From the lab to the field: Cooperation among fishermen[*]

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Abstract

We conduct an experiment to measure cooperation among groups of sports fishermen at a recreational fishing facility. Group benefits increase when group members catch fewer fish, in a manner similar to the Voluntary Contributions Mechanism (VCM). In contrast to received VCM laboratory results, however, we find no evidence of cooperation in the field. We construct a series of additional treatments to identify causes of the difference. We rule out the subject pool and the laboratory setting as the sources of the lack of cooperation in our field experiment. The evidence suggests that lack of cooperation is related to the activity, in this case fishing, that must be modified in order to achieve cooperation.

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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 an individual maximizes his own payoff when he does not cooperate, but where attaining the social optimum requires cooperation. One experimental paradigm commonly employed to study social dilemmas is the voluntary contribution mechanism (VCM). In a canonical version of this game, each member of a group receives an endowment of money. The members of the group then simultaneously choose to contribute any portion of their endowment to a group account. Contributions to the group account benefit all members of the group. The tradeoffs are specified so that each individual has a dominant strategy to place his entire endowment in his private account, but the social optimum is attained only if all individuals contribute their entire endowment to the group account.[1] The percentage of endowment placed in the group account can be readily interpreted as a measure of cooperation.

The behavior of individuals who repeatedly play the VCM has been shown to exhibit two robust patterns (for a survey, see Ledyard (1995)). The first pattern is that initial average contributions to the group account are significantly different from both zero and 100 percent of their endowment. This reveals positive, 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 et al. (1985), Andreoni (1988), and Isaac and Walker (1988)).

In this paper, we consider whether these two patterns appear in a framed field experimental environment. The setting of our field experiment is a recreational fishing pond where sports fishermen can catch rainbow trout. We create a social dilemma similar in structure to the VCM. The fisher-

[1]In a finitely-repeated version of the game, the only subgame perfect equilibrium is for each individual to place his entire endowment in his private account every period, regardless of the history of play. The social optimum requires all individuals to place their entire endowment in the group account in every period.

men 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 an individual foregoes catching, each of the three other members of the group receives a cash payment. Thus, a social dilemma is created in that each individual has a dominant strategy to catch two fish in each period, while the social optimum requires all individuals to forego their catches. Cooperation measures are derived from the actual catch of fish, and the effort made to catch fish, relative to a control treatment where no collective incentives exist to reduce the catch of fish.

As described in section 2, the data show no cooperation at all. Beginning 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 average number of fish as those without such gains. To explore the source of the difference between our setting and received results from the laboratory, we conduct four additional treatments. These treatments are described and reported in sections 3 and 4. They establish that the discrepancy in cooperation is not due to the fact that: (i) the subject pool differs, (ii) the field experiment is conducted in a natural rather than in a structured laboratory setting, (iii) the group benefits and private costs of cooperation are denominated in terms of different units (money and fish) in the field experiment, or (iv) an idiosyncratic property unique to the field experiment we have designed. The data from these treatments suggest that the key difference between the laboratory and our field setting, that leads to a lack of cooperation in the field, is the activity that must be modified in order to cooperate. When cooperation requires a reduction of fishing, whether the reduction translates into more money or into more fishing opportunities for the group, individuals are not cooperative.

The *FieldDyna* treatment, described in section 4, is also of independent interest because it provides the first experimental test of the standard renewable resource model (see for example Brown (2000)). In this treatment, we create a social dilemma, in which overfishing creates a more than offsetting reduction in future fishing opportunities. The number of fish that an individual catches in a particular period reduces the number of fish available to other members of the group in the same period, as well as the number available to the whole group in the subsequent periods. In this treatment, we find no cooperation. Instead, there is a strong tendency to exhaust the stock of fish.

Our work bears a relation to a number of other field experiments that focus on cooperation. An active literature is investigating influences on charitable giving (see for example List and Lucking-Reiley (2002), Frey and Meier (2004), Martiny and Randal (2005), Alpizar et al. (2008) and Croson and Shang (2008)). Another strand of research uses artefactual field methods to study behavior of non-student subject pools in the VCM game (see for example Barr (2001) and Ruffle and Sosis (2007)), and a closely related paradigm, the common pool resource game (see for example Cardenas (2003), Cardenas (2004), Cardenas and Ostrom (2004), and Rodriguez-Sickert et al. (2008)). These studies all find positive cooperation in the VCM game among the subject pools studied. The available evidence from framed and natural field experiments is mixed. Erev et al. (1993) find considerable evidence of free-riding when students pick oranges in team production. When groups act individually, subjects pick thirty percent less oranges than in case a bonus is given to the group with the highest output. Bandiera et al. (2005) report a substantial degree of cooperation in a fruit picking firm, but only when the subjects are able to monitor each other. A few field experiments have documented a positive correlation between individuals' cooperativeness in a VCM game and pro-social behavior in another activity (see for example Carpenter and Seki (2005), Laury and Taylor (2005), Benz and Meier (2008), and Fehr and Leibbrandt (2008)).

Levitt and List (2007, 2008) have taken the view that social preferences appear with differing prominence in the laboratory than in field settings. Our results are consistent with this view. Furthermore, for the particular game that we study, differences in cooperativeness can be directly attributed to differences in (a) the subject pool, (b) the use of the laboratory, as well as (c) the decision variable that must be modified in order to cooperate. More specifically, the absence of cooperation in our framed field experiment can only be attributed to the decision variable, since the effect of subject pool and the laboratory operate in the opposite direction.

2 The FieldVCM treatment

The first pair of treatments we describe consist of a field implementation of the Voluntary Contributions Mechanism, and a control treatment. The treatments, which constitute a framed field experiment in the sense of Harrison and List (2004), are described in section 2.1. In sections 2.2 and 2.3 we consider methodological issues that arise under our design. We present the analysis of the data in section 2.4.

2.1 The setting, the game, and the experimental design

The sessions were conducted at a commercial trout fishing facility called 'De Biestse Oevers', located in the village of Biest-Houtakker.[2] This village lies in close proximity to Tilburg, in Noord-Brabant province, in the south of the Netherlands. De Biestse Oevers is privately owned, and comprises three separate fishing ponds with surface areas of about 8,500 square feet each. One of these ponds served as the venue for our experiment. On a typical day, when no experiment is taking place, a customer can fish for four hours for €12.50. The pond has space for twenty fishermen at a time. 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. There are strict rules regarding fishing gear and type of bait that may be used, but a customer is allowed to catch as many fish as possible. Also, because of sanitary considerations with respect to the remaining fish, any trout fish caught cannot be thrown back into the pond and must be taken away from the site (presumably home). The typical customer, and hence our typical participant, is Dutch, male, and over fifty years old.

Participants were recruited for our experiment two weeks in advance by distributing flyers on site informing them of the opportunity to take part

[2] See www.biestse-oevers.nl for pictures of the site.

in a study conducted by Tilburg University. A maximum of sixteen people was allowed to participate in each session.

Two treatments, FieldVCM and FieldPI, were conducted under the following conditions. A session consisted of six consecutive periods of forty minutes each, and therefore took four hours to complete. Within a session, each period proceeded under identical rules. Participants were assigned to groups of four, and group membership remained fixed throughout the session. Subjects were not informed at any time of the identity of the other members of their group. At the end of each period, each participant was informed privately of the total number of fish caught by his group.[3]

Before a session began, two rainbow trout per participant were put into the pond, plus an additional six trout. For a session of 16 participants, we thus threw in 38 rainbow trout. Before the first period, the participants were randomly assigned a spot at the pond by picking a numbered spot tag out of a bag. This random assignment procedure was repeated before 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.[4]

Each participant was allowed to catch a maximum of 2 fish per period (Rainbow Trout or Salmon Trout). Any fish caught was his to keep – consistent with the standard rules and regulations of De Bieste Oevers, throwing back trout is not permitted. 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 equalling the total catch of the previous period was put into the water. Therefore, the total number of fish in the pond was the same at the beginning of each period within a given session. Communication among subjects was strictly

[3]Informing subjects that they are matched into groups is awkward in a setting in which individual outcomes are completely independent of others' actions. Nevertheless, we wanted to check whether framing the FieldPI treatment as a group exercise has an impact on behavior. Therefore, we conducted one of the FieldPI sessions without informing subjects about any matching procedures. We did not detect any differences in behavior resulting from the different framing.

[4]Our data show no actual significant relationship between location and the number of fish caught, suggesting that this belief may be incorrect or exaggerated.

prohibited.

This completes the description of the FieldPI treatment; the FieldVCM treatment only differed in that a social dilemma was created by introducing group incentives for reducing the number of fish caught. Each fish that a participant did not catch below his maximum quota of two per period resulted in a cash payment of €2 to each of the other three group members. Therefore, a participant faced a tradeoff between individual catch and monetary income for other members of his group. Either a participant caught a fish, or he provided a surplus of €6, divided equally among the three other members of his group. Note that this game differs from the standard VCM game in that cooperation poses a pure externality; the decision maker does get any private return to the investments she makes. We imposed this simplification in order to ensure that subjects would be very aware of the social dilemma they are confronted with. At the end of each period participants in the FieldVCM treatment were not only informed about group catch in the that period but also about the amount of money he had earned in that period, as well as about his cumulative earnings. The average earnings over a session of a participant in the FieldVCM treatments were €49.60.

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. Therefore, the data from each of the two seasons is analyzed separately. The data from June will be described as having been conducted in the *Low* season and abbreviated as FieldVCML. Those data acquired in September and October will be said to have been gathered in the *High* season and referred to as FieldVCMH.

2.2 Establishing the existence of a social dilemma

In the FieldVCM treatment, a social dilemma exists if the private benefit of the right to catch an extra fish is smaller than the amount of money received by the other three members if that fish is not caught. In other words, a social dilemma exists if valuing the right to catch one more fish is less than €6, for some level of fish less than or equal to the maximum permitted catch of twelve for one session.

The private value of the right to catch a fish has two components: the value of the fish itself and the utility of fishing. The price of rainbow trout in local fishmongers' 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. Because an equivalent fish can be purchased nearby for at most €4, it is an upper bound for the value of a fish itself.

To place a value on the utility of fishing, recall that our subjects are regular customers at the fishing pond, so that the value of the marginal half-day of fishing is close to the market price of €12.50. This is an upper bound of the utility of the act of fishing itself, since individuals typically are able to take home some fish after four hours of fishing. Thus, a generous upper-bound for the total value of acting non-cooperatively in our experiment is then €4/fish $\times$ 12 fish + €12.50 = €60.50, though the actual private value is likely to be much lower. If we suppose that the usual fee of €12.50 is paid with an expectation of catching four fish on average, the amount typically thrown into the pond per paying customer, the experiment gives participants an opportunity to catch eight additional fish. Under this assumption, the value of acting non-cooperatively for an entire session is €4/fish $\times$ 8 fish + €12.50 = €44.50. This calculation assumes that the value of each fish is the highest price available in the area, and that individuals can catch twelve fish. The data from the FieldPI treatment, presented below in section 2.4, indicate that catching 12 fish was extremely difficult if not impossible for participants.

If all subjects cooperate fully and catch zero fish during all six periods, they would each go home with €72, which is substantially more money than the private value of fishing as calculated above.[5] Indeed, it would

[5] In the literature we find one study that estimates the total surplus of sports fishing (rather than the marginal value of a fishing trip). Toivonen et al. (2004) estimate the total surplus sports fishermen in five Nordic countries obtain from all fishing trips they make per year. The estimates are fairly consistent across these five countries in that they range between 1.30 and 1.54 times the actual fishing expenses. If we apply the maximum

be enough to go fishing five times at 'De Bieste Oevers', and have €9.50 remaining, or alternatively to buy twelve fish in a fishmonger's shop and have €24 remaining – or more.[6]

A second test of whether our game is correctly parameterized is a survey of members of our subject pool. We surveyed eighteen fishermen on a day when no experiments were conducted. The fishermen were presented with three hypothetical options, and they were asked which one they preferred. The first option is to fish for free for four hours while being allowed to catch at most twelve fish. Once twelve fish are caught, the fisherman would have to stop fishing. This first option represents the level of individual welfare obtained if none of the members of a group would cooperate. The second option is to receive €36, be allowed to fish for four hours, and to catch at most six fish (and being forced to stop fishing when six fish are caught). This option captures the level of individual welfare obtained if all subjects in a group would decide to partially cooperate by voluntarily limiting their catch to one fish per period. Finally, the third option captures the level of individual welfare obtained if all fishermen in a group would cooperate. Under this option, the fisherman receives €72, but he is not allowed to fish at all.

The results of the survey are the following. Nine of the eighteen fishermen indicated a preference for the second option (catching six fish and receiving €36). Four chose the third option (receiving €72 but not fishing at all), and five fishermen chose the first option (receiving no money but being

ratio (1.54, measured in Norway), to our case, the amount of compensation needed for not being allowed to fish equals €19.25 (= 1.54 times the entrance fee) plus €32 (as an upper bound for the consumption value of the eight extra fish one can catch in our experiment). The calculation indicates that, even when using total surplus of fishing rather than the marginal value, the total estimate of the private value of a half-day of fishing of €51.25, is well below the monetary returns to cooperating of €72.

[6]There are various ways to decrease the opportunity cost of acting cooperatively. For example, fishermen can decide to cooperate at least partially by fishing leisurely rather than at full force, and thus enjoying the act of fishing while reducing the chances of actually catching two fish per forty-minute time period. Alternatively, they can decide to just fish for, say, three hours rather than four, or they can decide to voluntarily limit their catch to just one fish per period. We deliberately specified the strategy space as zero, one or two fish (rather than just zero or one, for example) to allow for partial cooperation.

allowed to catch maximally twelve fish). This means that 72.2 percent of the interviewed fishermen prefer one of the two options that we associate with cooperation.[7] This percentage is sufficiently high that we are confident that paying €6 per fish not caught results in a social dilemma. Furthermore, we believe that the hypothetical nature of our questionnaire is likely to result in an overestimate of the share of people choosing option 1.

2.3 Measuring cooperation

The measurement of cooperation in this setting raises methodological issues that do not usually appear in laboratory experiments. The number of fish caught depends on exogenous factors, such as weather conditions, as well as cooperativeness. Here, results obtained in the FieldPI treatment serve as the non-cooperative benchmark as it provides the same incentives to catch the quota of two fish as the FieldVCM does in case agents are acting non-cooperatively.

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As was the case with FieldVCM, one round of FieldPI was carried out in June 2008, and a second round in September 2008. The data collected in June is designated as Low season (FieldPIL), while those gathered in September are classified as High season (FieldPIH).

Comparing catch in FieldPI and FieldVCM during a given season provides one measure of cooperation. Cooperation corresponds to a smaller catch of fish in FieldVCM than in FieldPI in the same season. We call the magnitude of this difference the *Catch* measure of cooperation. A second measure of cooperation is the number of times an average fisherman casts his fishing rod per minute. There are several advantages of this measure. One, casting a rod is a conscious decision of a fisherman. A fisherman can deliberately 'work harder' to catch more fish – in appendix A, we show that there is a significantly positive effect of effort on the number of fish caught. Two, the measure gives a clean interpretation of cooperation. Whereas catching

[7] The survey offered individuals pairwise choices between the three alternatives. However, because no subject's choices were intransitive, the choices imply an unambiguous ranking of the three choices for each individual.

zero fish might be a consequence of bad luck, not casting a rod cannot be reasonably interpreted in a manner other than as indicating cooperation. Three, whereas catching fish is influenced by weather conditions, casting a rod is not – as shown in appendix A. We consider the average number of casts per minute registered by members of the group in FieldVCM, and compare it to FieldPI in the same season. If this is lower in FieldVCM than in FieldPI, we interpret the difference as an indication that cooperation is observed. We refer to the magnitude of the difference as the *Effort* measure of cooperation.

2.4 Results from the FieldVCM treatment

Table 1 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, we treat the activity of each group of four subjects over an entire session as one observation. This gives us a minimum of four observations per treatment.

	High season	Low season
Private Incentive (FieldPI)	1 session	1 session
	16 subjects	16 subjects
	4 groups	4 groups
Voluntary Contribution Mechanism (FieldVCM)	1 session	2 sessions
	16 subjects	28 subjects
	4 groups	7 groups

Table 1 Number of sessions, groups and subjects, in the FieldVCM and FieldPI treatments

Figure 1 presents the average aggregate number of fish caught in a group in the FieldVCM and FieldPI treatments. The average in each of the two seasons is indicated as a separate series. In the figures, higher catch reflects less cooperation. Two patterns are obvious in Figure 1. The first is that, in a given season, the average number of fish a group catches in FieldVCM is at least as great as in FieldPI. Second, whereas the number of fish caught falls over time, the decrease is not more pronounced in FieldVCM than in

FieldPI.[8]

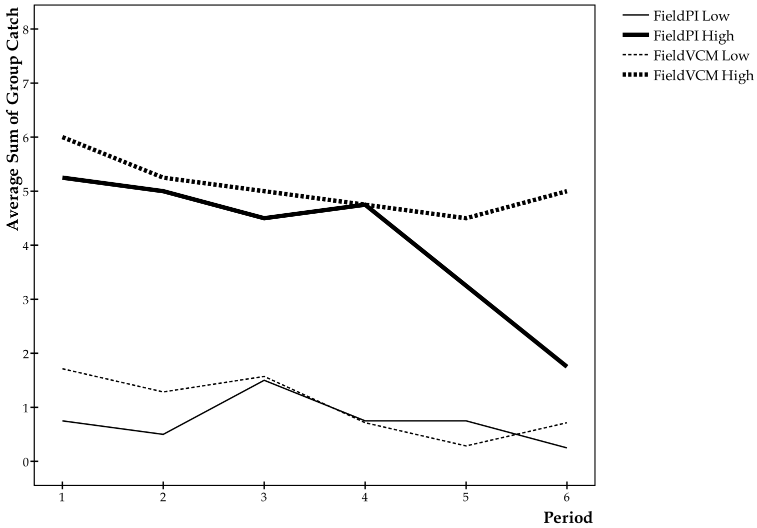


Figure 1 Average group catch by period, FieldVCM and FieldPI, High and Low season.

Our second measure of cooperation, effort as captured in the number of casts per minute, is shown in Figure 2. The figure shows that the four treatments yield similar behavior. On average, the fishermen cast their rod 0.59 times per minute in FieldPI, compared to 0.63 in FieldVCM. Thus, by both the Catch and the Effort measures, the figures suggest no evidence of cooperation. The support for result 1 below provides the statistical basis for this claim.

Result 1 In our social dilemma experiment conducted in the field, FieldVCM, no cooperation is observed.

Support for result 1: We first consider cooperation measured in terms of catch. On average, the catch of fish is actually higher in the FieldVCML

[8] 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.

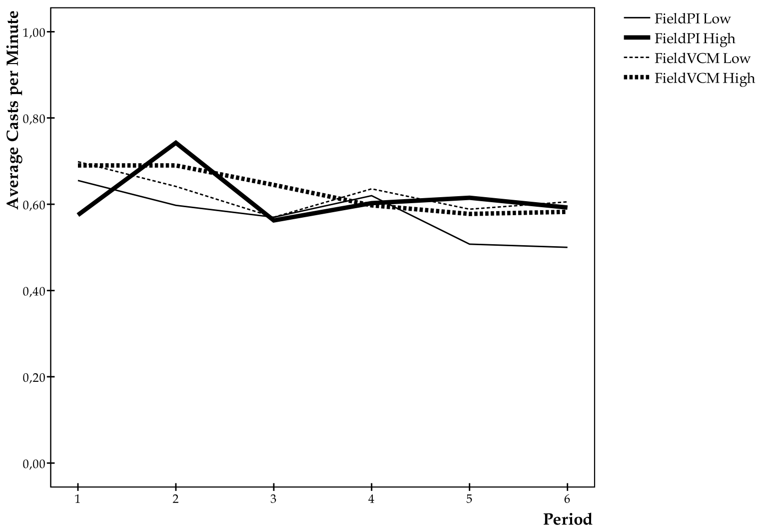


Figure 2 Average individual casts per minute by period, FieldVCM and FieldPI, High and Low season.

and FieldVCMH treatments than in the corresponding FieldPIL and FieldPIH treatments. A Mann-Whitney test, taking each group's activity over a session as one observation, and comparing the catch of fish in the low season, fails to reject the hypothesis of equal catch in the two treatments ($N_1 = 4, N_2 = 7, p = 0.164$). In the high season, the Mann-Whitney test indicates that more fish are caught in the FieldVCMH treatment than in FieldPIH ($N_1 = 4, N_2 = 4, p = 0.057$). Consider now the Effort measure. Here, the appropriate Mann-Whitney test indicates no significant differences in casts per minute between FieldVCM and FieldPI, neither in the Low season ($N_1 = 4, N_2 = 7, p = 0.412$) nor in the High season ($N_1 = 4, N_2 = 4, p = 0.886$). There is no evidence of cooperation by either of our two measures.

Another place to look for evidence of cooperation, is to consider the effort levels associated with attempting to catch a second fish, conditional on having caught one fish already in the current period. The quota of catching two fish gives the fishermen the opportunity to cooperate partially, by catching one fish. Such cooperation would be revealed in lower effort in trying to catch a second fish in FieldVCM than in FieldPI. However, we find no evidence of a difference in effort to catch a second fish between FieldPI and FieldVCM (Mann-Whitney test, $N_1 = 19, N_2 = 33, p = 0.50$, taking the average effort levels of each subject over the course of the entire session as an independent observation).[9]

We now consider whether there is a trend in cooperation over time. A downward trend in the number of fish caught is evident in Figure 1. The decrease is similar in the two treatments, although it is more pronounced in FieldPI than in FieldVCM in late periods of the high season. This indicates that cooperation becomes even more negative over time in FieldVCM. The visual impression gained from Figure 2 is that there is no discernible trend in effort levels. For both catch and effort we test whether the relevant measure of cooperation is different between early and late periods, and the weight of the evidence favors result 2.

Result 2 The level of cooperation in FieldVCM is equal in early and late periods.

Support for result 2: For purpose of this analysis, the *early* periods of a session consist of periods 1 and 2, while periods 5 and 6 are considered the *late* periods. The average group catch over all groups in the first two periods of the FieldPI treatment in a given session is taken as the zero cooperation baseline for early periods. A similar baseline is constructed for the late periods. The early baseline is subtracted from group catch in the first two periods for each group in the FieldVCM treatment separately, and the late baseline from group catch in periods 5 and 6 for each group in FieldVCM. Thus, the difference between each group's catch in FieldVCM

[9] We test for differences in the variance of the number of casts across the two treatments. A Mann-Whitney test cannot 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 ($N_1 = N_2 = 8$) and 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.

and the average catch in FieldPI is an observation. The exercise is conducted separately for each season. We then test whether cooperation is the same in the early and late periods, treating each group's behavior as a matched pair.

For the Low season, the Wilcoxon test yields a p-value of 0.088 ($N_1 = N_2 = 7$). In the High season, a similar test gives a p-value of 0.068 ($N_1 = N_2 = 4$). Using the Effort measure, and conducting a similar analysis to that for the Catch measure, we find that in the Low season, the difference in cooperation between early and late periods is insignificant (Wilcoxon test, $N_1 = N_2 = 7, p = 0.11$). An insignificant result is also obtained in the High season (Wilcoxon test, $N_1 = N_2 = 4, p = 0.85$).

3 Bridging the gap between the laboratory and the field

Section 2 shows that the pattern of cooperation in the FieldVCM is very different from the pattern of behavior observed in traditional VCM experiments conducted in the laboratory. However, there are a number of candidates for causes of the difference, since the two conditions differ in several major aspects. These include the subject pool participating, whether the experiment is conducted within or outside the laboratory, and characteristics of the game itself, such as in the decision variable and the framing. To isolate the effect of the subject pool and the laboratory setting, we conduct three treatments, called StuLab, FisherLab and FisherPond. We will refer to these as collectively as the *Lab* treatments because of their relatively close adherence to traditional laboratory experimental procedures.

In section 3.1 we describe the procedures that are common to the three treatments. Section 3.2 describes differences between the three treatments. The results are presented in section 3.3.

3.1 The laboratory version of our social dilemma game

As in the FieldVCM treatment, participants in the three lab treatments were assigned to groups of four subjects. Each group's composition remained constant throughout the six-period sessions. Sessions were conducted by hand using pen and paper. Participants were asked to decide how many hypothetical fish to catch in each period, with a maximum of two fish per period. Each fish that a participant decided to catch, yielded a real cash payment of €1; each fish that the participant did not catch yielded €0.50 for each of the other three group members. The earnings of an individual are given by the following:

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

where π_{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, yielding individual payoffs of €2 per period. The social optimum, with each group member receiving €3 per period, can be reached only if all players choose to catch zero fish. The language of the instructions was contextualized. For example, the terms 'fish', 'catch' and 'pond' were used, rather than terms such as 'tokens' and 'project'.

After each period the experimenter provided all participants with the decisions of all subjects in the session, next to their subject identification numbers. This meant that each subject was able to monitor the decisions of each other subject in the session, and was also able to track each individual subject's decisions over time. However, none of the subjects was informed about which of the other session participants were in the same group, and there were either twelve or sixteen subjects in each session. This approximated the content of the information available to participants in FieldVCM and FieldPI, in which individuals could observe others, but did not know who was in their group. After the instructions were read out loud, the participants had to answer some test questions. Once every participant correctly answered all questions, the experiment began.

3.2 Constructing the bridge from the laboratory to the field

The first treatment, StuLab, was a conventional lab treatment conducted with student participants in the CentER laboratory at Tilburg University. We specifically and exclusively invited students with a Dutch nationality to participate. This restriction was intended to control for cultural factors, which could potentially influence the results (see for example, Brandts et al. (2004), and Hermann et al. (2008)). 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 €17.98 (including a 5 euro participation fee).

The second lab treatment, FisherLab, was identical to the StuLab treatment except for the subject population, who were customers of 'De Biestse Oevers', the same subject pool sampled for the FieldVCM and FieldPI treatments. Thus, it can be classified as an artefactual field treatment. The treatment was conducted in the restaurant of De Biestse Oevers, which was temporarily transformed into an experimental lab. We took every effort to rearrange the restaurant so that it resembled a standard laboratory as closely as possible. We brought folding tables (normally used as exam tables for students taking large-scale written examinations at Tilburg University), and placed them in rows well apart from each other. This ensured that subjects could not read their neighbors' decision sheets. We installed a blackboard in front of the rows of tables on which decisions could be recorded. We applied the procedures customary to sessions conducted in our 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 €13.65. In lieu of a participation fee, participants were allowed to fish for free during the remainder of the morning.

The third lab treatment, FisherPond, was identical to the FisherLab treatment, except that the FisherPond treatment was conducted while participants were actually fishing at the pond. Recruitment took place by approaching fishermen at the pond and asking them if they would be willing to participate in a research study conducted by Tilburg University. We deliberately approached fishermen located at some distance from other participants, in order to minimize the contact that participants had with each other. Once we had recruited all participants, the rules were explained to all of them simultaneously at a central location. This was intended to ensure common knowledge of comprehension of the task among all participants. This was the only time during a session that the participants were not at their designated fishing spots. Participants were given a typed summary of the instructions, and listened to the experimenter reading out the full version of the instructions loud.

After instruction, the fishermen returned to their fishing spots, and resumed fishing. An experimenter circulated among the subjects collecting their decisions and providing information about others' decisions and outcomes, while the participants continued fishing. As in StuLab and FisherLab, participants were informed about the decisions of all subjects. After period six was completed, each participant was paid his earnings and then continued fishing for the remainder of the morning. No participation fee was awarded. The average earnings for the participants in this treatment were €14.30. Table 2 summarizes the number of groups and sessions in each treatment.

Treatment	# Sessions	# Groups
Students in Lab (StuLab)	2	8
Fishermen in Lab (FisherLab)	2	8
Fishermen at Pond (FisherPond)	3	7

Table 2 Number of sessions and groups in the lab treatments.

3.3 Results of the lab experiments

Figure 3 shows the average levels of cooperation over time in the three lab treatments, StuLab, FisherLab and FisherPond. Cooperation is measured as the average number of fish not caught per group. That is, the level of cooperation is the maximum possible group catch in a period, eight, minus the actual catch. The figure shows that the level of cooperation is positive in the early periods of the game, and decreases as the game progresses. We obtain the following result:

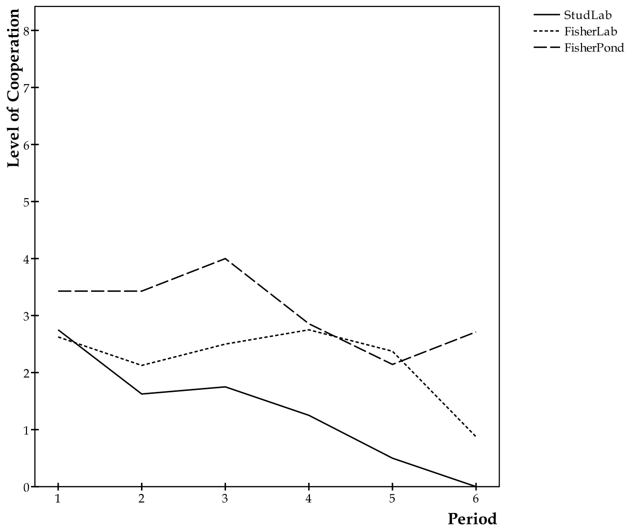


Figure 3 Levels of cooperation (maximum possible group catch minus actual catch) in the lab treatments by period, averaged over all groups.

Result 3 Contribution patterns in the StuLab treatment conform to the typical patterns observed in the VCM game as typically implemented in the laboratory. The lack of cooperation in FieldVCM is therefore not due to systematic differences between the standard version of the VCM game and our version.

Support for result 3: Figure 3 shows that in early periods of the StuLab treatments, students 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 ($N = 32, p < 0.01$) treatment. In this test, the choice of an individual, rather than a group's average contribution, is taken as an independent observation. This can be done because in the first period, there are no intragroup dependencies resulting from the history of play. A Wilcoxon test comparing 'early' and 'late' play, taking the group average contribution over periods 1 and 2 as an observation of early play and the group average over periods 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. Hence, cooperation decreases significantly over time.[10]

So, we find that the lack of cooperation in the field is not a structural result of the game we implemented. Next, we test whether the lack of cooperation found in the field treatments is due to differences in the subject pool. 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. However, when comparing play in the StuLab and the FisherLab treatments – which are identical except for the characteristics of the subjects that participate – we find that, if anything, recreational fishermen are more cooperative than students. This is reported as result 4.

Result 4 Cooperation is greater in FisherLab than in StuLab. The lack of cooperation in FieldVCM is therefore not due to recreational fishermen being less cooperative than students.

Support for result 4: Figure 3 shows that students exhibit a lower level of cooperation than the fishermen in the laboratory. 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 laboratory 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 very similar to an experimental laboratory, while

[10]Initial cooperation is also significantly different from zero for the FisherLab and FisherPond treatments. Student t-tests show that cooperation levels are significantly different from zero in period 1 in the FisherLab ($N = 32, p < 0.01$) and the FisherPond ($N = 28, p < 0.01$) treatments. In both treatments, cooperation decreases over time, and the decrease is significant for FisherPond. A Wilcoxon test comparing the group average of period 1 and 2 to that of period 5 and 6, yields a p-value of 0.23 ($N_1 = N_2 = 8$) for the FisherLab treatment and a p-value of 0.03 for FisherPond ($N_1 = N_2 = 7$).

the other is conducted in more natural conditions, while individuals are engaged in another activity. From this comparison, we obtain result 5.

Result 5 Cooperation in the FisherPond treatment is greater than in the FisherLab treatment. Cooperation is reduced by the laboratory setting.

Support for result 5: Figure 3 shows that the average level of cooperation in the FisherPond treatment is higher than in FisherLab. 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. Therefore, the fact that our experiment is conducted outside of the laboratory cannot, on its own, account for the lack of cooperation we have observed in FieldVCM.

4 The FieldDyna treatment: a dynamic social dilemma

The treatments reported in section 3 show that the difference between our field results and traditional laboratory results persist when the effects of subject pool and the laboratory are removed. The source of the discrepancy in results must lie in differences between our field and the traditional laboratory implementations of the VCM. While there are several substantive differences, we believe that the most salient is the decision variable that must be modified in order to cooperate. In FieldVCM players cooperate by fishing less, while in the lab treatments, they cooperate by giving up money.

There are two separate mechanisms whereby the decision variable could affect the level of cooperation. The first is the possibility that the decision variable itself influences cooperation. It may be that if a reduction in fishing is required to achieve cooperation, individuals are less cooperative. The second is that when group benefits and private costs of cooperation are measured in different units, as in the FieldVCM treatment (money versus fish not caught), individuals are less cooperative. Different units of account might introduce self-serving biases in beliefs about the tradeoffs between the two units. For example, individuals may convince themselves that other players prefer to fish rather than to have money, and thus failure to reduce one's fishing is compatible with attaining the social optimum.

To investigate whether the decision variable is the key factor influencing behavior, and to distinguish between the first and second possibilities for how it influences behavior, we construct a additional field treatment, called FieldDyna. In this treatment, both the private costs and group benefits of cooperation are measured in terms of fishing. If we find an absence of cooperation, we would rule out the second explanation, but fail to rule out the first.

The FieldDyna treatment is a dynamic game. In the first period, fishermen are divided into groups of four. Each group has the opportunity to catch a maximum of eight fish in the first period. The total number of fish the group can catch in the second period, however, depends on the total number of fish the group catches in the first period. A logistic function relates the increase in the number of fish that the group is allowed to catch in the next period to the number of fish remaining at the end of the current period. Hence, catching too many fish in the current period results in the group being allowed to catch fewer fish in the next period. The social dilemma is entirely in terms of fish. An individual who catches a fish reduces the number of fish available to other members of his group in the current period, as well as the number available for the group in the subsequent periods.

This treatment is interesting for at least three reasons. First, as stated above, it controls for the impact of the benefits and costs of cooperation being measured in different units. As such, it isolates potential factors causing the qualitative differences in play between in laboratory and the field, as captured in the difference between FisherPond and FieldVCM. Second, if there is any doubt about whether our parameterization in FieldVCM constitutes a social dilemma, it is obvious that FieldDyna unambiguously does so; fish caught by one fisherman reduces the initial number of fish and fishing opportunities available to the group. Third, the FieldDyna treatment is the first test of the canonical renewable resource model used in the environmental and resource economics literature (see Brown (2000)).

This section is organized as follows. Section 4.1 describes the structure of the game. Section 4.2 presents the experimental design and discusses some methodological issues. Section 4.3 presents the main findings from this treatment.

4.1 Description of the game

Consider the following model, which is the basis of the FieldDyna treatment. A finite number ($n \geq 2$) of agents, has access to a renewable resource. Each agent aims to maximize his net present value of resource harvesting, taking into account the dynamics of the renewable resource as well as the behavior of his $n-1$ fellow agents harvesting the resource. That is, agent i faces the following maximization problem:

$$\max_{x_i(t)} \quad V_i = \int_{t=0}^{\infty} \bar{p} x_i(t) e^{-rt} dt \tag{2}$$

$$\text{s.t.} \quad 0 \leq x_i(t) \leq \overline{x}, \tag{3}$$

$$\dot{S}(t) = Q(S(t)) - x_i(t), \tag{4}$$

$$Q(S(t)) = G(S(t)) - \Sigma_{j \neq i} x_j(t). \tag{5}$$

Here, $\bar{p}$ denotes the constant net revenues of selling a unit of the resource, and $x_i(t)$ is the quantity of resource agent i harvests in period t. r is the discount rate, possibly the interest rate. $S(t)$ is the stock of the resource in period t. $\dot{S}(t)$ is the change in the stock of the resource over time. $G(S(t))$ is the net natural regeneration of the resource, whose rate depends only on the size of the current stock, and $Q(S(t))$ is the net change in stock. We assume that there is a maximum number of units of the resource that an agent can harvest per period (($\bar{x}$); see (3)). As constraints (4) and (5) describe, the change in the stock of the resource, $\dot{S}$, is equal to the net natural regeneration of the resource $G(S)$, minus the total quantity of resource the $n-1$ other agents, $\Sigma_{j \neq i} x_j(t)$, and agent i, $x_i(t)$, harvest.

In the theoretical literature, the functional form most often used is the logistic growth function given by (omitting time indicators):

$$G(S) \quad = \quad \gamma S \left(1 - \frac{S}{K}\right). \tag{6}$$

Here, $K > 0$ is the maximum possible stock of the resource, also referred to as the carrying capacity. $\gamma > 0$ is the maximum rate at which the resource regenerates, also referred to as the intrinsic growth rate. Note that $G(0) = G(K) = 0$, and that the increment in population size is largest at $S = K/2$, where $dG(S)/dS = 0$. This stock level is also referred to as the maximum sustainable yield stock (i.e., $S_{MSY} = K/2$).[11] In the social optimum, the maximum sustainable yield stock is permanently maintained, while in the unique Nash equilibrium steady state, the stock is zero. In appendix B, the social optimum and steady state Nash equilibrium are derived and characterized.

4.2 Experimental design and parameters

As in FieldVCM and FieldPI, there were sixteen participants in a session, assigned to groups of four with fixed membership. In each period t, the four fishermen in a group were confronted with a catch quota denoted by Z_t, but any fisherman in the group was allowed to catch as many fish he or she wanted and was able to in any period as long as $X_t \leq Z_t$. The number of fish remaining at the end of period t, $S_t \equiv Z_t - X_t$, determined the number of new fish the group was permitted to catch, $G(S_t)$. Therefore, the available quota for period $t + 1$ was equal to $Z_{t+1} = S_t + G(S_t)$. Thus, the stock of fish available to a group satisfied (4):

$$S_t = S_{t-1} + G(S_{t-1}) - X_t. \tag{7}$$

[11]Note that absent harvesting, equations (4) and (6) combined would result in the size of the resource stock growing over time according to an S-shaped function. Starting from a very small population size the stock increases very slowly in the first periods (in the case of fish, because the number of mating pairs is small), then increases and reaches its maximum increment at $S_{MSY} = K/2$. Beyond this stock level, resource growth tapers off because of increased competition between individuals in the population for food and basic resources. Eventually, the resource would reach its maximum size K, where net growth is zero as the number of offspring would just be equal to natural mortality.

In order to facilitate the implementation of the experiment, we modified the model of section 4.1 as follows. First, the rate of time preference, r, was set equal to zero.[12] Second, the model (2)-(4) assumes that there are constant benefits of catching fish (equal to $\bar{p}$). However, in the field, the marginal utility of fish may be declining. In the experiment, we ensured that the benefits of catching fish were always strictly positive, by not only allowing fishermen to keep any fish caught, but also by paying them an additional €5 for every fish they caught. Third, in the experiment, the continuous logistic growth function of the model was approximated by a discrete function. The values chosen are represented by the dotted line in Figure 4. Fourth, instead of implementing an infinite time horizon model we restricted the number of periods to four ($t = 1, \ldots, 4$).

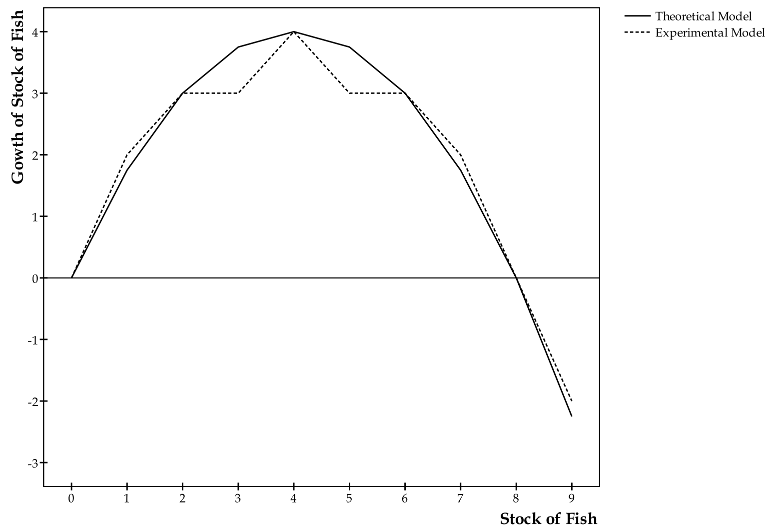


Figure 4 Actual experimental parameterization and continuous approximation of the regeneration function. In the approximation function, $\gamma = 2$ and $K = 8$.

[12]In an infinite horizon model this would require limiting catch below the available quota ($X_t < Z_t$ leaving $S_t > 0$ fish in the pond) such that the number of new fish subsequently thrown in $G(S_t)$ is maximized. That is, S_t should be chosen such that $dG(S^*)/dS = 0$, and hence $S^* = S_{MSY} = K/2$.

For the parameter values we use, the socially optimal harvesting path is the following. In the first three periods each group catches 4 fish, and in the fourth period the group catches the remaining 8 fish (that is, $X_t^* = K - S^*$ in periods $t = 1, 2, 3$, and $X_4^* = K$). The associated subgame perfect equilibrium path is $x_{i,t} = \bar{x}$ for all i, t. The equilibrium outcome is that the entire allowable catch is made in the first period, and there are no fish available to the group afterwards. Since $G(0) = 0$, the session would end after the first period. Because each period is one hour long, in the social optimum, a group receives 20 fish and can fish for four hours. In the subgame perfect equilibrium, a group receives 8 fish and can fish for at most one hour.

At the beginning of the first period 32 rainbow trout were released into the pond. At the beginning of periods 2-4 a quantity of fish was released equal to the number caught in the previous period by all groups that were still active in the current period. Hence, the actual number of fish in the pond, per fisherman still participating, was the same at the beginning of each round. The replacement of the fish caught avoids the possibility that one group's harvesting path affected the feasibility of other groups to follow their intended path.

In the FieldDyna treatment, participants were aware of which other individuals were in their group. Fishermen wore colored ribbons identifying their group. We give this information because the model presented in section 4.1 has a closed-loop solution, which requires fishermen to be aware of the size of the remaining quota (S) at any moment. We believe that if this feature of the design affects behavior, it would enhance cooperativeness. If fishermen are able to monitor the development of the remaining quota over time, it may induce them to cease fishing if they see that the remaining quota is getting too small. Hence, if we do not find any evidence of cooperation, the results would be even more convincing than in the absence of the group affiliation information.

At the beginning of each period, subjects were informed of (i) their total earnings in the previous period, (ii) total group catch in the previous period X_{t-1}, (iii) the total group quota remaining at the end of the previous period S_{t-1}, (iv) the number of fish the total group quota is increased, $G(S_{t-1})$, and (v) the size of the resulting allowable catch for the period which is about to start $Z_t = S_{t-1} + G(S_{t-1})$.

As in FieldPI and FieldVCM, the instructions were read out aloud by the experimenter at a central location, participants were provided with a handout summarizing the instructions, and communication was strictly forbidden. We explicitly tested the participants' understanding of the dynamic game by having them answer test questions before the start of the session. The sessions of the FieldDyna treatment were conducted in April 2009. Average earnings of the participants were €15.30. No participation fee was awarded.

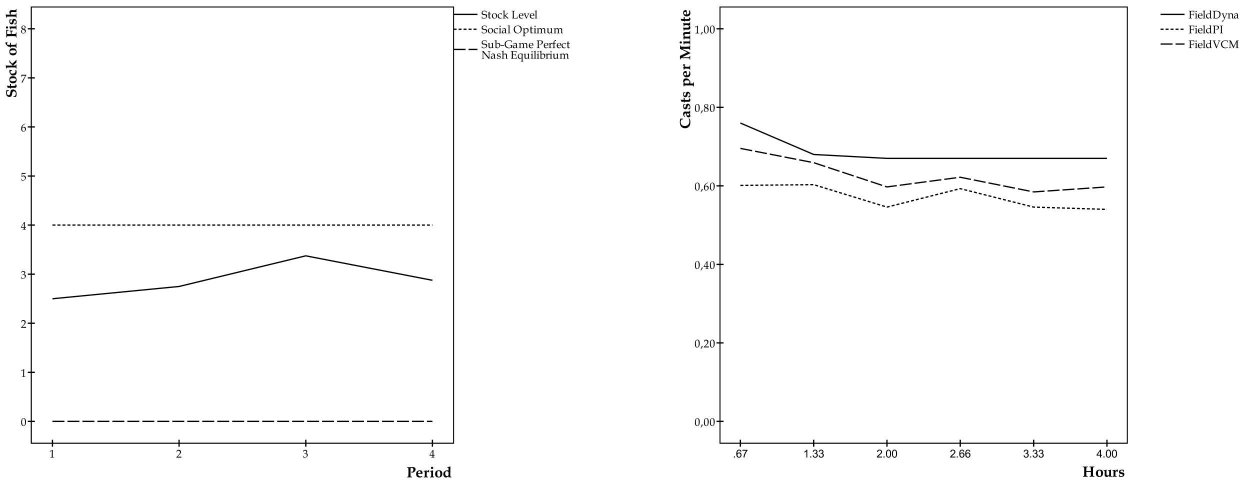
4.3 Results from FieldDyna

There are two patterns that we use to distinguish cooperation from non-cooperation in this treatment.[13] The first is that, under non-cooperative behavior, there would be no difference in behavior over the four periods. Players would fish with the same, maximal, effort in all periods. Under the social optimum, however, effort would be greater in the last period, relative to the first three periods. The second pattern is that, under cooperative behavior, effort would exhibit a dependence on the number of fish remaining in the group's quota. If individuals fish less intensely when there are fewer fish in the pond in periods 1 - 3, it is consistent with cooperation. If they exert less effort when the stock of fish is below the socially optimal level than when it is above, it is consistent with a targeting of the social optimum. If they fish with the same intensity regardless of the social cost, we interpret it as evidence of non-cooperative behavior.

The results of the FieldDyna treatment are presented in Figure 5, where panel (a) shows the stock of fish remaining at the end of each period S_t, and panel (b) shows the associated effort, averaged over all active groups, in

[13] Because it may not be feasible to catch the subgame perfect equilibrium quantity of fish in each period, comparing the absolute stock of fish remaining with the point predictions of the two models may give a misleading impression of support for a particular model. In particular, a catch close to the socially optimal level may be a consequence of a binding feasibility constraint rather than an intention to cooperate.

the four periods. For comparability we have also included the average effort levels observed in FieldPI and FieldVCM in Figure 5(b).



(a) **(b)**

Figure 5 (a) Amount of allowable catch remaining at the end of a period in the FieldDyna treatment, averaged over all groups. **(b)** Casts per minute in the FieldDyna treatment, averaged over all active groups.

At first glance, Figure 5(a) seems to suggest that participants acted fairly cooperatively; the size of the remaining stock at the end of each of the first three periods is positive. Indeed, of the eight groups participating in this treatment, only two actually depleted their quota before the final period – and only one caught the total allowable catch in the first period. However, there is evidence from the catch data that the stock was not depleted in most sessions because catching the full quota in one period was not feasible. The allowable catch remaining at the end of the fourth period is greater than zero in six of eight groups. Furthermore, the allowable catch remaining at the end of periods 1-3 is on average very close to the amount of allowable catch remaining at the end of period 4.

Figure 5(b) shows that effort starts at a high level in the first period and decreases slightly in the second to remain approximately constant between periods 2 and 4. Furthermore, effort in FieldDyna is not lower than effort in the FieldPI treatment, suggesting that participants did not voluntarily limit their effort.

We also find that effort is independent of the current stock of fish. The model in section 4.1 and Appendix B suggests that if players are cooperating, that effort in periods 1-3 would be as great as possible if the total allowable catch remaining at time S is larger than $S^* = 4$, and zero if $S < S^* = 4$. The relationship between the number of casts and the quota remaining is shown in Figure 6. The figure shows the average individual number of casts in the five minute interval after a specific stock level has been reached.[14]

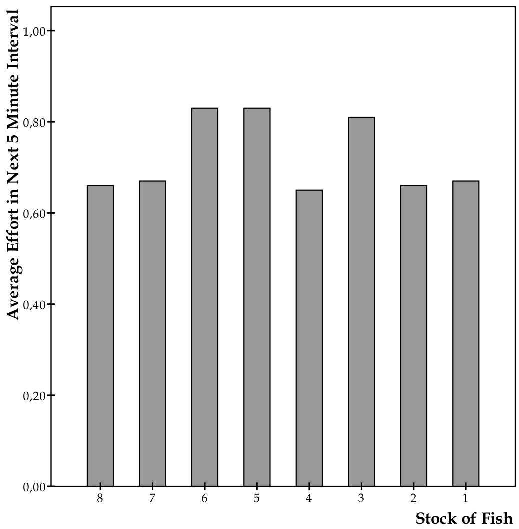


Figure 6 Average individual effort conditional on stock level in period 1 - 3. Each 5 minute interval is an observation.

[14]Data from the first ten minutes of a period are not included in the figure. During the first ten minutes of each period fishermen have the tendency to put in more effort than in the subsequent time intervals within a period. An explanation for this effect could be that fishermen are more excited at the start of a new period. Alternatively, given their new spot at the pond, fishermen have to adjust the optimal settings of their rods by trial and error. Since all groups begin with a stock of eight fish in the first period, effort levels for this particular stock of fish are higher when the first ten minutes are included. Inclusion of the first ten minutes causes the average effort at a stock size of eight to equal 0.88 rather than 0.66. Excluding the first ten minutes of each period does not change the average effort at the other stock levels appreciably.

The figure suggests that the average effort level in a group is independent of the allowable catch remaining. There is no evidence that effort is greater for $S > 4$ than for $0 < S \leq 4$. The following result summarizes our findings with regard to cooperation in FieldDyna:

Result 6 In the dynamic social dilemma treatment, FieldDyna, no cooperation is observed. The lack of cooperation in FieldVCM is not specific to that particular treatment nor to a setting in which private and group gains are denominated in different units.

Support for result 6: Consider the differences in effort levels over the four periods (see Figure 5(b)). A Wilcoxon test indicates no difference in effort between the fourth period and the first period ($N_1 = N_2 = 6, p = 0.75$), taking the average effort levels of each group as an independent observation. Similar results are found when the fourth period is compared with either the second period ($N_1 = N_2 = 6, p = 0.67$), or the third period ($N_1 = N_2 = 6, p = 0.60$). Note that 6 observations are used, because two groups caught their entire stock of fish in a period before the fourth (one in period 1 and one in period 3).

Now consider the allowable catch remaining at the end of each of the four periods (see Figure 5(a)). A series of Wilcoxon tests indicate that a group's allowable catch remaining at the end of period 4 does not differ from that remaining at the end of each of the first three periods. The allowable catch at the end of period 4 does not differ from that in period 1 ($N_1 = N_2 = 8, p = 0.60$), period 2 ($N_1 = N_2 = 8, p = 0.89$), or period 3 ($N_1 = N_2 = 8, p = 0.40$).

The difference in effort between the range where it is in a group's interest to catch more fish (a stock level of five and higher), and the stock levels where it is harmful to catch fish (four and lower), is investigated with a fixed effects panel data regression. The estimates, which show no significant differences in effort between these two ranges of stock, and are presented in Table 3.

Effort levels in period 1, 2 and 3 are estimated as a function of the current stock levels. Each period is divided into twelve five-minute intervals. The dependent variable is the amount of effort exerted by fisherman i in interval

$I(\text{Stock} = 4)$	-0.042
	(0.035)
$I(\text{Stock} = 3)$	0.031
	(0.083)
$I(\text{Stock} = 2)$	-0.065
	(0.080)
$I(\text{Stock} = 1)$	-0.180
	(0.148)
Time	-0.014^{*}
	(0.006)
Constant	0.806^{***}
	(0.033)
N	937

Table 3 Effect of current stock level on individual effort.
Standard errors, clustered at the group level, are reported between parentheses. ***: significant at the 1%-level, **: significant at the 5%-level, *: significant at the 10%-level.

$s + 1$. The independent variables consist of dummy variables for each stock size of four or less. Therefore, the baseline against which each dummy variable should be interpreted is the range at which the stock sizes are five or greater.

All dummy variables are insignificant. Hence, irrespective of the stock size, fishermen fish with the same intensity as they do so when it is both individually and socially desirable to exert full effort. They make no attempt to replenish the resource when levels are critically low. The only significant variable in this model is the variable Time. Its negative sign indicates that fishermen exert less effort within a period of one hour. Thus, we find that our subject pool of recreational fishermen displays a similar lack of cooperation in the FieldDyna treatment as in the FieldVCM treatment.

5 Conclusion

We find no evidence of cooperative behavior in our framed field social dilemma experiment. The design is based on the VCM paradigm widely used in experimental economics, and is conducted in the field using recreational fishermen as subjects. We can detect no difference in behavior between a situation in which refraining from fishing yielded a large positive externality to the group (the FieldVCM treatment) and when it does not (the FieldPI treatment). This conclusion contrasts sharply with results from studies of the VCM game when it is implemented in the laboratory. In such laboratory settings, cooperation is typically positive at the outset of a group's interaction, and declines over time.

Additional treatments allow us to explore potential causes of the difference between the results we have observed and those from previous laboratory studies. The treatments permit us to rule out four would-be explanations: (i) differences in the subject pool (students versus recreational fishermen), (ii) differences in the setting in which the experiments are conducted (the laboratory versus a more natural environment, the recreational fishing pond), and (iii) differences in the units in which the benefits and costs of cooperation are measured (money versus money, or money versus fish), and (iv) an idiosyncratic property that appears only in the FieldVCM treatment. The most plausible remaining explanation, in our view, is the nature of the decision variable. Our subjects are unwilling to forego fishing to yield benefits to the group, even when group benefits are also in terms of fishing. Nevertheless, subjects from the same pool are willing to cooperate if it involves sacrificing own monetary earnings for the benefit of the group. Taken together, our data are consistent with the assertion that cooperativeness depends on the decision variable, the activity that must be modified in order to yield group benefits.

We find that using students as participants lowers cooperation compared to our subject pool of sports fishermen. Therefore, the use of students alone cannot account for the greater cooperation observed in received laboratory experiments than in FieldVCM. Conducting the experiments in the structured and formal setting of an experimental laboratory decreases cooperation among our subjects. They are more cooperative when participating in a voluntary contributions game while they are fishing than when they are in the laboratory. Therefore, the fact that the experiment is conducted outside the laboratory, cannot on its own account for the lack of cooperation.

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. The propensity to cooperate appears to depend on the nature of the activity that individuals must undertake to increase group payoffs. It may be the case that to reliably achieve cooperation in a setting such as ours, 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 at least make it more likely, to achieve cooperation in some unfavorable field settings, such as the one we have studied here.

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A Statistical analysis of the effect of effort on catch

This appendix shows that the number of casts per minute, the key variable in computing one of our measures of cooperation, is correlated with the number of fish caught, which is used to calculate other measure of cooperation. Thus, we establish that casts per minute is a legitimate measure of cooperation: more casting increases expected private payoff and decreases expected group payoff.

An Ordered Probit model is used to estimate the effects of effort on catch of fish, as presented in Table 4. The dependent variable is a group's catch of fish in a period. Column (i) contains estimates of the pooled data from the FieldVCM and FieldPI treatments, while column (ii) presents the estimates from the data of the FieldDyna treatment.

Both models show a clear positive and significant effect of our measure of effort, casts per minute, on the catch of fish. The dummy variable I(HighSeason) has a value of 1 when an observation is taken from the high season. The quadrant fixed effects are dummy variables that capture the position at the pond at which a fisherman is fishing. In all models, these dummy variables are insignificant, indicating that the position at which an individual fishes has no influence on his catch of fish.

	(i)	(ii)
Effort	0.739***	1.777***
	(0.301)	(0.477)
I(High Season)	1.522***	
	(0.127)	
Quadrant Fixed Effects	Yes	Yes
N	456	112
pseudo-R^2	0.1928	0.0704

Table 4 Effect of individual effort on individual catch.
Standard errors, clustered at the subject level, are reported between parentheses. ***: significant at the 1%-level.

B The socially optimum and subgame perfect equilibrium extraction paths of the dynamic game

In this appendix we derive the socially optimal and Nash equilibrium harvesting paths for the theoretical model in section 4.1. Consider first the social optimum. Assuming homogenous agents and defining $X \equiv \sum_{i=1}^{n} x_i$, we have a social dilemma if $\bar{X} \equiv n\bar{x} > G(S_{MSY})$; that is, if $\bar{X} > G(S)$ for all $0 \leq S \leq K$. The social welfare function can be derived by inserting (5) into (4), noting that this implies that $X = G(S) - \dot{S}$, and then summing V_i over all $i = 1 \ldots n$:

$$\max_{X(t)} \int_{t=0}^{\infty} \bar{p} \left(G(S) - \dot{S}(t) \right) e^{-rt} dt. \tag{8}$$

Integrating by parts allows us to rewrite the objective function as:

$$\max_{X(t)} \left[\bar{p} S_0 + \bar{p} \int_{t=0}^{\infty} \left(G(S) - rS(t) \right) e^{-rt} dt \right]. \tag{9}$$

Objective function (9) is maximized if $dG(S)/dS$ and r are equated as quickly as possible. Using (6), we find that the socially optimal steady state stock is equal to $S^* = \max[0, K(\gamma - r)/(2\gamma)]$ and that the socially optimal harvesting levels equal $X = \bar{X}$ if $S > S^*$, $X = G(S)$ if $S = S^*$, and $X = 0$ if $S < S^*$.[15]

We now derive a unique Nash equilibrium steady state. The solution is straightforward – all $n \geq 2$ agents harvest the resource at maximum effort level ($\bar{x}$) until it is depleted, even if $\gamma > r$. This can be shown as follows. Suppose that $S = \widetilde{S}$ where $\widetilde{S} \in \langle 0, K]$, and where $\widetilde{S}$ may or may not be equal to S^*. For $\widetilde{S}$ to be an interior equilibrium steady state, all agents $j = 1 \ldots n$ must harvest at $x_j = G(\widetilde{S})/n$ if $S = \widetilde{S}$, and choose $x_j = 0$ ($x_j = \bar{x}$) if $S < \widetilde{S}$ ($S > \widetilde{S}$).

That means that the amount of net regeneration agent i faces for any

[15] Hence, the socially optimal transition path towards the steady state is a so-called Most Rapid Approach Path (see for example Tsur and Zemel (2001)).

stock level S, $Q(S)$, equals:

$$\begin{aligned} Q(S) &= G(S) - (n-1)\bar{x} \text{ if } S > \widetilde{S}; \\ Q(S) &= G(\widetilde{S})/n \text{ if } S = \widetilde{S}; \\ Q(S) &= G(S) \text{ if } S < \widetilde{S}. \end{aligned}$$

That means that if agent i decreases the stock infinitesimally below $\widetilde{S}$, she would increase the regeneration she faces by a factor n (from $G(\widetilde{S})/n$ to $G(\widetilde{S})$). Forever harvesting at a rate such that the stock remains infinitesimally below $\widetilde{S}$ would then yield a present value of (almost) $\bar{p}G(\widetilde{S})/r$ for agent i and a zero payoff for all other agents $j \neq i$. Clearly, this holds for all agents $i = 1 \ldots n$ and for all $\widetilde{S} \in \langle 0, K]$, and hence the only steady state equilibrium stock is $S = 0$. Hence, if one or more of the $n-1$ agents are greedy and harvest at maximum rate, no individual agent is able to keep the resource stock at the desired level, and hence each agent's best response is to harvest at maximum rate (see also Clark (1980), or (Dockner et al., 2000, p. 333–335)).

C Promotional material

This appendix contains a translation of the flyer, which we used to recruit participants in the Field treatments. The original flyer is in Dutch, and is available upon request from the authors.

TILBURG UNIVERSITY IS REQUESTING YOUR PARTICIPATION IN A STUDY

DATE: ...

TIME: PRESENT AT 7.15 A.M., START OF THE STUDY AT 7.45 A.M.

- Duration: 4 hours.
- Participation is free.
- You can earn money during the study.
- Each participant can catch at most twelve fish.
- Each fish you catch, you can take home.
- You should use your own fishing equipment and bait.
- You will fish at pond 3.
- You will fish at more than one spot.
- You will fish according to the standard rules of ‘De Biestse Oevers’ plus some modifications.
- You are not allowed to talk during the study.

D General rules at 'De Biestse Oevers'

This appendix gives the rules for fishing which apply at 'De Biestse Oevers. They are copied from their website, www.biestse-oevers.nl, and translated from the original Dutch text.

Everyone is cordially invited to fish at our recreational fishing facility De Biestse Oevers. You are obliged to abide by the following rules.

- Entering the site is at your own risk.
- Do not cause unnecessary noise nuisance.
- Each person fishes with one rod.
- Fly-fishing is only allowed when there is enough space (we decide if this is so).
- Feeding the fish, in any way or form, is prohibited.
- Fishing is only allowed with natural bait and/or Trout Dough (no fish).
- Fishing with artificial bait, twister, dreg, jigs, shiner, etc..., is not allowed.
- It is not allowed to throw back any trout caught (Rainbow Trout and Salmon Trout) into the pond.
- All trout caught (Rainbow Trout and Salmon Trout) must be taken home.
- Using a keepnet is not allowed.
- Using a scoopnet to catch fish is not allowed.
- Any grass carp or catfish caught should be thrown back into the pond.

- It is not permitted to fish at a different pond than the one selected upon entering.
- You are allowed to clean fish only at the designated cleaning area.
- Everyone should keep the area clean, including the fish cleaning area.
- Damage to rented material due to incompetent use must be compensated for.
- We cannot be held accountable for theft, accidents, etc. which take place on our property.

E Instructions for the FieldPI treatment

This appendix contains a translation of the instructions for the FieldPI treatment. Part (a) is the summary of the rules handed out to participants, who could refer to its text throughout the sessions. Part (b) is the text of the instructions read aloud at the beginning of the session.

a) Summary of the rules

Group formation

- You are placed in groups of 4 persons.
- The group will remain the same throughout the entire morning.
- We do not tell you who belongs to your group and you are not allowed to exchange information with other participants.

Timing

- The fishing takes place for four hours, from around 8.00 a.m. until noon.
- If we begin later, we will end later.
- The four hours will be divided into 6 periods of 40 minutes.

Your earnings per period

- In the first period, we will put (16 x 2) + 6 = 38 rainbow trout into the pond.
- You are allowed to take home each fish you catch.
- We make sure that an equal number of rainbow trout is in the pond at the beginning of each period. We do this by putting in a new rainbow trout at the beginning of a new period for each fish that is caught in the previous period.

- In each period, you are allowed to catch at most 2 fish. Whenever you catch a Salmon Trout, it also counts as one fish.

In each period

- The number of rainbow trout put into the pond is equal to the number of fish caught in the previous period.
- You are not allowed to talk with the other participants.

In period 1, 3 and 5:

- The fishing spots are determined by a lottery.

At the end of the session:

- You will receive 5 euro for your participation.

b) Word of welcome

Welcome to this study by Tilburg University. Before we start, we want to point out two things. Firstly, this study is independent of the organization 'De Biestse Oevers'. We are grateful that we are allowed to conduct this study here, but the organization 'De Biestse Oevers' has nothing to do with this project. All responsibility lies with Tilburg University. Secondly, we want to make clear that this study has nothing to do with the well-being of animals, environmental causes or the like. As researchers, we accept the rules and habits of sports fishing as it is practiced at 'De Biestse Oevers'. We cannot tell you the exact aim of this study. We do want to stress that your privacy is protected; none of the results we report can be traced back to individual participants.

As you know, you do not have to pay to take part in this study. The entrance fees are paid by Tilburg University. You are allowed to take home all fish you caught.

We ask you to abide strictly by the rules which we impose.

The experiment

In the next four hours, we ask you to fish according to the rules as we will explain them now. All rules that normally apply at 'De Biestse Oevers' remain in place. This means that it is not permitted to throw fish you have caught back into the pond, you are only allowed to fish with one rod, you are only allowed to use a scoop net to set fish ashore, you are only allowed to use the usual types of bait, etc.

You are placed in a group with 3 other participants during the session. A group therefore consists of 4 persons. Your group remains the same for the whole session, but we do not inform you about who is in your group, and who is not. We urgently ask you not to talk with others during the study. This is so important to us that we will exclude you from the session if you violate this rule.

The study takes a total of four hours, from about 8.00 a.m. until noon. The study consists of 6 periods of 40 minutes. In the first period, we will put 2 rainbow trout into the pond for each participant. In addition, we put another 6 rainbow trout into the pond. If we have 16 participants, this means that we will put $(16 \times 2) + 6 = 38$ rainbow trout into the pond. You are allowed to take home all fish that you catch. We make sure that, at the beginning of each period, the number of rainbow trout is always equal to the other periods. We do this by putting in a number of rainbow trout, at the beginning of a new period, equal to the total catch of fish in the previous period. In each 40 minute period you are allowed to catch a maximum of 2 fish. Whenever you have caught 2 fish and a period is not finished yet, you have to take your rod out of the pond. You then have to wait until the next period begins. You are not allowed to talk with others while you wait.

The spot at which you are fishing may influence the number of fish you can catch. For this reason, we determine the spot at which you fish by means of a lottery. We do this in the first round, the third round and the fifth round. This means that you will fish twice at each of your three spots.

Questions

If you have any questions regarding the session, you can ask them now, but also during the session. We do not answer questions how to act in this study – all decisions you take are yours. We also do not answer questions about the purpose of this study. When we have analyzed the data, we will inform you about its results. We hope that you will abide by all our rules.

F Instructions for the FieldVCM treatment

This appendix contains a translation of the instructions for the FieldVCM treatment. Part (a) is the summary of the rules handed out to the participants, who could refer to its text throughout the sessions. Part (b) is the text of the instructions read aloud at the beginning of the session.

a) Summary of the rules

Group formation

- You are placed in groups of 4 persons.
- Your group will remain the same throughout the entire morning.
- We do not tell you who belongs to your group and you are not allowed to exchange information with other participants.

Timing

- The fishing takes place for four hours, from around 8.00 a.m. until noon.
- If we begin later, we will end later.
- The four hours will be divided into 6 periods of 40 minutes.

Your earnings per period

- In the first period, we will put (16 x 2) + 6 = 38 rainbow trout into the pond.
- You are allowed to take home each fish you catch.
- We make sure that an equal number of rainbow trout is in the pond at the beginning of each period. We do this by putting in a new rainbow trout at the beginning of a new period for each fish that is caught in the previous period.

- In each period, you are allowed to catch at most 2 fish. Whenever you catch a Salmon Trout, it also counts as one fish.
- If you (decide to) catch less then two fish, we give money to the other three participants of your group.
- If you catch fewer fish than the two you can catch maximally, we divide 6 euro equally among the other 3 participants in your group for each fish you did not catch. Hence, for each rainbow trout you do not catch (or decide not to catch), each of the other 3 participants in your group receives 2 euro. This means that:
  - If you catch 2 rainbow trout, the other 3 participants in your group do not receive any money.
  - If you catch 1 rainbow trout, each of the other 3 participants in your group receives 2 euro.
  - If you catch 0 rainbow trout, each of the other 3 participants in your group receives 4 euro.

This holds for all participants. This means that you will receive 2 euro for each rainbow trout that is left in the pond by the other participants in your group.

In each period

- The number of rainbow trout put into the pond is equal to the number of fish caught in the previous period.
- You are not allowed to talk with the other participants.

In period 1, 3 and 5:

- The fishing spots are determined by a lottery.

At the end of the session:

- You will be receive €2 for every fish not caught by the other three members of your group.

b) Word of welcome

Welcome to this study by Tilburg University. Before we start, we want to point out two things. Firstly, this study is independent of the organization 'De Biestse Oevers'. We are grateful that we are allowed to conduct this study here, but the organization 'De Biestse Oevers' has nothing to do with this project. All responsibility lies with Tilburg University. Secondly, we want to make clear that this study has nothing to do with the well-being of animals, environmental causes or the like. As researchers, we accept the rules and habits of sports fishing as it is practiced at 'De Biestse Oevers'. We cannot tell you the exact aim of this study. We do want to stress that your privacy is protected; none of the results we report can be traced back to individual participants.

As you know, you do not have to pay to take part in this study. The entrance fees are paid by Tilburg University. You are allowed to take home all fish you catch. In addition, you can earn money.

We ask you to abide strictly by the rules which we impose.

The experiment

In the next four hours, we ask you to fish according to the rules as we will explain them now. All rules that normally apply at 'De Biestse Oevers' remain in place. This means that it is not permitted to throw fish you have caught back into the pond, you are only allowed to fish with one rod, you are only allowed to use a scoop net to set fish ashore, you are only allowed to use the usual types of bait, etc.

You are placed in a group with 3 other participants during the session. A group therefore consists of 4 persons. Your group remains the same for the whole session, but we do not inform you about who is in your group, and who is not. We urgently ask you not to talk with others during the study. This is so important to us that we will exclude you from the session if you violate this rule.

The study takes a total of four hours, from about 8.00 a.m. until noon. The study consists of 6 periods of 40 minutes. All the money you earn during the study is paid to you at the end. In the first period, we will put 2 rainbow trout into the pond for each participant. In addition, we put another 6 rainbow trout into the pond. If we have 16 participants, this means that we will put (16 x 2) + 6 = 38 rainbow trout into the pond. You are allowed to take home all fish that you catch. We make sure that, at the beginning of each period, the number of rainbow trout is always equal to the other periods. We do this by putting in a number of rainbow trout, at the beginning of a new period, equal to the total catch of fish in the previous period. In each 40 minute period you are allowed to catch a maximum of 2 fish. Whenever you have caught 2 fish and a period is not finished yet, you have to take your rod out of the pond. You then have to wait until the next period begins. You are not allowed to talk with others while you wait.

You are allowed to catch at most 2 rainbow trout in each of the 6 periods. If you (decide to) catch less than 2 rainbow trout, the other three group members receive money from us. For each rainbow trout you catch less than 2, we pay in total 6 euro to the other members of your group. For each rainbow trout that you catch less than 2, each of the other group members receive 2 euro. This means that if you catch 2 rainbow trout, the other 3 participants in your group do not receive any money. If you catch 1 rainbow trout, each of the other 3 participants in your group receives 2 euro. If you catch 0 rainbow trout, each of the other 3 participants in your group receives 4 euro.This rule holds for all participants. Hence, if a group member catches – or decides to catch– 1 fish less, you will receive 2 euro in that period.

The spot at which you are fishing may influence the number of fish you can catch. For this reason, we determine the spot at which you fish by means of a lottery. We do this in the first round, the third round and the fifth round. This means that you will fish twice at each of your three spots.

Questions

If you have any questions regarding the session, you can ask them now, but also during the session. We do not answer questions how to act in this study – all decisions you take are yours. We also do not answer questions about the purpose of this study. When we have analyzed the data, we will inform you about its results. We hope that you will abide by all our rules.

G The instructions for the StuLab, FisherLab and FisherPond treatments

Part (a) of this appendix presents the translation of the instructions for the StuLab treatment. Part (b) indicates how the instructions for the FisherLab and FisherPond treatments differed from those of the StuLab treatment.

a) Instructions for the StuLab treatment

Word of welcome

Welcome to this study by Tilburg University. You can earn money during the study. The amount of money you can earn crucially depends on your decisions during the session and the decisions of others. We will read out aloud the instructions now, and you are invited to read along.

Before we begin, we want to stress that it is important that you do not talk during the study. This is so important, that we will exclude you from the session if you violate this rule.

The session

You are placed in a group with 3 other participants during the session. A group therefore consists of 4 persons. Your group remains the same for the whole session, but we do not inform you about who is in your group, and who is not. We urgently ask you not to talk with others during the study. This is so important to us that we will exclude you from the session if you violate this rule.

The study consists of 6 rounds in which we mimic a fishing scenario at a pond. However, instead of really catching fish, you are requested to decide many fish you would like to catch. The rules of the study are as follows. In each round, you are allowed to catch a maximum of 2 fish. Each fish you catch, will yield a revenue of €1,– for you. Each fish you decide not to catch, will yield a revenue of €0.50 for each other group member, but nothing for you. In each round, we therefore ask you to make a decision between the following options.

0) You catch 0 fish. You will earn €0 and the other members of your group each earn 2 x €0.50 = €1 (the other members of your group receive in total 3 x €1 = 3)
1) You catch 1 fish. You will earn €1 and the other members of your group each earn 1 x €0.50 (the other members of your group receive in total 3 x €0.50 = 1.50)
2) You catch 2 fish. You will earn €2 and the other members of your group each earn €0.

Example

Suppose that you and all your other group members chose option 0). You will earn €3. This amount consists of the 2 x €0.50 = €1 as a consequence of the choice of each of your other group members. Because there are 3 other group members, you will earn 3 x €1,– = €3. Because you have not caught a fish yourself, you will earn nothing due to your own fishing activities.

If you choose option 2) while all of your other group members choose option 0), you will earn €5. This amount consists of the 3 x €1 as a consequence of no catch of your other group members plus the earnings from your own fishing activities, 2 x €1 = €2.

Suppose that you and all your other group members choose option 2). You will earn €2. This amount consists of the 2 x €1 of the two fish you have caught. Because all of your other group members have also caught 2 fish, you will earn no money.

If you choose option 0) and all of your other group members choose option 2), then you will earn €0. You will earn nothing as a consequence of your own fishing activities. Because no other group member leaves a fish, you will earn nothing.

Filling in the form

You can indicate your choices for all 6 rounds on the form we have provided you. We will now explain how you can do this. Please have a look at the form now.

In the upper right corner you should fill in your participant number. This number is simply the number written on your table. Please make sure to fill in the correct number; we need this in order to make the payments at the end of the session.

On the form you will find the choices you can make. Below these options, we have printed the numbers 0, 1, and 2 next to each round. We ask you simply to circle your choice for each round.

When you have made your choice for round 1, you should turn your form face down and place it on top of your computer desktop. This tells us that you have made your decision for round 1. When all participants have made their choice, we will collect all of the forms. We will calculate how much you have earned in this round. We will return the form to you, so that you know how much you have earned. On the form, we will write the total number of fish your group has caught. In addition, we will write down all the participants' choices on a white board. Note that the white board does not provide information on who is in your group.

After this procedure, round 2 starts. We ask you to make your choice for this round, and place your form face down on top of your desktop. When everyone has made their choice, we will collect the forms, and calculate your earnings for period 2. We will then write the decisions of all participants on the white board. This procedure is repeated until all 6 rounds are finished. You should not make a choice for a round that has not yet begun.

At the end of the session, we will pay all participants in private. We will summon all participants one by one to the adjacent room. When you have collected your earnings, the session is finished. There is no reason for you to return to this room, so please take all your belongings when your name is called.

The total time of the session depends on the time it takes to make a decision. You will have enough time to thoroughly think through your decision, but we hope that you will not delay the session unnecessarily. Our estimate is that the session will take slightly over one hour.

Questions

If you have any questions about the rules, you can pose them now, but also during the session. We do not answer questions about which choices you should make. We also don't answer questions about the nature of this study. Once we have analyzed the results, we can keep you informed if you would like. We hope that you will cooperate in our study and that you will abide by all our rules.

Test questions

Because we want to make sure that you have understood all of the rules, we ask you to answer the following three questions. Once all participants have answered these questions correctly, the session will begin.

1. With how many other participants will you be placed in a group?

2. How much money will you earn due to your own fishing activity when you decide to catch 2 fish in a round?

3. How much money will you earn when the following takes place?

- You catch 1 fish,
- Two participants catch 0 fish,
- One other participant catches 2 fish.

The form

The study consists of 6 rounds. In each round, we ask you to chose one of the following options.

0) You catch 0 fish. You will earn €0 and the other members of your group each earn 2 x €0.50 = €1 (your group members receive in total 3 x €1 = 3)
1) You catch 1 fish. You will earn €1 and the other members of your group each earn 1 x €0.50 (your group members receive in total 3 x €0.50 = 1.50)
2) You catch 2 fish. You will earn €2 and the other members of your group each earn €0.

	Your choice			Total group catch	Your earnings
Round 1	0	1	2		
Round 2	0	1	2		
Round 3	0	1	2		
Round 4	0	1	2		
Round 5	0	1	2		
Round 6	0	1	2		

b) Instructions for the FisherLab and FisherPond treatments

The instructions for the FisherLab treatment are identical to those for the StuLab treatment. The instructions for the FisherPond treatment only differs from those of StuLab and FisherLab treatments with respect to the mechanics of the conduct of the experiment. In the FisherPond treatment decisions sheets were to be handed back to the experimenter (rather than out on the participant's table for the experimenter to collect) and information about the decisions of the other participants in the session were shown on a paper sheet for the participant to peruse rather than recorded on a white board.

H Questionnaire about the value of fishing

Dear fisherman,

On behalf of Tilburg University, we are conducting a study, and we would like your cooperation. We would like you to answer the following four questions.

Question 1. Which of the following alternatives would you choose, if this situation presented itself?

1. You are allowed to fish for free at the Biestse Oevers for four hours on a particular morning or afternoon. Twelve rainbow trout will be put into the pond for you. If you catch all twelve fish within four hours, you have to stop fishing.

2. You receive €72, but you are not allowed to fish during that particular morning or afternoon.

Question 2. Which of the following alternatives would you choose, if this situation presented itself?

1. You are allowed to fish for free at the Biestse Oevers for four hours on a particular morning or afternoon. Six rainbow trout will be put into the pond for you. If you catch all six fish within four hours, you have to stop fishing. In addition, you receive €36.

2. You receive €72, but you are not allowed to fish during that particular morning or afternoon.

Question 3. Which of the following alternatives would you choose, if this situation presented itself?

1. You are allowed to fish for free at the Biestse Oevers for four hours on a particular morning or afternoon. Twelve rainbow trout will be put into the pond for you. If you catch all twelve fish within four hours, you have to stop fishing.

2. You are allowed to fish for free at the Biestse Oevers for four hours on a particular morning or afternoon. Six rainbow trout will be put into the pond for you. If you catch all six fish within four hours, you have to stop fishing. In addition, you receive €36.

Question 4. Which option do you think most other fishermen would choose?

1. You are allowed to fish for free at the Biestse Oevers for four hours on a particular morning or afternoon. Twelve rainbow trout will be put into the pond for you. If you catch all twelve fish within four hours, you have to stop fishing.
2. You are allowed to fish for free at the Biestse Oevers for four hours on a particular morning or afternoon. Six rainbow trout will be put into the pond for you. If you catch all six fish within four hours, you have to stop fishing. In addition, you receive €36.
3. You receive €72, but you are not allowed to fish during that particular morning or afternoon.

I Instructions of the FieldDyna treatment

This appendix is a translation of the instructions for the FieldDyna treatment. Part (a) is the summary of the rules handed out to participants, who could refer to its text throughout the sessions. Part (b) is the text of the instructions read aloud at the beginning of the session. Part (c) is the quiz that participants took before their session began.

(a) Summary of the rules of the study

Group formation

- You are placed in groups of 4 persons.
- These groups remain the same throughout the entire session.
- Other members of your group have the same color ribbon as you have.
- You are not allowed to talk during the study

Timing

- Fishing takes place from around 8.00 a.m. to noon, in 4 periods of 1 hour.

Your earnings

- Each fish you catch is yours to take home. For every fish you catch, you also receive €5. Rainbow trout and salmon trout count both as one fish.

Placing fish into the pond

- In the first period, we will put 8 rainbow trout into the pond for each group; in total this is 32 fish.
- At the beginning of each new period, we put fish into the pond equal to the total catch in the previous period.

- The number of fish in the pond per participant is therefore equal at the start of each period.

Available fish for your group

- Each period, you and your group members allowed to catch at most the number of fish available to your group.
- In the first period this is 8 fish.
- The number of fish available for your group does NOT depend on the number of fish caught by other groups.
- The number of available fish for your group depends ONLY on the number of fish your group leaves in the pond at the end of the previous period. See the table on page 4.
- Whenever a group catches all of the fish that are available for that group, the session stops for that group.
- We pay your earnings at the end of the period in which your session ends.
- Example:
  - In the first period 8 fish are put into the pond for your group
    * The maximum number of fish that your group is allowed to catch is 8 fish.
    * When 8 fish are caught, all members of your group have to take their rods out of the water.
  - Suppose your group catches 6 fish in the first period.
    * At the beginning of the second period, there are 2 fish left from the first period and 3 new fish are put into the pond; see the table.
    * Your group is then allowed to catch $2 + 3 = 5$ fish in the second period.

        * If your group catches all 5 fish in the second period, all members of your group have to take their rods out of the water.
    - If your group catches less than 5 fish, new fish will be placed into the pond as indicated by the table.
        * Suppose your group catches 1 fish in the second period.
        * Then, at the end of the period there are $5 - 1 = 4$ fish left for your group.
        * The available number of fish for your group in the next period is then raised by 4 fish, and the total number of available fish in period 3 is $4 + 4 = 8$.

Your fishing spot

- Each group has four spots, each member of the group fishes one time at each spot.
- You will draw a number out of a bag which indicates your spot for the first period.
- You will receive a ribbon at the beginning of the session.
- At the end of each period, we will tell you where you will be fishing in the next period.
- You are not allowed to talk during the session.

This information holds for all groups.

(b) Test questions

1. How many other group members are in your group, besides you?

2. Suppose your Group catches 6 fish in the first period.
a. How many fish are left at the end of the first period?

Number of fish left at the end of the previous period	Increase in the number of available fish	Number of available fish in the coming period
0	0	0
1	2	3
2	3	5
3	3	6
4	4	8
5	3	8
6	3	9
7	2	9
8	0	8
9	2 fish subtracted	7

b. How many available fish will be added for your group in period 2?

c. How many available fish is your group allowed to catch in total in period 2?

Suppose next that you and the other participants of your group catch all available fish in period 2.

d. How many fish are you and your group members allowed to catch in the third period?

e. How many fish are you and your group members allowed to catch in the fourth period?

3.

a. How many fish is your group allowed to catch in the first period?

b. How many fish should your group have left at the end of the first period in order to have the largest increase in fish at the start of period 2?

c. How much is this increase?

d. What is the total number of available fish for your group in the next period?

(c) Instructions

Word of welcome

Welcome to this study by Tilburg University. Before we start, we want to point out two things. Firstly, this study is independent of the organization 'De Biestse Oevers'. We are grateful that we are allowed to conduct this study here, but the organization 'De Biestse Oevers' have nothing to do with this project. All responsibility lies with Tilburg University. Secondly, we want to make clear that this study has nothing to do with the well-being of animals, environmental causes or the like. As researchers, we accept the rules and habits of sports fishing as it is practiced at 'De Biestse Oevers'. We cannot tell you the exact aim of this study. We do want to stress that your privacy is protected; none of the results we find can be traced back to individual participants.

As you know, you don't have to pay to take part in this study. The entrance costs are paid by Tilburg University. Each fish you catch, you are allowed to take home. In addition, you can earn money.

We ask you to abide strictly by the rules which we impose.

The experiment

In the next four hours, we ask you to fish according to the rules as we will explain them now. All rules that normally apply at 'De Biestse Oevers' remain in place. This means that it is not permitted to throw fish you have caught back into the pond, you are only allowed to fish with one rod, you are only allowed to use a scoop net to set fish ashore, you are only allowed to use the usual types of bait, etc.

Group formation

You are placed in a group with 3 other participants during the session. A group therefore consists of 4 persons. The group remains the same throughout the study. Each participant receives a ribbon. The members of your group have the same color ribbon as you have. We urge you not to talk with other participants during the study. This is of such importance, that we will exclude you from the session if you violate this rule.

Timing

The study consists of four periods of one hour. The study therefore takes four hours, from 8.00 a.m. until 12.00 a.m. If we start a little later, we will end a little later.

Earnings

Each fish you catch is yours to take home. In addition, you receive €5 for each fish you catch. During the study, rainbow trout and salmon trout are counted equally.

Putting fish into the pond

In the first period, we put 8 rainbow trout into the pond for each of the four groups, these are 32 fish in total. At the beginning of period 2, 3, and 4 we put a number of fish into the pond equal to the number of fish caught in the previous period by all participants. This means that the number of fish in the pond for each fisherman is the same at the beginning of each period.

Available fish for your group

Although the number of fish per participant remains constant over all periods, you are not allowed to catch fish without limit. Each period, you and your group members are not allowed to catch more than the maximum available fish for your group. In the first period, we put 8 fish into the pond for each group, and you and your group members are not allowed to catch more than 8 fish in this period. Keep in mind that each fisherman is allowed to catch as much as possible, as long as the total number caught is not more than 8 fish.

The number of fish available for your group does not depend on the number of fish caught by other participants. The number of fish available for your group in a period depends only on the number of fish left for the same group at the end of the previous period. And this number depends on the number of fish caught in the previous period and all earlier periods.

The way in which this works is indicated in the table.

Whenever the number of fish caught is such that there are zero fish left at the end of a period, the number of available fish is not raised and your group is not allowed to catch any more fish. The session stops for your group. We pay you your earnings at the end of the period in which your group has caught the maximum available fish.

Whenever the number of fish caught is such that at the end of a period 1 fish is left, then the number of available fish is raised by 2, and your group is allowed to catch 3 fish in the next period.

Whenever the number of fish caught is such that at the end of a period 4 fish are left, then the number of available fish is raised by 4, and your group is allowed to catch 8 fish in the next period.

Whenever the number of fish caught is such that at the end of a period 6 fish are left, then the number of available fish is raised by 3, and your group is allowed to catch 9 fish in the next period.

Example

Let's consider an example. In the first period, 8 rainbow trout are put into the pond for your group. This means that your group is allowed to catch at most 8 fish in this period. When the 8th fish is caught, all members of the group have to take their rods out of the water. The session then stops for your group and you have to leave the pond.

Suppose your group does not catch 8 fish in the first period, but rather 6. In that case there are 8 - 6 = 2 fish left at the end of the first period. The table shows that when 2 fish are left at the end of a period, 3 new rainbow trout are put into the pond at the beginning of the next period.

At the beginning of the second period there are 2 + 3 = 5 fish available for your group. Once again, the number of fish caught by other groups has no influence on the number of fish we put into the pond for your group.

When your group catches 5 fish in the second period, all members of your group have to take their rods out of the water at the moment the fifth fish is caught. If your group catches less than five fish in the second period, we put fish back into the pond. The number put back into the pond depends on the number of fish left at the end of the second period, as indicated in the table. Suppose your group catches one fish in period 2, then the total number of available fish at the end of that period is 5 - 1 = 4 fish. In the table you can see that the number of available fish is raised by 4 fish. The number of available fish for your group is 8 in period 3, in this example.

Fishing spot

Each group of fishermen is allocated 4 fishing spots. You will fish one time at each of those group spots. You will draw a number out of a bag which indicates the spot at which you will be fishing during the first period. You will receive a ribbon before the session starts. At the end of each period we tell you at which spot to fish in the next period. We want to stress again that it is important that you are not allowed to talk during the session. This is of such importance, that we will exclude you from the session if you violate this rule.

Questions

If you have any questions about the rules of the study, you can ask them now, but also during the session. We do not answer questions about how you should fish. We also do not answer questions that go into the purpose of the study. When we have analyzed the results, we will keep you informed.

Before the study starts, we ask you to answer some test questions. You can do this at the spot at which you will be fishing in the first period. Only when all participants have answered all questions correctly, the study will start.