustees personally in the trust game Karlan presents, the back-transfers may have been influenced by selfish reputation motives.[7] List's (2006) study with sports card traders suggests that cooperativeness in the field is likely to be affected by reputational concerns. He finds that dealers classified as "local dealers" show gift exchange behavior in the laboratory and the field, while dealers classified as "nonlocal dealers" show less overall cooperation in the field. This finding is consistent with a role for strategic reputation building among local dealers; it is also possible, however, that local dealers care, per se, about their reputations, i.e., that their reputation has a direct effect on their utility. One important difference of our study compared to List (2006) is that we combine both laboratory and field data from the *same* individuals which enables us to directly study the extent to which the laboratory preference measures predict an individual's field behavior.

The studies by Benz and Meier (2008) and Laury and Taylor (2008) examine the link between students' lab behavior and their charitable contributions. This contrasts with our study which predicts the fishermen's resource conservation behavior *in their professional activity* – constituting their main source of income – with laboratory measures of impatience and cooperativeness.[8]

[7] A similar argument also applies to the public goods game in Karlan (2005) which was *not* played anonymously. In addition, it was a step level public good with many Nash equilibria, implying that purely selfish players have an incentive to contribute if they believe they are the pivotal players. This may be the reason why the author finds no significant relationship between the public goods game and loan repayment.

[8] The study by Carpenter and Seki (2005) suggests that cooperative fishermen – as measured by a laboratory public goods game – are more likely to self-select in groups which implemented team-based compensation and work schemes. Cooperative fishermen are more likely to work in situations where income and operating

Our findings help assess the relevance of cooperativeness as well as the scope of other-regarding preference theories in naturally occurring situations. We show that there is no insurmountable gap between the laboratory and the field, even though the context in our laboratory environment differs in important ways from the field context. Our findings show that individuals' traits are not so malleable and context-dependent that they render the economic preference approach meaningless. In addition, our evidence shows that both cooperativeness and impatience are important in understanding the exploitation of CPRs, suggesting methods for reducing their overexploitation. Overexploitation can be constrained, for example, with the help of economic policies that shift the perception of the cost of current overexploitation from the future into the present. Likewise, belief management and information policies may be used for the management of CPRs, if they take the inherent bandwagon effects caused by preferences for conditional cooperation into account.

The paper proceeds as follows. Section I presents the field setting and the field data. Section II presents the laboratory experiments. Section III links the behavior of shrimp fishermen in the laboratory experiments with their field behavior. Section IV provides further corroborating evidence for the role of cooperativeness and impatience in CPR conservation by linking the behavior of fishermen who catch fish in the laboratory experiments with their field behavior. Section V concludes.

expenses are shared over a group of fishing boats than in those environments where sharing only occurs among the members of the own boat. In contrast to our study, the authors do not examine individual cooperation behavior in the field, but only aggregate productivity across the two different groups.

I. Field Setting and the Data

A. Field Setting

Our study took place at a lake in northeastern Brazil. Several rural fishing villages[9] are situated around this lake where fishing is the main and often the only possible way of earning a living. Most fishermen catch shrimp and fish on their own, sell their catch at fish markets, and thus provide their family with nutrition and income. There is free access to the fishing grounds (shrimp and fishing grounds), and a fisherman's capital requirements are rather low. For catching shrimp, fishermen only need a small boat and shrimp traps which they manufacture from used PET bottles.[10] While fishing, fishermen are typically scattered over the lake and fish at their preferred, sometimes remote spot(s). Other fishermen usually respect these spots, i.e. most fishermen do not fish at or close to another fisherman's spot. Their respect for others' fishing spots means that the fishing ground at this lake is not a pure CPR, but shares some features of a private property. The fishermen are aware of the fact that overfishing has negative externalities on others, but the private aspect of their fishing spots also means that private investments like refraining from catching small shrimp or fish affect their own chance to catch these same shrimp or fish at a larger size at the same spot in the future.

There are no legal constraints concerning the studied fishing instruments, and there are no legal regulations concerning the catching of shrimp.[11] In recent years, many fishermen have complained about decreasing catch rates, which they mostly blame on the overexploitation of the shrimp and fish resources, i.e., the catching of large amounts of small, not yet fertile, shrimp and fish (Cavalcanti, 2003). A research project with fishermen revealed

[9] We use the term "villages" for reasons of simplicity. In this field setting, these are sometimes not villages in the ordinary sense, but rather community agglomerations where the borders between the neighboring community agglomerations or villages are unclear.

[10] Fishermen typically use a fishnet for catching fish. The costs for a fishnet can be normally paid with the income generated from one week's catch.

[11] There is only one legal regulation concerning the catching of fish which is the prohibition of catching small fish (below 20–30 centimeters, depending on fish type). This regulation is, however, not enforced.

their strong concern about the excessive exploitation of shrimp resources in this field setting (Cavalcanti, Schläpfer, Schmid, 2008). Governmental and local university institutions have taken note of the severity of the situation and first steps have been initiated to help sustain the fishing grounds. A management council has been introduced to examine the current fishing situation.

B. Field Data

In the following sections, we report the 2008 data from the fishermen who catch shrimp. The 2006 data for the fishermen who catch fish is presented briefly as further corroborating evidence in section IV.[12] We investigated the fishing instruments from 114 shrimp fishermen, collected data from their behavior in laboratory experiments and their responses to survey questions.

During the laboratory experiments and surveys, participants received a code to ensure anonymity and were free to leave at any point in time. The majority of our participants were male (73%), and were experienced, full-time fishermen who generated their income mainly from fishing. On average, the fishermen had been in the profession for 17.4 years and their average daily working time was roughly 4 hours, not including the time spent for preparing and selling the shrimp. 57% derived their income exclusively from fishing, 29.5% derived a small additional income from selling agricultural products, and 16.1% also had a part-time job. In order to control for income, we also asked fishermen about their monthly income. On average, they earn a monthly income of 302 Reais from all activities (variable: *income*).[13] Fishermen spent on average 3.4 years in school and lived in a household with 5.5 persons

[12] A more detailed analysis of the 2006 data can be found in our working paper (Fehr and Leibbrandt, 2008).
[13] The Brazilian currency is called Real (singular) or Reais (plural). 1 Real equaled US $ 0.47 in September 2008, 302.4 Reais = US $ 142.1.

(variable names: *schooling and household size*). 95.4% of the fishermen only used modified PET bottles with small holes to catch shrimp.[14]

We take the fishermen's shrimp traps as a measure of their cooperativeness in sustaining the fishing grounds. Fishermen manufacture their shrimp traps from used PET bottles and make many holes in these traps. The smaller the holes in the traps, the more small, not yet fertile, shrimp are caught in the trap. The average size (i.e., length) of caught shrimp is usually between two and three centimeters. For our purposes it is important to stress that even very small variations in the millimeter domain make a difference as to which shrimp are caught. Thus, by varying the size of the holes in the shrimp trap, the fishermen determine the extent to which they decrease their own and other fisher's future yield by catching small, not yet fertile, shrimp.

We examined one to two bottles from each of 114 fishermen and measured five to ten holes in each bottle at the 0.1 centimeter level to construct our variable *hole size*. This variable denotes the average size of the holes in the shrimp traps for each fisherman. Figure 1 shows the distribution of hole sizes in our sample. The average hole size is 0.448 centimeters. Half of our participants use shrimp traps with a hole size between 0.367 and 0.500 centimeters, while 90% of the average hole size lies between 0.320 and 0.580 centimeters.

[INSERT FIGURE 1 ABOUT HERE]

The use of hole size as a measure of fishermen's cooperativeness in the field has several advantages compared to other indices of cooperativeness such as the catch quantity or catch composition. First, catch quantity is not an unambiguous measure of the extent to which a fisherman decreases the *future* yield for himself and for others because – in principle – a large quantity of shrimp caught need not contain many infertile shrimps. In fact, catching a large

[14] The remaining 4.6% use two different shrimp traps at the same time (PET bottles and "bamboo baskets").

quantity of *big* shrimp may even be perceived as a skill and not necessarily as an uncooperative act among fishermen. A small hole size, in contrast, is clearly associated with the persistent catch of small, infertile, shrimp which diminishes the future shrimp yield. In practice, a small hole size will, of course, lead to a larger quantity of shrimp caught[15], but because a larger quantity of shrimp caught is a less precise indicator of cooperativeness in the field, the hole size measure is preferable.

The second advantage of hole size as a measure of cooperativeness derives from the fact that the shrimp traps are durable goods that can be used over long periods of time. Thus, our hole size measure gives us a measure of cooperativeness over an extended time period. As the fishermen do not record their catch quantity or their catch composition over time, it is impossible to collect objective data on these variables over longer time periods (i.e. several months). Instead, one has to rely on self-reported data which tend to be less reliable. For this reason, we also prefer the hole size measure.[16]

We also collected survey data regarding fishermen's perception and beliefs about current CPR exploitation in their setting which are measured on an ordinal scale with five categories. The variable *field perception* measures how fishermen perceive the risk that the shrimp population will be depleted in the near future due to the use of PET bottles with small holes. The variable *field belief* measures the fishermen's belief about the fraction of the other fishermen's shrimp catch that is below two centimeters. Furthermore, we measure how

[15] Our measure of hole size is positively related to self-reported catch quantity. In the survey, we asked fishermen to estimate how many liters of shrimp they catch in general during a good week and find that the larger the hole size the fewer liters of shrimp the fishermen report catching (Spearman Rank Correlation, r =-0.246, p=0.0077). In addition to the reasons given in the text, we did not use our catch quantity measure because it is self-reported and therefore imprecise. This contrasts with our hole size measure which is based on our own precise measurements.

[16] However, we would like to point out that we also examined the relationship between the self-reported composition of the shrimp catch and laboratory measures of cooperativeness and impatience in an earlier version of this paper (Fehr and Leibbrandt, 2008). The results in the earlier version were in line with the results that we present below, i.e. fishermen that are more impatient and less cooperative in the laboratory experiments had a catch composition that contained a larger share of small, infertile, shrimps. It is reassuring (and supports the robustness of our findings) that different measures of cooperativeness in the field lead to similar results.

centrally fishermen live by asking how many people live in their close surroundings (variable name: *centrality*, average: 24.5). In addition, we have data on the cognitive ability of shrimp fishermen. We measured their cognitive ability by giving them three Raven`s matrices (32.1% provided no, 39.7% one, 23.1% two, and 5.1% three correct answers).[17]

II. The Laboratory Experiments

A. The Public Goods Experiment with Shrimp Fishermen

Shrimp fishermen took part in an anonymous laboratory public goods experiment (PGE) with comparatively high monetary stakes. The participants earned approximately 1.8 times their available daily income during an experimental session. They were divided into groups of three and played this experiment for one period. The payoff function was: $\prod_i (x_i, x_j) = (10 - x_i) + 0.5 \times \left(\sum_{j \neq i} x_j + x_i \right)$. Each fisherman had to decide how many out of ten monetary units (MUs) he wants to contribute ($x_i \in \{0,10\}$) to a public good.[18] For each unit he contributed, he increased the monetary payoff of each of his group members *j* by 0.5 MUs, but at the same time, his own balance was reduced by 0.5 MUs. For each unit one of his group members decided to contribute, his own balance was increased by 0.5 MUs. Since the fishermen's net return from contributing was negative, selfish fishermen should never contribute. However, if all three individuals in the group decided not to contribute, each of them only earned 10 MUs, compared to 15 MUs if all of them contributed all ten MUs. The experiment was *framed in abstract and neutral terms*. Fishermen decided how many of the ten MUs they want to keep in their private account and how many they want to transfer to a group account. They were given two envelopes, one containing ten MUs (i.e. their

[17] Raven`s matrices are multiple choice tests of abstract reasoning. They are widely accepted as a culture-free measure of cognitive skills. In each of our three tests, we asked participants to find among six segments the missing one required to complete a larger pattern.

[18] One MU always equaled one Real if the PGE was selected for payment. Participants only knew which experiment was actually paid out after they had played all experiments.

endowment on the private account) and one containing 0 MUs. The participants could transfer MUs from one envelope to the other; then they put both envelopes in a box. During the decision, the experimenter turned his back to the subject so that the fisherman was sure that the experimenter did not know his decision. After participants made their decisions, they were asked about their expectations of others` contributions. If they guessed the contribution of another participant correctly, they could win five additional MUs. All rules were explained individually to the fishermen. No fisherman was informed about the identity of his group members.

Most fishermen do not behave completely selfishly, but contribute to the public good (only 15.8% do not contribute and 11.4% contribute one MU). 21.1% contribute five MUs and 18.4% contribute more than five MUs. Approximately half of the participants contribute no more than three MUs (58 out of 114). In regression table a in the appendix, we observe that expectations about the contributions of the other group members are by far the most important variable for predicting the behavior in the PGE ($t>5.09$, $p<0.0001$) – a finding that is in line with earlier evidence that many individuals are conditionally cooperative (Fischbacher, Gächter, Fehr, 2001, Keser and van Winden, 2002; Frey and Meier, 2004; Shang and Croson, 2008). In addition, we find that several control variables are marginally significant. We observe that more experienced fishermen contribute more ($t>1.97$, $p<0.052$), that fishermen who work more hours per day contribute marginally less ($t>1.83$, $p<0.071$), that fishermen who live in larger households contribute less ($t>1.95$, $p<0.055$), and that fishermen who report a higher monthly income contribute more ($t>1.88$, $p<0.064$). We will control for these variables in the following regressions.

B. The Time Preference Experiment with Shrimp Fishermen

At the beginning of the experimental session, we implemented a time preference experiment (TPE) to obtain a measure for impatience. In this TPE, all fishermen had to indicate whether they preferred two pralines immediately or three pralines at the end of the experimental session (on the same day) when they received their overall monetary payments from the experiment. The pralines ("Sonho de Valsa") are very popular among the fishermen; the vast majority (97%) liked the pralines (variable name: *preference for praline*).

We have time preference data from this experiment for 83 of our 114 shrimp fishermen.[19] 61.45% are patient and prefer waiting approximately two hours until the end of the experimental session to get three pralines whereas the remaining 38.55% are impatient and prefer receiving two pralines immediately.[20] In column 2 of regression table a, we observe that none of the control variables significantly predicts the decision in the TPE.

C. The Relation between Other-Regarding Preferences and Impatience in the Laboratory

Other-regarding preferences and impatience might play an important role in explaining the individual degree of CPR exploitation in the field. The laboratory provides an opportunity for deriving distinct measures for both factors. We use our PGE to obtain an individual measure for other-regarding preferences and the TPE to obtain an individual measure for impatience. Because there are no inter-temporal spillovers in the PGE, measured impatience in the TPE should not predict cooperativeness in the laboratory. Our data confirm this prediction. Individuals who are impatient in the TPE are neither more nor less likely to contribute in the PGE (Fisher Exact Test, p=0.574). This is also true after controlling for covariates. In

[19] Unfortunately, we could not play the TPE in two of our experimental sessions because the pralines were sold out in the local store.

[20] Note that once the pralines were given to the fishermen, they had to be consumed right away because otherwise they would melt in the heat. We kept the pralines in a cooler before we distributed them to the participants.

regression table a, models 3 and 4, we observe that the impatience dummy is insignificant ($p>0.310$).[21]

III. Predicting Cooperation in the Field with Laboratory Preference Measures

The heart of this paper uses our laboratory preference measures to predict individual levels of CPR exploitation. We use the public goods and time preference experiment to predict the average hole size in the fishermen's shrimp traps. We hypothesize (i) that fishermen who contribute more in the PGE use shrimp traps with bigger holes so that small, infertile, shrimps can more easily escape, and (ii) that fishermen who are impatient in the TPE use shrimp traps with smaller holes that are more exploitative of the fishing grounds.

A. Other-regarding Preferences and Hole Size in Shrimp Traps

Figure 2 provides a first insight into the relationship between contributions in the PGE and the average hole size in the shrimp traps. This figure shows the average hole size for fishermen categorized in three groups according to their level of contributions in the PGE. Fishermen with the lowest contributions (0 or 1 MUs) have the smallest hole sizes (0.413 centimeters, N=31), followed by fishermen with medium contributions (2–4 MUs, 0.443 centimeters, N=38). Fishermen with the highest contributions who contribute at least half of their endowment have substantially larger hole sizes than the other fishermen (0.482 centimeters, N=45). Overall, there is a positive and highly significant correlation between contributions in the PGE (0,1,…,10) and hole size (Spearman Rank, $r=0.253$, $p=0.0067$).

In regression table 1, we investigate whether the impact of lab cooperation on the hole size is robust to different specifications and controls. Model (1) shows that without using controls, each MU contributed is associated with a 0.0105 centimeter increase in average hole

[21] The absence of a correlation between our time preference measure and our lab cooperation measure replicates our finding in Fehr and Leibbrandt (2008).

size (t=2.58, p=0.011), which means that a maximally cooperative fishermen uses on average 0.105 centimeter larger holes (i.e. approximately 25% larger holes) than a fully selfish fisherman who contributes nothing to the laboratory public good. Model (3) shows the effect after adding several controls. The effect is of equal size as in Model (1) and highly significant (t=2.85, p=0.005). In model (4), we add the impatience dummy as a control variable. This leaves the size (0.0104) and the significance (t=2.48, p=0.016) of the coefficient of individual contribution levels unaffected. We introduce village fixed effects in model (5) to account for potential regional differences. In this regression, the coefficient of individuals' contributions in the PGE is slightly smaller but still significant (t=2.15, p=0.036).

[INSERT FIGURE 2 ABOUT HERE]

[INSERT TABLE 1 ABOUT HERE]

B. Impatience and Holes in Shrimp Traps

The evidence indicates that fishermen who are impatient in the TPE and prefer two pralines immediately over three pralines at the end of the experimental session use smaller holes in their shrimp traps than patient fishermen. The average hole size for impatient fishermen is 0.406 centimeters, whereas patient fishermen who prefer three pralines at the end of the experimental session use holes that are on average 0.457 centimeters. Regressions 2, 4, and 5 in table 1 indicate that this difference in hole size is significant and robust to the inclusion of controls. In the absence of controls (model 2), the estimated coefficient is roughly 0.05 centimeters with a t-value of 2.19 and a p-value of 0.031. Model (4), which adds our standard control variables, leaves the size and the significance of the coefficient largely unchanged

(coefficient = 0.054 centimeter, t=2.25, p=0.028). Impatience remains also significant at the 5 percent level after controlling for village fixed effects (model 5).[22] [23]

Apart from contributions in the PGE and impatience, only *field perception* is a significant predictor of hole size in all models. Fishermen who perceive a higher risk that the shrimp population will be depleted in the near future tend to use larger holes in their shrimp traps, indicating that information policies aiming to change fishermen's perception may be useful in mitigating CPR exploitation. Moreover, there are some variables which seem to play a role for hole size, although they are not significant in all regressions. The variable *field belief* is significant in model 4, and marginally insignificant in models 3 and 5. Fishermen who believe that other fishermen catch a larger fraction of small shrimp use smaller holes, suggesting that fishermen are also conditionally (un-) cooperative in the field. Male fishermen tend to use larger holes, but this effect becomes insignificant after controlling for village fixed effects. Years in profession is negatively related to hole size, but this effect seems to be partly explainable by multicollinearity between experience and age. When we drop age in the regression, the effect of years in profession gets weaker and becomes insignificant or is only marginally significant. Household size is marginally positively related to hole size, suggesting that fishermen with more children are more concerned about sustainable fishing. The quantity

[22] We also examined whether there is an interaction effect between time and other-regarding preferences on hole size. The interaction term is not significant, regardless of whether we include it in the model without controls (model 1; p=0.165) or in the model with the full set of controls (model 5; p=0.167). Note that because fishermen can establish some elementary (i.e., weak) forms of property rights by using the same fishing spots for longer time periods, their time preferences are predicted to play a role in the field regardless of whether they have other-regarding preferences.

[23] We also measured the role of cognitive skill for hole size. We have data on cognitive skills (measured by Raven`s matrices) for 78 fishermen for whom we also have the data on hole size as well as on other-regarding and time preferences. We find that our measure for cognitive skills is completely unrelated to hole size; this holds regardless of whether we look at the pure correlation (Spearman Rank Correlation, r=-0.01, p=0.914) or at the coefficient of this variable in our regression models (e.g., in model 3 t=0.12, p=0.907). The additional control for cognitive skills also leaves the effect of individual contribution levels and impatience on hole size largely unchanged (Coefficient for cooperativeness=0.0094, p=0.038; Coefficient for impatience=-0.0594, p=0.021).

of shrimp traps fishermen report to use is significantly predictive of hole size in model 3 which shows that fishermen who use larger holes also tend to use fewer shrimp traps.[24]

IV. Further corroborating evidence

In this section, we provide further evidence on the role of other-regarding and time preferences for CPR conservation by examining the behavior of fishermen who catch fish. Most fishermen use fishnets to catch fish. The fishnets differ according to their *mesh size*, and the smaller the mesh size of the fishnet, the more infertile fish are caught in the fishnet.[25] Thus, the same arguments that speak for hole size as a measure of cooperativeness in the field also apply for mesh size. We hypothesized that fishermen who display more cooperation in a public goods experiment use fishnets with larger mesh sizes while we predict that impatient fishermen use smaller mesh sizes.

A. The 2006 Field Data

We collected data on the mesh sizes of the fishnets from two sources: survey responses in 2006 and field observations in 2008. While re-visiting the fishermen in 2008, we investigated the fishnets of approximately every third fisherman who participated in 2006 and who used a

[24] Note that the quantity of shrimp traps in use is *not* a good measure of CPR exploitation. First, the measure is self-reported and, second the quantity of shrimp traps is not informative for the catch composition, i.e. it provides no information about the fraction of small, not yet fertile, shrimp. Note also that fishermen vary the quantity of shrimp traps they use.

[25] Note that while fishnets differ according to their mesh size, the price of the fishnet is independent of the mesh size. Fishnets with smaller mesh sizes are not more expensive than fishnets with bigger mesh sizes. In case fishermen possess more than one fishnet, the variable *mesh size* specifies the mesh size of the fishnet that is used most frequently. Using a fishnet with a larger mesh size leads to an income reduction of approximately 8%. We asked fishermen to fill out a daily report for several weeks where they reported which mesh size they used, the amount of fish they caught, and the weight of fish caught in kilograms. Nine fishermen reported frequently using two different mesh sizes. When they use the smaller mesh size, they report catching a 21.5% larger number of fish per hour ($p < 0.01$) and 16% more kilograms of fish per hour ($p = 0.07$). If we assume that the additional fish caught with a small mesh size are all small fish that are sold at a 50% lower price (e.g., instead of a normalized price of 1 for larger fish the small fish are sold at a price of 0.5), the fishermen who use a small mesh size earn roughly 8% (0.16 x 0.5) more income per hour. A 50% lower price for small fish is a realistic assumption.

fishnet (35 out of 121).[26] We find that the two year old survey responses are very much in line with the recent field data (Spearman Rank Correlation, $r = 0.70$; $p<0.0001$). Figure d in the appendix illustrates the relation between the survey data and the field observations. Almost two-thirds of the fishermen use a mesh size smaller than five centimeters, with a mean of 4.42 centimeters. The most frequently used mesh sizes are 3.5, 5, and 6 centimeters. Figure e in the appendix shows the distribution of mesh sizes in our sample.

The fishermen also took part in an anonymously played laboratory public goods and time preference experiment (PGE 06 and TPE 06). In the PGE 06, fishermen had to decide how many out of seven MUs they contributed to a public good in each of five different periods. The group size was four and stable during all periods. Because the fishermen's net return from contributing to the public good was negative, never contributing anything was always in their material interest if the selfishness and rationality of all individuals was common knowledge. The more cooperative the fishermen are, however, the more they should contribute. 87% contributed in the first period, with almost half of the fishermen contributing between three and five units. Contributions declined continuously in the remaining four periods.

In the TPE 06, fishermen had to indicate whether they prefer one bottle of mineral water immediately or two bottles the next day. If they preferred the good immediately, the fishermen received it immediately after the experiment. If they preferred two units of the good the next day, we distributed vouchers with which they could collect their good the next day at the village leader's house. The village leader was elected by the residents and is usually considered an extraordinarily trustworthy person.[27] We observe that 59.6% were impatient

[26] Typically, we went to their houses or to the lake and asked them to show us their fishnet.

[27] In practice, the participating fishermen were confident about receiving their good (the next day). Nevertheless, before individuals made their choice in the TPE, we assured them that they would receive their good. We also asked many participants if they were concerned about not receiving their good – which was not the case. Participating fishermen also had the possibility of seeing the experimenters give the village leaders the mineral water for distribution on the next day. After the experiments we asked the village leader whether all

and preferred one bottle of mineral water immediately. As in our 2008 laboratory experiments, we find no significant relationship between cooperativeness and impatience in the 2006 experiments.

B. Cooperativeness, Impatience, and Fishnet Mesh Size

We find a highly significant positive relationship between behavior in the PGE 06 and mesh size. The correlation between contributions in the PGE 06 and mesh size is 0.31 (Spearman Rank, p=0.0004). If we perform a median split and divide the fishermen into two equally sized groups according to their contributions in the first period of the PGE[28], we observe that those who are less cooperative and who contribute less than five MUs (N=61) use an average mesh size of 4.03 centimeters (the mode in this group is 3.5 centimeters with 25 of the 61 subjects choosing the mode), whereas those who are more cooperative and contribute at least five MUs (N=62) use an average mesh size of 4.73 centimeters (there are two modes at 5 and 6 centimeters in this subgroup and each mode is chosen by 15 subjects). The difference in mesh size between the low and the high contributors is significant at any conventional level (t=-3.891, p=0.0002) and substantial.[29]

In regression table 2, we use two OLS models to predict the mesh size. In model (1), we use the behavior in our two laboratory experiments as independent variables and control for several socio-economic and fishing related measures and for village fixed effects. We find that the individual levels of contributions in the first period of the PGE 06 are positively related to the mesh size of the fishnet. Each MU contributed in the first period of the PGE is

participants collected their goods – which was the case. When we re-visited the participants, none complained about not receiving her/his good.

[28] Our results are similar if we use the average contributions in all five periods as a measure instead of the contribution in the first period (see Fehr and Leibbrandt, 2008).

[29] While it is difficult to find an exact correlation between a difference of one centimeter in mesh size with respect to the size of fish ultimately caught (since this does depend on the fish type), the fishermen estimate this to be approximately 3–7 centimeters. Note as a rough reference point that small fish that are below the legal minimum size (20–30 centimeters depending on fish type) are frequently caught in fishnets with mesh sizes smaller than five centimeters.

associated with a 0.133 centimeter larger mesh size (t=2.72, p=0.008). In model (2), we only use the small sub-sample of 35 fishermen where we observed the fishnets and we control for the significant covariates from model (1). We still find a marginally significant relationship for cooperativeness (t=1.80, p = 0.083).

We also find a negative effect of impatience on mesh size in model (1). Fishermen who are impatient and prefer one bottle of mineral water immediately over two bottles tomorrow use 0.366 centimeter smaller mesh sizes (t=1.99, p=0.049). In our smaller subsample with only those fishermen for whom we directly observed the fishnets (model 2), the coefficient for impatience is even larger though somewhat less significant (t=1.86, p=0.074).

[INSERT TABLE 2 ABOUT HERE]

The regressions in table 2 also show that the variable field perception plays an important role in all models. Fishermen who already perceive a relatively large mesh size as harmful tend to use larger mesh sizes. In addition, we find that the variable field belief is significant in both models. It turns out that the more pessimistic a fisherman is about the exploitation level of the other fishermen, the more likely he is to use a small mesh size.

V. Conclusion

In this paper, we show that cooperativeness plays an important role in economic decisions with lasting consequences in naturally occurring situations. We find in two different data sets that fishermen who behave more prosocially in a public goods experiment use fishing instruments that are less likely to exploit the fishing grounds. At the same time, we show that impatience plays a significant role for cooperation in the field; in both data sets, fishermen who are impatient in a time preference experiment use fishing instruments that are more likely

to exploit the fishing grounds. We establish this link between laboratory and field behavior, even though there are important contextual differences between the lab and the field environment. Subjects play a one-shot public goods game in the lab, while they face a permanent common pool resource problem in the field; the lab experiment is framed in abstract terms, while subjects face the cooperation problem in its naturally occurring frame in the field; and we elicited time preferences over hours and days in the lab, while individuals' time preferences over weeks, months and years matter in the field.

The fact that we nevertheless find a robust and significant link between our laboratory preference measures and our field measures challenges the view that preferences are context-dependent to such a degree as to render the economic preference approach useless. This does of course not imply that we should not be very cautious when extrapolating laboratory experiments measuring economic preferences (for an overview see Levitt and List, 2007).

While we should keep this in mind, we believe that our results also may have important implications for policymakers, managers, and social scientists. They provide empirical evidence that when designing policy measures, taking impatience into account is useful, as it is an obstacle in the implementation of resource preserving policies. Likewise, knowledge about the conditional nature of fishermen's cooperativeness may be useful, i.e., their conditional willingness to cooperate in concrete situations, even if cooperation goes against their immediate self-interest. Thaler and Benartzi (2004) designed the Smart commitment mechanism which helped impatient employees who lack self-control increase their future savings. We imagine a similar mechanism for promoting resource conservation which would incorporate both the propensity to discount future outcomes as well as the propensity to cooperate voluntarily (if others cooperate as well). Individuals could be approached to commit in advance to change their behavior towards a more sustainable use of resources, but this commitment would only become binding if a specified majority of the

other resource users also were to commit. For example, the fishermen could commit (e.g., by signing a contract with an environmental agency) to exchange their fishnets with small mesh size to fishnets with bigger mesh size in the future if a specified majority of the other fishermen were also willing to commit to this policy. This proposal takes advantage of the conditional nature of fishermen's willingness to cooperate and furthermore reduces the perception of the cost of cooperation by shifting the exchange of the fishnets into the future. Thus, impatient individuals who lack self-control and conditionally cooperative individuals would be more likely to commit to this policy than to an alternative policy requiring unconditional cooperation and imposing the cost of cooperation in the current period. Similar mechanisms could be applied to other settings as well. For example, policymakers could ask commuters in metropolitan areas to commit to buy a one-month ticket for public transportation for the following year as soon as a sufficient number of commuters were also willing to keep this commitment. Such a mechanism, which takes conditional cooperativeness and impatience into account, could discourage environmental unfriendly behavior and help sustain natural resources.

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TABLES

Table 1—Determinants of Size of Holes in Shrimp Traps
(*OLS)*

Dependent Variable	Average Size of Holes in Shrimp Trap in cm				
Model	1	2	3	4	5
Contribution in PGE	0.0105**		0.0106***	0.0104**	0.0088**
	(0.0041)		(0.0037)	(0.0042)	(0.0041)
Impatience (Praline Dummy)		–0.0504**		–0.0544**	–0.0475**
		(0.0230)		(0.0242)	(0.0229)
Belief in PGE			0.0000	0.0011	0.0005
			(0.0045)	(0.0051)	(0.0050)
Preference for Praline				–0.1658	–0.1352
				(0.1621)	(0.1479)
Age			0.0006	0.0013	0.0004
			(0.0008)	(0.0009)	(0.0009)
Gender (Male Dummy)			0.0927***	0.0568**	0.0415
			(0.0227)	(0.0236)	(0.0325)
Household Size			0.0070*	0.0059	0.0049
			(0.0036)	(0.0040)	(0.0041)
Centrality			–0.0004	–0.0005	–0.0007*
			(0.0003)	(0.0004)	(0.0004)
Years of Schooling			–0.0063*	–0.0007	–0.0027
			(0.0035)	(0.0047)	(0.0046)
Years in Occupation			–0.0012	–0.0023**	–0.0021*
			(0.0010)	(0.0011)	(0.0011)
Field Belief			–0.0139	–0.0278**	–0.0233
			(0.0110)	(0.0138)	(0.0148)
Field Perception			0.0307***	0.0199**	0.0167*
			(0.0095)	(0.0097)	(0.0098)
Daily Hours Fishing			0.0058	0.0086	0.0040
			(0.0067)	(0.0061)	(0.0063)
Quantity of Shrimp Traps			–0.0001**	–0.0001	–0.0000
			(0.0000)	(0.0000)	(0.0000)
Monthly Income			–0.0000	–0.0000	–0.0000
			(0.0000)	(0.0000)	(0.0000)
Constant	0.4122***	0.4061***	0.2102**	0.4387**	0.4743**
	(0.0174)	(0.0164)	(0.0813)	(0.1860)	(0.1909)
Village Fixed Effects?	no	no	no	no	yes
Observations	114	83	113	83	83
R^2	0.064	0.051	0.322	0.377	0.450

Notes: *** 99-percent significance, ** 95-percent significance; * 90-percent significance. Robust Standard Errors in Parentheses.

Table 2—Determinants of Mesh Size of Fishnet
(*OLS)*

Dependent Variable	Frequently Used Mesh Size of Fishnet in cm	
Model	1	2
Contribution in First Period of PGE	0.133***	0.171*
	(0.049)	(0.095)
Impatience (Mineral Water Dummy)	–0.366**	–0.641*
	(0.184)	(0.345)
Age	-0.000	
	(0.013)	
Gender (Male Dummy)	0.732*	
	(0.374)	
Family Size	0.023	
	(0.037)	
Years of Schooling	–0.010	
	(0.033)	
Years in Occupation	0.007	
	(0.010)	
Field Belief	0.182**	0.503**
	(0.073)	(0.244)
Field Perception	0.156***	0.352**
	(0.056)	(0.132)
Belief in first Period of PGE	0.009	-0.144
	(0.059)	(0.141)
Weekly Hours Fishing	–0.006	
	(0.006)	
Constant	2.784***	2.023**
	(0.664)	(0.985)
Village Fixed Effects?	yes	no
Observations	121	35
R^2	0.334	0.227

Notes: *** 99-percent significance, ** 95-percent significance; * 90-percent significance. Robust Standard Errors in Parentheses.

FIGURES

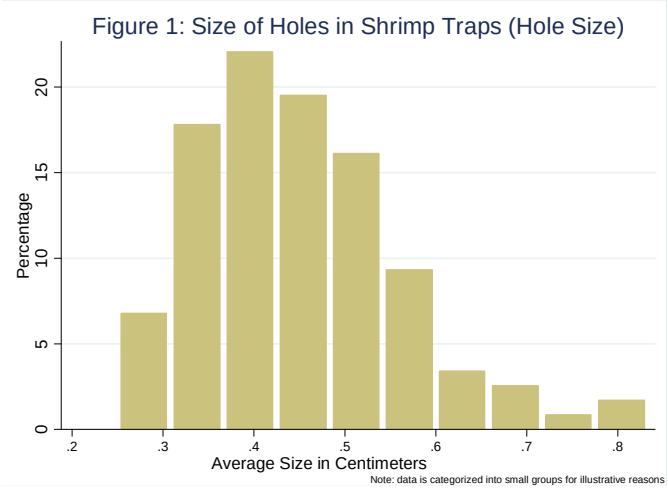


Figure 1: Size of Holes in Shrimp Traps (Hole Size)
Percentage
0
5
10
15
20
.2
.3
.4
.5
.6
.7
.8
Average Size in Centimeters
Note: data is categorized into small groups for illustrative reasons

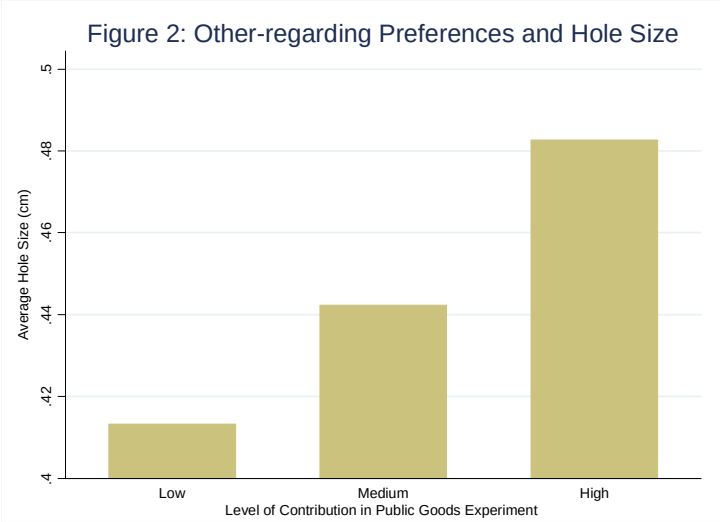


Figure 2: Other-regarding Preferences and Hole Size
Average Hole Size (cm)
.4
.42
.44
.46
.48
.5
Low
Medium
High
Level of Contribution in Public Goods Experiment

APPENDIX TABLES

Table a—Determinants of Laboratory Behavior
(*OLS, Probit)*

Dependent Variable	Cooperation in Public Good Experiment (OLS)	Patience (Probit)	Cooperation in Public Good Experiment (OLS)	Cooperation in Public Good Experiment (OLS)
Model	1	2	3	4
Impatience Dummy (Praline)			-0.386	-0.539
			(0.587)	(0.527)
Belief in PGE	0.600***			0.564***
	(0.094)			(0.111)
Preference for Praline		0.256		-0.046
		(0.391)		(1.527)
Age	-0.037	-0.005		-0.035
	(0.028)	(0.007)		(0.038)
Gender (Male Dummy)	0.204	0.040		0.019
	(0.412)	(0.138)		(0.544)
Household Size	-0.143**	-0.012		-0.173*
	(0.065)	(0.021)		(0.089)
Centrality	-0.010	0.002		-0.008
	(0.006)	(0.002)		(0.006)
Years of Schooling	0.056	-0.023		0.139
	(0.113)	(0.024)		(0.146)
Years in Occupation	0.050*	-0.002		0.066**
	(0.026)	(0.007)		(0.029)
Field Belief	-0.243	0.061		-0.206
	(0.279)	(0.071)		(0.272)
Field Perception	-0.100	0.026		-0.113
	(0.240)	(0.060)		(0.262)
Daily Hours Fishing	-0.254*	-0.009		-0.349**
	(0.139)	(0.037)		(0.162)
Monthly Income	0.002**	0.000		0.002*
	(0.001)	(0.000)		(0.001)
Observations	113	83	83	83
R^2	0.412		0.005	0.398
Pseudo R^2		0.055		

Notes: *** 99-percent significance, ** 95-percent significance; * 90-percent significance. Robust Standard Errors in Parentheses.

APPENDIX FIGURES

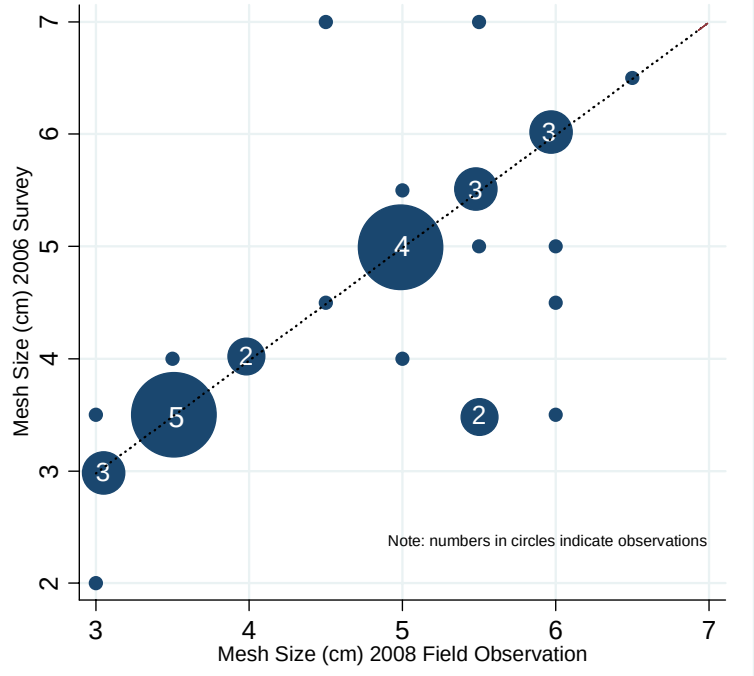
Figure a: Shrimp Trap made from a PET bottle

Note: Shrimp enter through big hole in front and can only escape through small holes at the bottom of the bottle.

Figure b: One Fisherman's Fishnet

Figure c: Measuring the Fishnet Mesh Size

Figure d: Fishnet Mesh Size in Survey & Field Observations



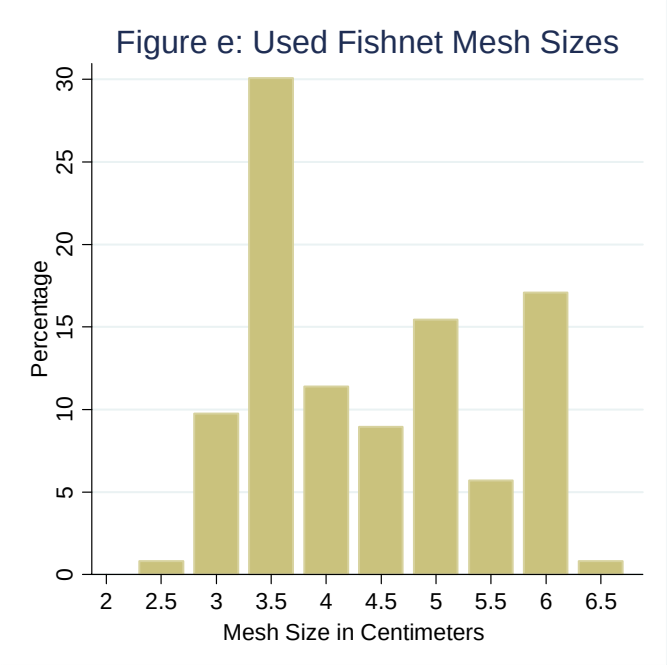


Figure e: Used Fishnet Mesh Sizes
Percentage
0
5
10
15
20
25
30
2
2.5
3
3.5
4
4.5
5
5.5
6
6.5
Mesh Size in Centimeters