

# From the lab to the field: public good provision with fishermen\*

Jan Stoop<sup>†</sup>  
Charles Noussair<sup>‡</sup>  
Daan van Soest<sup>§</sup>

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## Abstract

We conduct a field experiment to measure cooperation among a group of sports fishermen at a recreational fishing facility. Group incentives are created to reduce the number of fish caught. Nonetheless, no cooperation is observed. Additional treatments explore the origin of the differences between behavior in our field setting and traditional laboratory experiments. These treatments establish that students cooperate less than fishermen in a lab setting and that fishermen cooperate more in their natural environment than in the lab, and thus neither the subject pool nor the non-laboratory setting account for the low cooperation in the field experiment.

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<sup>†</sup>Tilburg University, Department of Economics and CentER, Tilburg, the Netherlands.

<sup>‡</sup>Tilburg University, Department of Economics and CentER, Tilburg, the Netherlands.

<sup>§</sup>UV University Amsterdam, Department of Spatial Economics and IVM, Amsterdam, The Netherlands, and Tilburg University, Department of Economics and CentER, Tilburg, the Netherlands.

# 1 Introduction

A large literature in experimental economics has focused on the extent to which individuals cooperate in social dilemmas. Social dilemmas are group interactions, in which it is optimal for an individual not to cooperate, but where the social optimum involves cooperation. One standard experimental paradigm employed to study social dilemmas is the voluntary contribution mechanism (VCM). In a typical VCM experiment (see for example Marwell & Ames (1981)) individuals receive an endowment of money which they can allocate between a private account, which yields a return to the investor only, and a group account, which pays a return to each group member. While each individual has a dominant strategy to place his entire endowment in his private account, the social optimum is for all individuals to contribute their entire endowment to the group account.

The behavior of individuals in this setting has been shown to exhibit two robust patterns (for a survey, see Ledyard (1995)). One pattern is that initial average contributions to the group account are significantly different both from zero and from 100 percent of endowments. This reveals a degree of, but less than full, cooperation on the part of the average individual entering a new social dilemma. The second pattern is that a decline in the level of cooperation occurs as the game is repeated (see, for example Isaac & Walker (1988), Isaac et al. (1985), and Andreoni (1988)).

In this paper, we report a field experiment to explore the generality of these patterns of cooperation. Specifically, we study whether the patterns appear in a non-laboratory experimental environment. The setting of our field experiment is a recreational fishing pond where sports fishermen can catch rainbow trout. The fishing pond setting allows us the opportunity to create an interaction with a very similar structure to the VCM game as studied in the laboratory. In addition to the field experiment, a series of treatments are conducted to isolate the effects of several differences between our field setting and the traditional laboratory experimental environment.

Field experiments are often used to examine the robustness of laboratory findings (for a survey see Harrison & List (2004)). These field tests have

yielded mixed results in the sense that some studies find results consistent with those obtained in the laboratory (see for example Bohm & Lind (1993), Bosch-Domenech et al. (2002), and List (2007)) while others fail to find consistency (see for example Andersen et al. (2005), Bohm (1972), Haigh & List (2005), List (2006), Lusk & Fox (2003), and Potters & van Winden (2000)).

Recently, several field experiments have been conducted that investigate different aspects of behavior in social dilemmas. A popular arena for investigating social dilemmas is the decision to donate to charity, where an active experimental literature has investigated the role of social influences (see for example Frey & Meier (2004), Heldt (2005), Croson & Shang (2008), and Martiny & Randal (2005)). Another strand of research studies the behavior of non-standard (non-student) subject pools in the VCM game (see for example Cardenas (2004), Ruffle & Sosis (2007), and Fehr & Leibbrandt (2008)). The results of these studies show that cooperative behavior in the VCM game is correlated with other independent measures of cooperativeness. All of the studies find that, in a similar manner as in the laboratory, subjects display a degree of cooperative behavior in early periods of play and that this cooperation diminishes over time. Natural field experiments on cooperation have been conducted by Bandiera et al. (2005) and Erev et al. (1993). Their results reveal that workers in a fruit picking firm do not take into account the consequences their effort has on other workers. However, mechanisms that give incentives to reduce negative externalities on others were found to be effective.

In our study, we measure the level of cooperation among a group of sports fishermen at a privately owned recreational fishing pond. The fishermen are placed in a social dilemma very similar to the VCM. They are assigned to anonymous groups of four persons, who interact for six forty-minute periods. In each period, each fisherman is allowed to catch a maximum of two fish, which are his to keep. However, for each fish he foregoes catching below his maximum quota, each of the other members of his group receives a cash payment. Thus, a social dilemma is created in that each individual has a dominant strategy to catch two fish each period, while the social optimum

requires all individuals to forego their catch. The level of cooperation is compared to a baseline treatment in which individuals have no collective incentives to reduce their catch. Data are gathered in both high and low fishing seasons. This allows us to test our hypotheses under two different conditions, as well as to consider whether the level of cooperation responds to the cost-benefit ratio associated with effort. As explained later, in the low season, it takes more effort to catch fish, and thus it is less costly to cooperate with others, than in the high season.

Our data show no cooperation at all. Starting in the first period, and continuing throughout the sessions, fishermen in the treatment with group-level gains from cooperation fish with the same effort and catch the same number of fish as those without such gains. We thus fail to find any evidence of cooperation in our field setting, even in the initial periods of our experimental sessions.

We then consider some potential sources of the difference between the received results from the laboratory and our field experiment. First, we test whether the difference is a result of the use of a different participant pool. Subjects in laboratory experiments are university students, while in our field experiment, participants are older, have less formal education, and have no previous experience with experiments. Isolating differences in participant pool is done by comparing two conditions. One of these, the StuLab treatment, is a laboratory VCM, in which students are used as a subject pool, and in which cash is the exclusive means for rewarding participants. The results from StuLab are compared to the FisherLab treatment, which is identical to StuLab, except that the subjects are drawn from our subject pool of fishermen.

A second difference between our field experiment and the laboratory is that the field experiment is conducted in a natural setting, rather than in an experimental laboratory known to participants to be used for research. Isolating the effects of the setting in which the treatments occur, is done by comparing the results of the FisherLab treatment with the FisherPond treatment. The FisherPond treatment is the same as FisherLab, and employs the fishermen as subjects. However, instead of playing the game in

the laboratory, participants play it while fishing recreationally at the pond.

The main results from these additional treatments are the following. The StuLab treatment replicates the laboratory findings generally reported in the literature; there is substantial cooperation in the early periods, but the level declines over time to eventually reach low levels. The fishermen in the laboratory setting (FisherLab treatment) exhibit a greater level of cooperation than the students. Finally, in the FisherPond treatment, the fishermen exhibit more cooperation than in FisherLab. The data from these treatments reveal that the key difference between the laboratory and our field setting leading to a lack of cooperation in the field is neither the subject pool nor the laboratory setting. As we argue later, the results suggest that the tendency to cooperate is a characteristic of the particular social dilemma in which individuals find themselves, as well as of the participating individuals. Individuals drawn from the same population may behave cooperatively in one social dilemma but not in another.

The structure of this paper is as follows. In section 2 the design and procedures of the experiments are described. Section 3 introduces the hypotheses that we test. In section 4 the data is presented and analyzed, and section 5 contains some concluding remarks.

## **2 Experimental design and procedures**

The experiment consists of a total of seven treatments. Four of these are designated as ‘field’ treatments, and followed a two-factor, two-level structure. The field treatments are described in section 2.1. There are three other treatments, included to isolate possible sources of differences between the results of the field treatments and those typically obtained in the laboratory. These are described in section 2.2.

## **2.1 The field treatments**

### **2.1.1 General Setting**

The sessions comprising the four field treatments were conducted at the trout fishing pond ‘De Biestse Oevers’, located in the village of Biest-Houtakker.<sup>1</sup> This village lies in close proximity to Tilburg, in Brabant province, in the south of the Netherlands. De Biestse Oevers is a privately owned fishing site, consisting of three separate ponds. Each pond has room for twenty fishermen; ten spots on the north and ten on the south side. For €12.50 or €15.–, depending on the pond, a customer can fish for four hours. For each paying customer, either four rainbow trout or two rainbow trout and one salmon trout (a larger trout species) are put into the pond. A customer is allowed to catch as many fish as possible. There are limitations in the fishing gear and bait that may be used. The typical participating fisherman is Dutch, male, and over the age of 50.

### **2.1.2 Procedures common to the field treatments**

Participants were recruited two weeks in advance by distributing flyers informing them of the opportunity to take part in a study conducted by Tilburg University. The flyer indicated that money could be earned during the study. A maximum of sixteen people could participate in a session.

Each session of the field treatments consisted of six consecutive periods of forty minutes each. A session, therefore, took four hours to complete. Within a session, each period proceeded under identical rules. Participants were assigned to groups of four. The composition of each group remained the same over the entire session. Participants were not informed at any time of the identity of the other members of their group.

Before the session started, two rainbow trout per participant were put into the pond, plus an additional six trout. These six extra fish were included in order to increase the probability of catching fish for any given level of fishing effort. For the first period, the participants were assigned a spot

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<sup>1</sup>See [www.biestse-oevers.nl](http://www.biestse-oevers.nl) for photos of the site.

at the pond randomly by picking a number out of a bag. This random assignment procedure was repeated in periods three and five. The rotation of positions was intended to create a degree of procedural fairness since many fishermen believe that their physical position at the pond influences their probability of catching a fish.<sup>2</sup>

During each period, a fisherman was allowed to catch up to two fish, and each fish that was caught had to be taken home after the session. We decided to set the quota at two fish (rather than just one) in order to allow for partial cooperation – when voluntarily limiting their catch to one fish, fishermen are able to enjoy fishing while also earning money for their other group members. Once a participant had caught his maximum quota, he was required to wait until the next period began to resume fishing. At the beginning of the next period, a number of trout that equaled the total catch of the previous period was put into the water. Therefore, the total number of fish in the pond was constant over all periods within a given session. Communication about the experiment was strictly prohibited, and this rule was well-observed.

One round of sessions was carried out in June 2008, and a second round in September and October 2008. The season influences the number of fish caught. In June the water temperature is too high for the fish to bite in large numbers, while this is typically not the case in September and October. For this reason, the sessions conducted in June are designated as Low Season sessions, while those in September and October are classified as High Season sessions.

### **2.1.3 Procedures Specific to Particular Field Treatments**

Two of the treatments will be termed the Private Incentive (FieldPI) treatments. These are FieldPIL and FieldPIH, where I. and H designate the Low and High seasons, respectively. In the FieldPI treatments the conditions described in the previous subsection were in effect. In FieldPIL and FieldPIH

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<sup>2</sup>Our data show that there is no actual significant relationship between location and the number of fish caught in our study, suggesting that this belief is incorrect or exaggerated.

there was no social dilemma; catching fish had no consequences for other group members.<sup>3</sup>

In the other two field treatments, the VCM (FieldVCM) treatments (FieldVCML and FieldVCMH), the participants were assigned to groups of four. The same rules applied as under the FieldPI treatments, except that group incentives existed for reducing the number of fish caught. As in FieldPI, each fish that a participant caught, had to be taken away from the site (presumably home) at the end of the session. However, each fish that a participant did not catch below his maximum of two per period, yielded €2.– for each other group member. Therefore, a participant faced a tradeoff between individual catch and group income. Either a participant caught a fish, or the participant provided a surplus of €6.–, divided equally among the three other group members. At the end of each period, each participant was informed privately of the total number of fish that his group had caught, and the total earnings of the group. The average earnings over a session of a participant in the FieldVCM treatments was €49.60.

The following table illustrates the two-factor, two-level structure of the design and indicates the amount of data available. Unless indicated otherwise, in the analysis of the data reported in section four, we treat the activity of each group of 4 subjects over the entire six periods of a session as one observation, giving us a minimum of four observations per treatment.

#### 2.1.4 Creating the social dilemma

A social dilemma exists if the group (per-capita) payoff from some positive level of cooperation, in the form of reducing the catch to some extent, exceeds the sum of the (individual) private gains from zero cooperation. The group payoff is given in terms of the monetary payoffs each individual receives

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<sup>3</sup>The individuals in FieldPI are implicitly assigned ex-ante to groups based on their initial location at the pond. In one FieldPI session, subjects were explicitly informed that they were in a group with fixed membership, and they were informed about the total catch of fish by members of the group. In the other session, this ‘group’ structure is not created. The underlying incentive structure is unaffected by this information in the FieldPI treatment. The explicit grouping did not affect behavior in any way that we could detect.



	High season	Low season
Field Private Incentive (FieldPI)	1 session 16 subjects 4 groups	1 session 16 subjects 4 groups
Field Public Good (FieldVCM)	1 session 16 subjects 4 groups	2 sessions 28 subjects 7 groups

**Table 1** Summary of the sessions in the two field treatments.

when players reduce their catch. The private gains from non-cooperation consist of the private value of catching fish. We assume that the value of catching a fish is equal to the market value of the fish plus the utility of the fishing experience associated with the process of catching the fish. The price of rainbow trout in local fishmonger's shops varies from €4.85 to €10.– per kilo, and the average Rainbow Trout weighs around 400 grams. This translates into a price range from €1.95 to €4.– per fish. In order to create a social dilemma, we thus set the earnings that the group receives for every fish not caught equal to 150 percent of the highest price we were able to find in a local fishmonger's shop for an identical fish. Dividing this amount by the number of other group members translates into the €2 payment each individual receives for each fish a member of his group did not catch. Thus, the value to participants of full cooperation, in the sense of acting to maximize group earnings, is equal to €72.–; each individual earns (€2)  $\times$  (6 fish not caught)  $\times$  (6 periods). The value to each individual of an intermediate level of cooperation, a level corresponding to each individual catching one fish per period, is (€2)  $\times$  (3 fish not caught)  $\times$  (6 periods) + the value of catching 6 fish = €36 + the value of catching 6 fish. The value of fishing up to one's quota of 2 fish per period equals the value of catching 12 fish.

Thus, the existence of a social dilemma is assured if all or at least a sufficient majority of individuals prefer €72 to catching 12 fish, or prefer €36 and catching 6 fish to catching 12 fish. However, because the actual number of fish caught by non-cooperating individuals is likely to be considerably less

than 12 fish, the actual payoff from non-cooperation is lower than the value of catching 12 fish, meaning that a social dilemma is likely to exist under weaker conditions than those given here.

Because the utility of fishing itself is unobservable, we must indirectly infer that a social dilemma exists in the FieldVCM treatments. We list five arguments here to justify our claim that there is a social dilemma. The first is that fishing a morning or afternoon at the Biestse Oevers costs €12.50. This means that €72.– implies that if each group member decides not to fish during the session, each can go fishing five times and still have some money left.

Responses to a survey of members of the subject pool provides the second argument that the typical subject values a cooperative outcome more than a non-cooperative one.<sup>4</sup> We surveyed 18 of the fishermen on a day when no experiment was conducted. They were presented with three hypothetical options, and they were asked which one they preferred. The first option was to fish for free at the Biestse Oevers for four hours, and to catch at most twelve fish. Once twelve fish were caught, the fisherman had to stop fishing. This first option represented the payoff that would result under zero cooperation. The second option was to fish for four hours, and to catch at most six fish. Once all six fish were caught, the fisherman had to stop. In addition, under the second option, the fisherman received €36.–. Finally, under the third option, the fisherman received €72.–, but he was not allowed to fish at all. These last two options corresponded to two different levels of positive cooperation.

Out of the eighteen fishermen surveyed, nine indicated a preference for the option of catching six fish and receiving €36.–. Five fishermen indicated a preference not to fish, but to receive €72.–. The other five fishermen chose to catch twelve fish.<sup>5</sup> This means that 72.2 percent of the interviewed

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<sup>4</sup>The questionnaire can be found in the appendix.

<sup>5</sup>Motivations stated for this answer included 'being a fisherman is all about fishing'. Given that €36 or €72 would buy the fisherman almost 3 or 6 mornings/afternoons of fishing rather than just one, it is conceivable that the fishermen providing this answer would choose differently if confronted with a real choice rather than with a hypothetical one.

fishermen preferred one of the two options that we sought to associate with cooperation.

A third argument involves calculating an estimate of the value of catching fish and using the estimate to argue that the social value of reducing one's catch exceeds the private benefit of not doing so. We first note that the price for an afternoon of fishing at Biestse Oevers is €12.50. We use independent estimates of the willingness-to-pay for recreational fishing to approximate the value of fishing. Toivonen et al. (2004) estimate that the average willingness-to-pay to fish of sports fishermen in five Nordic countries is approximately 1.44 times the actual fishing expenses, with a maximum of 1.54 times in Norway. The ratio is very similar in all five countries, ranging between 1.30 and 1.54, suggesting that a similar ratio might apply for the Netherlands. If we assume that the highest ratio applies to our sample, the analogous estimate for the value of an afternoon of fishing, including the fish caught, would be approximately  $€12.50 \times 1.54 = €19.25$ . Subtracting the average market value of the four fish ( $4 \text{ fish} \times €3.- = €12.-$ ), we obtain a value of €7.25 as the willingness-to-pay for a afternoon of fishing (on top of the value of the value of the fish themselves). Therefore, the private value of non-cooperation, over the course of a session, equals  $(2 \text{ fish}) \times (3 \text{ Euro per fish}) \times (6 \text{ periods}) + €7.25 = €43.25$ . On the other hand, the value of catching one fish per period and receiving €36 equals  $(1 \text{ fish}) \times (3 \text{ Euro per fish}) \times (6 \text{ periods}) + €7.25 + €36 = €61.25$ . The private value of non-cooperation, €43.25 is considerably less than the payment each individual receives under full cooperation, €72, or under partial cooperation, €61.25.

The fourth argument is based on a similar comparison, but uses a different method to calculate the value of fishing. We calculate the amount fishermen pay for the act of fishing by subtracting the value of the expected catch from the entrance fee. We use four fish as the expected individual catch since this is the number of fish put into the pond for each fisherman. The value of fishing is then calculated as follows:  $€12.50 - (\text{expected catch of four fish}) \times (\text{value of fish between } €1.95 \text{ and } €4.-)$ . The range of values for fishing is then between  $-€3.50$  and  $€4.70$ . In our experiment, the value (at market prices) of catching twelve fish is between  $€23.40$  and  $€48.-$ .

This can be considered a high estimate, since individuals are typically unable to catch two fish consistently in 40 minutes, especially in the Low season. Adding the highest estimate of the value of twelve fish, €48 to the highest estimate of the value of fishing, €4.70, yields a total of €52.70 for the value of non-cooperation. Thus, at €72, the fishermen are compensated €18.30 more when they fully cooperate than when they do not. If all individuals catch one fish, each player's payoff is  $€24 + €4.70 + €26 = 64.70$ , which is €12 more than under non-cooperation.

Finally, a fifth argument is found by considering the price Biestse Oevers charges for a half-day of fishing, and the industrial organization of the recreational fishing industry. Full cooperation means that individuals receive €72 instead of a half-day of fishing. Consider two alternative cases, those of monopoly and of perfect competition. First, suppose the Biestse Oevers has sufficient market power to be reasonably modeled as a monopolist. The fact that the Biestse Oevers does not charge a price of €72.– indicates that a share of the market smaller than  $12.50/72 (=1/6)$  values their fishing experience plus their fish caught at €72.–. Alternatively, suppose that the Biestse Oevers operates in a market under perfect competition. Indeed, neighboring facilities where fishermen can pay to fish at rainbow trout charge prices similar to the price of the Biestse Oevers. This means that the willingness to pay of the typical consumer for fishing at the Biestse Oevers cannot be appreciably more than the price a competitor charges, and thus is unlikely to be more than €72.

## **2.2 The StuLab, FisherLab, and FisherPond treatments: The Bridge from the Laboratory to the Field**

To construct a bridge between the field environment to the traditional laboratory setting, we conduct three additional treatments, called StuLab, FisherLab and FisherPond. These three treatments follow, to varying degrees, traditional laboratory experimental procedures for studying voluntary contributions. The purpose of the inclusion of the three treatments is to isolate the effect of three differences between the field treatments described above,

and the traditional laboratory social dilemma experiment. These differences are: (a) the subject pool, (b) the setting in which the experiment is held, and (c) differences in the game itself. These last differences include the reward medium (fish as well as money in FieldVCM), putting in real effort (fishing instead of contributing money), and the timing of the game (a continuous process over 40 minutes rather than a one time decision to cooperate).

As in the field treatments, participants in the three additional treatments are assigned to groups of four subjects. A group's composition remains constant throughout the entire six-period session, but no information is given to individuals about the identity of the other members of his group. In contrast with traditional laboratory experiments, the language of the instructions is contextualized. For example, the terms 'fish', 'catch' and 'pond' are used, rather than the words 'tokens' and 'project'.

The experiment is conducted by hand and the rules of the experiment are the following. Participants are asked to make a choice each period of how many (hypothetical) fish they choose to catch, with a maximum of two fish per period.<sup>6</sup> Because a laboratory session takes roughly one hour, one-fourth as long as the field treatments, the earnings are scaled down by a factor of four relative to the field treatments. Thus, each fish that a participant catches yields a real cash payment to him of €1.–. Each fish that the participant forgoes catching yields €0.50 for each group member, excluding the decision maker. The earnings of an individual are given by the following:

$$\pi_{it} = \text{€}1 \times x_{it} + \text{€}0.50 \sum_{i \neq j} (2 - x_{jt}), \quad (1)$$

where  $\pi_{it}$  are the earnings in Euros of subject  $i$  in period  $t$ , and  $x_{it}$  is the catch of subject  $i$  in period  $t$ . There is a dominant strategy to catch two fish, but the social optimum can be reached only if all players choose to catch zero fish.

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<sup>6</sup>In the three laboratory treatments, there is no uncertainty about the number of fish an individual catches once he decides to catch them. Choosing to catch a fish is in effect catching a fish.

After each subject has indicated his choice for the period, all forms are collected and earnings are calculated. Before the next period starts, all subjects are informed about the choices of all of the other subjects in that session in the prior period, regardless of their group membership. The identification numbers of all subjects in a session are written down on a blackboard. This means that each subject is able to connect another subject's number to his choice, and to track his choices over time, but is not informed about which subjects are in his own group. This roughly corresponds to the field treatments in which all subjects have the opportunity to monitor the actions of the other subjects, even though they do not know which other individuals are in their group.

### **2.2.1 The StuLab treatment**

The StuLab treatment is conducted with student participants in the Center laboratory at Tilburg University. Only students with Dutch nationality were permitted to participate. This restriction was intended to control for cultural factors, which can potentially influence the results (see, for example, Hermann et al. (2008) and Brandts et al. (2004)). In total, 32 students participated in the StuLab treatment, yielding eight groups of four subjects. All of the students were economics, law or psychology majors. On average, the participants in this treatment earned €12.98, in addition to a participation fee of €5, for a total average compensation of €17.98.

### **2.2.2 The FisherLab treatment**

The FisherLab treatment is identical to the StuLab treatment except for the subject population used and the venue where the sessions are conducted. Fishermen at De Biestse Oevers were the participants rather than university students. The treatment was conducted in the restaurant of De Biestse Oevers, which was temporarily organized in a structured setting with physical separation between participants, in a manner similar to a typical experimental laboratory. In total, 32 fishermen participated in this treatment, comprising eight groups of four participants, and thus eight observations. On

average, the participants in this treatment earned €15.-, and were allowed to fish for free for the morning after the session, in lieu of a participation fee.

### **2.2.3 The FisherPond treatment**

The FisherPond treatment was identical to the FisherLab treatment, except that the FisherPond treatment was conducted while participants were fishing for leisure. An experimenter circulated among the subjects during the sessions collecting their decisions and notifying them of outcomes. Recruiting took place by approaching fishermen at the pond to ask if they would like to participate in a research study sponsored by Tilburg University. We deliberately approached fishermen located at some distance from other participants, in order to minimize the contact that participants have with each other.

Once we recruited all participants, the rules were explained to all of them simultaneously at a central location. This is the only time during a session when the fishermen were not at their fishing spot. After the experimenter read the instructions, the fishermen returned to their fishing spots, and the experiment began. After period six was completed, we paid each participant and then the experiment ended. No participation fee was awarded. The average earnings for the participants in this experiment were €14.30.

### **2.2.4 Data available**

Table 2 below summarizes some information for all the treatments, including the number of groups and sessions in each treatment. In the table, column two assigns each treatment to the typology suggested by Harrison & List (2004) to classify field experiments.

Treatment	Typology	# Sessions	# Groups
Private Incentives (FieldPI)	Framed Field	2	8
VCM (FieldVCM)	Framed Field	3	11
Students in Lab (StuLab)	Conventional Lab	2	8
Fishermen in Lab (FisherLab)	Artefactual Field	2	8
Fishermen at Pond (FisherPond)	Artefactual ‘Natural Setting’ Field	3	7

**Table 2** Number of sessions and groups, and treatment classification: all treatments.

### 3 Measures of Cooperation and Hypotheses

#### 3.1 Measures of Cooperation

To measure cooperation in the StuLab, FisherLab, and FisherPond treatments, we use the difference between the hypothetical fish individuals chose to catch, and the maximum possible number of two fish per person, which would be the catch in the absence of any cooperation. For a group of four, the level of group cooperation in period  $t$  is given by:

$$C = 8 - \sum_i x_{it}. \quad (2)$$

In the FieldVCM treatment we use two different measures of cooperation, which we will refer to as the *Catch* and the *Effort* measures of cooperation. We require measures that correct for the fact that it is not always feasible to catch the maximum of two fish per period. We thus take as the baseline level, corresponding to zero cooperation, average behavior in the FieldPI treatment in the same season.

The first measure, *Catch*, is the difference between the number of fish a four-person group catches in the FieldVCM treatment and four average individuals catch in the FieldPI treatment in the same season. The level of cooperation in the FieldVCM treatment, according to the *Catch* measure is thus:

$$C = 4 \sum_i x_{it}^{FieldPI} / n - \sum_i x_{it}^{FieldVCM^j}, \quad (3)$$



where  $\sum_i x_{it}^{FieldVCML^j}$  is the total catch in period  $t$  of group  $j$  of the Field-VCML treatment, and  $4 \sum_i x_{it}^{FieldPIL} / n$  is the average catch of 4 of the  $n$  total number of individuals in the FieldPIL treatment. An analogous measure is defined for the High season. A value of  $C$  equal to 0 would indicate zero cooperation, and a positive level would indicate the presence of cooperation.

The second measure of cooperation we use for the FieldVCM treatments is the Effort measure. This is as measured by the difference, between the FieldPI and FieldVCM treatments, in the number of times an average fisherman casts his fishing rod per minute. Precisely, to measure cooperation in a group, we consider the average number of casts per minute registered by members of the group, and subtract this number from the overall average casts per minute over all individuals participating in the FieldPI treatment in the same season. If less effort is exerted in FieldVCM, we interpret a difference as an indication that cooperation is observed. Casting a rod is a conscious decision of a fisherman, and a fisherman can deliberately ‘work harder’ to catch a fish. The effort measure is relatively independent of weather conditions except perhaps under extreme weather circumstances that we did not observe in our sessions.<sup>7</sup>

### 3.2 Hypotheses

The classical assumptions of rationality and the absence of social preferences imply that there is no cooperation in any of our treatments. Subjects would always choose to catch two fish in each period if possible, and there would be no difference between the FieldVCM and FieldPI treatments. Therefore, we will maintain the following as a null hypothesis.

**Hypothesis 1** There is no cooperation in the FieldVCM treatment. The catch of fish and the effort exerted, are equal in the FieldPI and FieldVCM treatments. In other words, both the Catch and Effort measures

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<sup>7</sup>The number of casts per minute is positively related to the number of fish caught. On average, increasing the number of casts by .1 per minute increases the catch by 0.028 in the Low season and 0.054 in the High season.

of cooperations are equal to zero.

If the findings of the FieldVCM treatment differ from the received results from previous laboratory experiments, we attempt to determine where these differences originate. The first part of this exploration is to test whether the participating population has any effect on cooperation. The sports fishermen differ from students in terms of age, gender composition, educational attainment. They may also differ in average competitiveness, or level and type of social preferences. A priori, however, we hypothesize that these differences do not influence the level of cooperation significantly. We thus propose the following hypothesis:

**Hypothesis 2a** The levels of cooperation in the StuLab and FisherLab treatments are equal.

The next comparison concerns whether the physical environment in which the fishermen interact influences the cooperation level. It could be the case that the artificial laboratory environment may accentuate, or alternatively, suppress, other-regarding behavior relative to naturally-occurring environments. We propose the following null hypothesis.

**Hypothesis 2b** The levels of cooperation in the FisherLab and FisherPond treatments are equal.

The last step, between FisherPond and FieldVCM, involves several differences between treatments. Fish are introduced as a reward medium, real effort has to be exerted to behave selfishly, and the timing of the game differs from that in the lab. It is plausible to conjecture that any one of these differences might cause a discrepancy between cooperation levels in the two treatments. Furthermore, the cooperation measures, if positive cooperation occurs in both treatments, are not comparable in terms of magnitude. However, if one of the treatments shows a cooperation level of zero and another shows a positive level according to their respective measures, we can conclude that there is more cooperation in the second treatment than in the first. Furthermore, if both treatments have a cooperation level equal to zero

according to their own measures, we can conclude that cooperation levels are similar in the two treatments. Since it is a dominant strategy to catch two fish in both treatments, implying the same level of cooperation, we advance the following hypothesis:

**Hypothesis 2c** The levels of cooperation in the FisherPond and in the FieldVCM treatments are equal.

Hypothesis 3 considers which treatments exhibit a similar pattern of behavior as the classical laboratory experiments with an abstract framing. This pattern is a tendency for positive cooperation in early periods and a decline in cooperation over time. Hypothesis 3 is evaluated for each treatment separately.

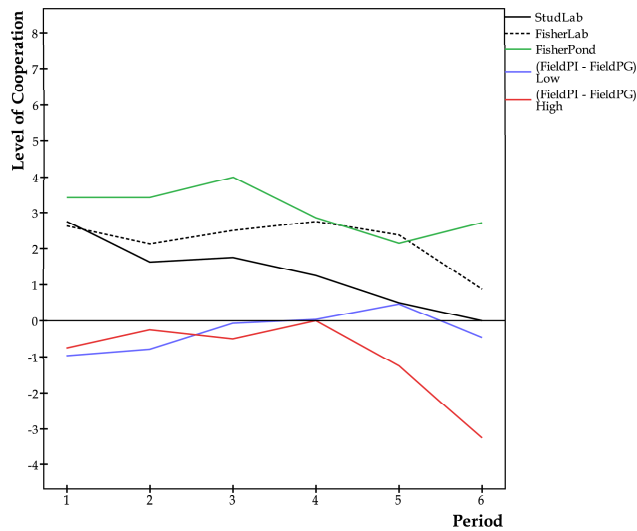
**Hypothesis 3** In the early periods, positive but less than full cooperation occurs in all treatments. The level of cooperation declines over time.

Finally, we advance a hypothesis about whether the level of cooperation differs between the Low and High seasons. If players are rational agents and have no social preferences, than all fishermen would fish to their maximum ability in both seasons. On the other hand, if effort is less likely to result in a catch, as in the Low season, it is less costly to cooperate. Therefore, in the Low season, the expected benefit of expending effort to fish (not cooperating) is lower than, while the social benefit from not fishing (cooperating) is the same as in the High season. This results in a different tradeoff between private gains from non-cooperation and group gains from cooperation. Higher cooperation in the Low season would thus be analogous to the positive relationship between marginal per-capita return and contributions observed in laboratory VCM experiments (see for example Isaac & Walker (1988)). Therefore, we hypothesize that there is no difference in our measures of cooperation between the sessions conducted in June (the low season) and the sessions conducted in September and October (the high season).

**Hypothesis 4** There is no difference in cooperation, measured with either Catch or Effort, between FieldVCML and FieldVCMH.

## 4 Results

Figure 1 shows the average group's level of cooperation in the StuLab, FisherLab, FisherPond, FieldVCML and FieldVCMH treatments, over the six periods of the sessions.

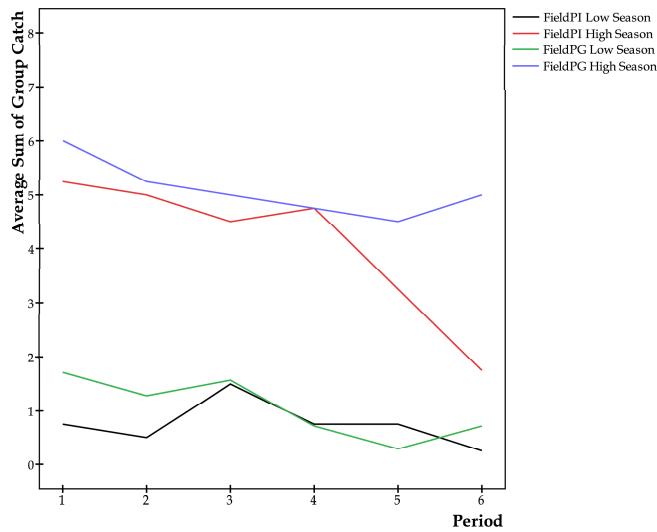


**Figure 1** Levels of cooperation in the lab treatments and the field treatments.

The figure shows that the cooperation level in the StuLab, FisherLab, and FisherPond treatments begins at a considerably positive level, but declines over time, in a similar manner as the typical laboratory VCM experiment. The decrease in cooperation is more pronounced for the students than for the fishermen. In contrast, the level of cooperation in the FieldVCMH and FieldVCML treatments is close to zero throughout the sessions.

Figure 2 shows the absolute catch in the field treatments. It indicates the sum of fish caught in a group, averaged across groups in the FieldVCM treatments. It also shows the catch of four average individuals (that is, four times the average catch) in the FieldPI treatments.

The number of fish caught is declining over time in both the FieldVCM



**Figure 2** Average sum of fish caught in the field experiments.

and FieldPI treatments and in both the High and the Low seasons.<sup>8</sup> However, it is declining in a similar manner in FieldVCM and FieldPI (with the exception of the last two periods of FieldVCMH), indicating no change in the cooperation level over time.

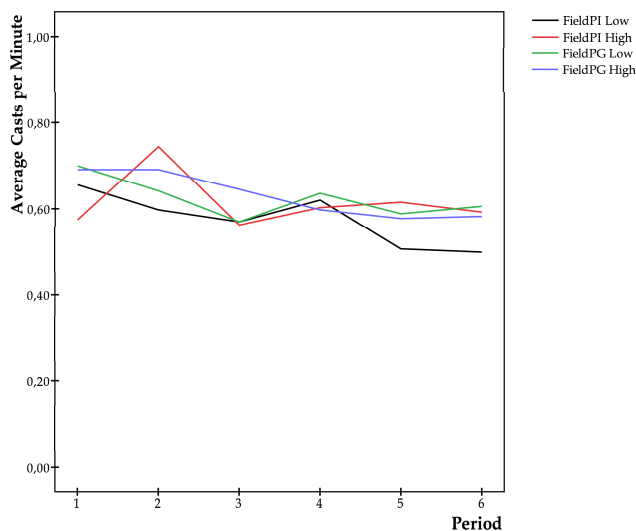
Figure 3 shows the amount of effort as captured by the number of casts per minute, averaged over all individuals in each of the field treatments.

The figure shows that the four treatments yield similar behavior. On average, the fishermen cast their rod 0.59 times per minute in FieldPI, whereas in FieldVCM, the fishermen cast their rod on average 0.63 times per minute. Thus, by both the Catch and the Effort measures, the figures suggest no evidence of cooperation in the field treatments.

The first step of our formal analysis is to consider whether cooperation occurs at all in the field treatments. As the following result indicates, we

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<sup>8</sup>According to the fishermen, the finding that less fish are caught over time is a typical pattern. The longer a fish remains in the pond, the longer it can feed itself from the natural resources that the pond offers. Therefore, it does not have to rely on bait in order to feed itself, and catch goes down over time.



**Figure 3** Casts per minute averaged over all groups in the FieldPI and Field-VCM treatment for the High catch and Low catch season.

find no evidence of any cooperation using either of our two measures.

**Result 1** In the two VCM treatments in the field (FieldVCM), no cooperation is observed.

**Support for result 1:** Consider first the Catch measure of cooperation. It actually has a negative value in all sessions of both the FieldVCM and FieldVCMH treatments. Thus we can reject at conventional levels the hypothesis that the level of cooperation is greater than zero in FieldVCM. Consider now the Effort measure of cooperation. Here, we also find no significant difference in casts per minute between FieldVCM and FieldPI. A Mann-Whitney test, taking each group's activity over a session as one observation, yields a conclusion of no difference ( $N_1 = 8, N_2 = 11, p = 0.44$ ). There is no evidence of cooperation by the effort measure.

Another way of looking for evidence of cooperation, is to consider the effort levels associated with attempting to catch a second fish, conditional on catching one fish in a round. The quota of catching two fish gives the

fishermen the opportunity to cooperate partially, by catching one fish. This would be revealed in lower effort in trying to catch a second fish. However, we find no evidence of a difference in effort to catch a second fish between the FieldPI and FieldVCM treatment (Mann-Whitney test,  $N_1 = 19, N_2 = 33, p = 0.50$ ).<sup>9</sup>

This lack of cooperation contrasts sharply with studies of social dilemmas in the laboratory using student subjects. As indicated previously, the structure of our experiment allows us to isolate some potential sources of differences between our field setting and the traditional laboratory setting. The first difference is the subject pool. It may make a difference, within the laboratory environment, if the individuals facing the social dilemma are students or are drawn from our population of fishermen. It may be the case that fishermen are systematically less cooperative than students, and that such a difference accounts for the behavior we observe in the Field treatments. We consider whether the subject pool influences our results by comparing cooperation levels between the StuLab and the FisherLab treatments, which are identical except for the characteristics of the subjects that participate. From this comparison, we obtain result 2a.

**Result 2a** Cooperation is greater in FisherLab than in StuLab. Under laboratory conditions, the fisherman cooperate more than the students.

**Support for result 2a:** Figure 1 shows that students exhibit a lower level of cooperation than the fishermen in the lab environment. This is supported by a Mann-Whitney test ( $N_1 = 8, N_2 = 8, p = 0.02$ ), that rejects the hypothesis of equal cooperation.

The above shows that subject pool composition alone does not account for the lack of cooperation in FieldVCM. We now consider whether the labo-

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<sup>9</sup>We test for differences in the variance in the number of casts across the two treatments. A Mann-Whitney test can not reject the hypothesis of an equal variance across the two treatments ( $N_1 = 8, N_2 = 11, p = 0.60$ ). There is no evidence of a diminishing variance over time. Comparing the variance in period 1 and 2 with the variance in period 5 and 6, a Wilcoxon test yields a  $p$ -value of 0.58 in the FieldPI treatment ( $N_1 = N_2 = 8$ ). The test yields a  $p$ -value of 0.18 in the FieldVCM treatment ( $N_1 = N_2 = 11$ ). The similarity between the two treatments is further evidence that the incentive to cooperate does not influence behavior.

ratory setting itself has an effect on the cooperation level that the fishermen exhibit. We do so by comparing behavior in the FisherLab and FisherPond treatments. These two treatments are identical except that one is conducted in a synthetic environment similar to an experimental laboratory, while the other is conducted in more natural conditions, while individuals are engaged in another activity. From this comparison, we obtain result 2b.

**Result 2b** Cooperation in the FisherPond treatment is higher than in the FisherLab treatment. Putting fisherman in the laboratory decreases their cooperation level.

**Support for result 2b:** Figure 1 shows that the average level of cooperation in the FisherPond treatment is higher than in the same game conducted in the laboratory with subjects drawn from the same pool, in the FisherLab treatment. A Mann-Whitney test shows that this difference is statistically significant ( $N_1 = 8, N_2 = 7, p = 0.04$ ).

This result suggests that the formally structured laboratory setting itself reduces cooperative behavior, at least for our subject pool.<sup>10</sup> Therefore, the fact that our experiment was conducted outside of the laboratory cannot, on its own, account for the difference between the laboratory and the field.

Finally, we consider whether the FisherPond treatment generates a different level of cooperation from the FieldVCM treatment. We find that:

**Result 2c** Cooperation is lower in the FieldVCM treatments than in the FisherPond treatment.

**Support for Result 2c:** A Mann-Whitney test of cooperation levels, according to the catch of fish in the two treatments, indicates a significant

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<sup>10</sup>One potential explanation for the result that students cooperate less than the fishermen is that the fishermen do not understand the game. One way to model such confusion is to suppose that players choose equiprobably from each of their available actions when they are confused. If this were the case, we would expect each action to be chosen roughly one-third of the time. This is tested by means of a  $t$ -test, comparing the frequency of zero choices with one-third. The  $t$ -test gives a value of  $-9.52$  in FisherLab and  $-4.77$  in FisherPond. We thus reject the hypothesis of equiprobable choice at any reasonable level of significance.



difference in cooperation between the two treatments ( $N_1 = 7, N_2 = 11, p < 0.01$ ).

Despite the fact that the cooperation measures are not exactly compatible in the two treatments, we are able to conclude that cooperation is greater in FisherPond. This is because the measure is actually negative in all sessions of the FieldVCM treatment, and significantly greater than zero in the FisherPond treatment. This significance reveals that differences in the game itself account for the discrepancy between our field treatment and received results from the laboratory.

We consider now the trend in cooperation as the game is repeated. Previous laboratory experimental research has observed that cooperation is positive at the outset of a group's interaction, but declines over time. As we report in Result 3, the same phenomenon is observed in all three of our Laboratory treatments, but in neither of the field treatments, FieldVCML nor FieldVCMH.

**Result 3** In the early periods of the StuLab, FisherLab, and FisherPond treatments, cooperation occurs. The level of cooperation declines over time. In contrast, the level of cooperation in the FieldVCM treatment is equal in the early and late periods.

**Support for Result 3:** Figure 1 shows that in early periods of the StuLab, FisherLab, and FisherPond treatments, both students and fishermen cooperate more than in later periods. A  $t$ -test shows that the cooperation level is significantly different from zero in period 1 in the StuLab ( $N = 32, p < 0.01$ ), the FisherLab ( $N = 32, p < 0.01$ ) and the FisherPond treatment ( $N = 28, p < 0.01$ ). In these tests, the choice of an individual rather than a group is taken as an independent observation, because no intergroup dependencies exist resulting from the history of play exist in the first period. A Wilcoxon test comparing 'early' and 'late' play, taking the group average of period 1 and 2 as an observation of early play and the group average of period 5 and 6 as an observation of late play yields a  $p$ -value of 0.01 ( $N_1 = N_2 = 8$ ) for the StuLab treatment. For the FisherLab treatment,

the effect is not significant ( $p$ -value of 0.23 ( $N_1 = N_2 = 8$ )). The FisherPond treatment pond does show a significant decrease ( $N_1 = N_2 = 7, p = 0.03$ ).

In terms of Catch, there is a marginally significant decline in cooperation in FieldVCML ( $N_1 = N_2 = 7, p = 0.088$ , as well as for FieldVCMH ( $N_1 = N_2 = 4, p = 0.068$ ). Using the effort measure, in the Low season, the difference in cooperation in FieldPI between early and late periods is marginally insignificant (Wilcoxon test,  $N_1 = N_2 = 7, p = 0.11$ ). A clearly insignificant result is obtained in the High season (Wilcoxon test,  $N_1 = N_2 = 4, p = 0.85$ ).

The FieldVCML and FieldVCMH treatments differ in the cost of cooperation. The expected number of fish caught for a given number of casts is lower in the Low season than in the High season. Thus the incentive to cooperate is stronger in FieldVCML than in FieldVCMH, because the cost of cooperation, in terms of expected catch of fish foregone, is lower. On the other hand, the gains to the group for every fish not caught is the same in the two treatments. In prior studies in the laboratory, lowering the cost of cooperation has been shown to increase cooperation (Isaac & Walker, 1988). Here, however, as reported in Result 4, the results are mixed. We detect no significant difference in cooperation in terms of effort level between FieldVCML and FieldVCMH. On the other hand, we do find more cooperation in FieldVCML than FieldVCMH when the catch of fish is considered. However, because cooperation in both FieldVCML and FieldVCMH is actually negative, the difference indicates that the cooperation level is even more negative in the High season than in the Low season.

**Result 4** There is no difference in cooperation, in terms of effort, between the Low and High seasons. However, in terms of fish caught, there is more cooperation (cooperation levels are less negative) in the Low season.

**Support for Result 4:** A Mann-Whitney test cannot reject the null hypothesis of equal cooperation between FieldVCML and FieldVCMH in terms of the Effort measure ( $N_1 = 7, N_2 = 4, p = 0.41$ ). For the Catch measure,

the results of the analogous test show a significant difference (Mann-Whitney test,  $N_1 = 4$ ,  $N_2 = 7$ ,  $p = 0.012$ ).

## 5 Conclusion

We find no evidence of cooperative behavior in the field experiment we have conducted. Within the context of fishing that we have studied, we could detect no difference in behavior between a situation in which refraining from fishing yields a large positive externality on the group and when it does not. This conclusion contrasts to some degree from those from games with a similar strategic structure reported in laboratory experiments. In such laboratory settings, cooperation is typically positive at the outset of a group's interaction, though it typically declines over time, often to very low levels.

We have explored, with additional treatments, some potential causes of the difference between the results we have obtained in our field setting and those from laboratory studies. We are able to rule out some explanations for the difference. We find that using students as subjects tends to lower cooperation compared to our subject pool. Therefore, the use of students alone cannot account for the different patterns of behavior, and explain why more cooperation occurs in early periods in laboratory experiments. Conducting the experiments in the structured and formal setting of an experimental laboratory also appears to decrease cooperation among our subjects. They were more cooperative when participating in a voluntary contributions game while they were fishing than when they were in the laboratory. Therefore, the fact that the experiment was conducted outside the laboratory, alone, cannot account for the lack of cooperation.

The only remaining explanation is that there are critical differences between the game played in our FieldVCM and FisherPond treatments that lead to lower cooperation in FieldVCM. There are a number of differences between the two settings. It is possible that these differences operate as main effects or interact with the subject pool or the non-laboratory nature of the setting. One possible candidate is the medium in which payoffs

are denominated. While in both treatments, cooperative behavior leads to cash payments for other group members, the private consequences for non-cooperative behavior differ between the two treatments. In the laboratory, non-cooperative behavior leads to more money, while in the FieldVCM treatment, it entails more fishing, and a possibility of having more fish. It may be the case that non-monetary rewards, such as the experience of fishing, are more difficult to forego than monetary rewards, or that it is more difficult to make tradeoffs between different reward media. Furthermore, the timing of the game differs between the traditional lab settings and our field experiment. Perhaps the constant flow of information that participants receive on efforts of others and their catch provides a feedback loop that accelerates the convergence to non-cooperation. The fact that these differences lead to lower cooperation is potentially significant. Some features of the field experiment are natural in many public goods situations, but are not taken into account in most laboratory experimental design. Social dilemmas such as air pollution reduction, fish stock or other renewable resource maintenance, or preserving the diversity of an ecosystem, all involve non-monetary rewards, real effort, and continuous interaction.

It has been shown in some field experiments that decentralized cooperation can be successful (see for example Erev et al. (1993) and Bandiera et al. (2005)). However, our results suggest that this successful cooperation does not spontaneously arise from the mere presence of group level gains resulting from the sacrifice of private payoffs. It may be the case that to reliably achieve cooperation, some additional structure is required. This structure might be an effective avenue of communication between individuals, a system of punishment of non-cooperators, or a mechanism for increasing and maintaining social cohesion. All of these factors have been found to increase the level and sustainability of cooperation in laboratory social dilemmas. It is thus reasonable to conjecture that presence of one or more of these instruments may be necessary, or make at least make it more likely, to achieve any cooperation at all in some field settings, such as the one we have studied. On the other hand, it may also be the case that social preferences are fluid, and can be constructed from the context under which individuals interact.

If this is the case, cooperativeness is a characteristic of the framing of the game, not just of particular individuals. That is, some individuals have a propensity to cooperate more than others, but some games evoke more cooperation than others.

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