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Abstract: This work presents the results of framed field experiments designed to study the co-enforcement of access to common pool resources. The experiments were conducted in the field with participants in the territorial use rights in fisheries (TURFs) management scheme that regulates access to nearshore fisheries along the coast of Chile. In the experiments, TURF members not only decided on harvest but also invested in monitoring to deter poaching by outsiders. Treatments varied whether the monitoring investment was an individual decision or determined by a group vote. Per-unit sanctions for poaching were exogenous as if provided by a government authority, and we varied the sanction level. Our results suggest that co-enforcement, in which monitoring for poaching is provided by resource users and sanctions are levied by the government, can reduce poaching levels. Monitoring investments were not high enough to lift the expected marginal penalty for poaching above the marginal gain from poaching when the sanction for poaching was low, but expected marginal penalties were higher than the marginal gain from poaching when the sanction was high. Despite this, poaching levels were not sensitive to changes in monitoring levels and sanctions. While co-enforcement did not eliminate poaching, it did eliminate the gains from poaching in all but one treatment.

Key Words: experimental economics, Common pool resources; enforcement; field experiments; poaching; territorial use rights fisheries; social dilemma; fisheries management; development economics; co-enforcement

JEL Codes: C72, C90, C93, D70, H41, K42, Q22, Q28, Q56

1. Introduction

Territorial use rights in fisheries (TURFs) is a management approach that allocates exclusive harvesting rights in a particular geographical location to a specific group of users (Charles 2002, Christy 1982, Wilen et al. 2012). Because TURFs may be affected by poaching from outsiders, access must be enforced (Chávez et al. 2018, Chávez et al. 2010, Gelcich et al. 2009, Gelcich et al. 2017). Defense is typically accomplished by a combination of TURF member efforts and the government.[1] Consequently, members of a TURF organization have to solve the problem of simultaneously managing their use of the resource and coordinating their efforts to help defend it against encroachment. In this paper, we explore the issue of co-enforcement of common pool

[1] While the acronym TURF refers to a particular fisheries management approach, we will also use it to refer to a group of individuals who have legal use rights to a resource in a specific geographical area.

resource use rights with a series of framed lab-in-field economic experiments with participants of the Chilean TURF system.[2]

An example of TURFs is the Chilean Management and Exploitation Areas of Benthic Resources (MEABR) system, which was introduced in the late 1990s to provide territorial use rights for near-shore fisheries in the country. This policy assigns local artisanal fishing organizations exclusive harvest rights to all the benthic resources from specific geographic areas located near the coast, in estuaries and fjords. The MEABR regime was introduced to overcome the severe depletion of *loco* (Chilean abalone), the most valuable benthic resource extracted by coastal communities. The MEABR system was intended to achieve three objectives: conserve benthic resources, enhance the welfare of coastal communities, and improve cooperation between artisanal fishing organizations and the National Fisheries Service (SERNAPESCA, by its Spanish acronym).

TURFs operating under the MEABR are responsible for developing a management plan at their own expense, including annual stock assessments to determine sustainable harvest levels, and defining the rules that govern how the resources will be harvested. In addition, the performance of the MEABR system depends upon the ability of the TURFs to overcome collective action problems, including extraction decisions and defense against poaching. Recent surveys of TURF members in central and southern Chile reveal that fishers believe that illegal poaching is an important concern (Aburto et. al. 2013, Chávez et al. 2018, Moreno and Revenga 2014, Gelcich et al 2009, Gelcich et al. 2017).

Deterring poaching in Chilean TURFs involves co-enforcement between local TURF organizations and the government. Monitoring for poaching can be performed by TURF organizations, the Chilean Navy, SERNAPESCA, or some combination of the three. However, because of the long Chilean coastline and resource constraints, by default monitoring is largely the responsibility of the TURF organizations. Although the TURFs have some ability to sanction their group members, they have no legal authority to impose penalties on outside poachers. Consequently, the government prosecutes and sanctions detected poachers through the judicial

[2] TURFs are currently used in Argentina, Australia, Brazil, Canada, Ecuador, India, Indonesia, Japan, Mexico, Korea, Philippines, Spain, United States, and Vietnam, among other countries. A recent review by Quynh et al. (2017) concluded that the performance of TURFs depends mainly on enforcement and contextual factors.

system.[3] While there are a number ways that common pool resource (CPR) users and government agencies could share enforcement responsibilities, co-enforcement in our research design follows the experience of Chilean TURFs; hence, the design features monitoring by the CPR users and sanctions imposed by the government on outsiders who are caught poaching.

Scholars of common pool resources have long recognized that successful management of these resources requires adequate defense from outside encroachment (Ostrom 1990 and 2006). However, only a few authors have uses economic experiments to investigate the consequences and deterrence of poaching. With a set of laboratory experiments Schmitt et al. (2000) found that outsider poaching made cooperation by a group of insiders much more difficult. De Geest et al. (2017), who also conducted laboratory experiments, found that insiders had difficulty deterring poaching because they were unwilling to impose high enough sanctions.

Chávez et al. (2018) is closely related to our study and we borrow from its design. Theirs was the first study of co-enforcement against poaching of common pool resources and was done with lab-in-field experiments.[4] In their experiments, a fixed per-unit poaching sanction was imposed by the government. Treatments varied whether monitoring was provided by the government, individual CPR users, or a combination of the government and the CPR users. Chávez et al. (2018) confirmed the Schmitt et al. (2000) result that undeterred poaching largely eliminated the incentive for common pool resource users to coordinate their harvest choices. Enforcement reduced poaching, but differences in the provision of monitoring did not alter levels of poaching. While CPR users were willing to invest in monitoring, similar to the main finding of De Geest et al. (2017), Chávez et al. (2018) found that CPR users were not able to coordinate their monitoring investments well enough to deter poaching completely, even with government

[3] Local TURFs try to protect their territories by patrolling their management areas; the effort and costs of these activities appear to have been increasing over time (Chávez et al. 2010). Patrols have sometimes escalated to violent encounters, including murders. In response to these incidents, in 2014 the Chilean National Service of Technical Cooperation (SERCOTEC by its Spanish acronym) together with the Regional Government of Los Lagos region in southern Chile launched a program to improve monitoring by local TURFs. Los Lagos has a high concentration of TURFs and there has been an increasing number of encounters between poachers and TURF members in this region. Funds have been invested in monitoring equipment, including fast modern patrol boats, engines, lights for night monitoring at sea, and radio equipment to facilitate communication between TURFs and the authorities. Moreover, there have been attempts to increase coordination between the Regional Office of Public Prosecution (Fiscalía Regional) and the TURF organizations to improve prosecution of poachers in Los Lagos region.

[4] There is an extensive literature that uses lab-in-field experiments to investigate other aspects of common pool resource use and management, and some of this literature is focused on the co-management of these resources by the resource users themselves and government authorities (e.g., Cárdenas et al. 2000, Velez et al. 2010 and 2012, Lopez et al. 2012, Santis and Chávez 2015). Except for Chávez et al. (2018), the existing literature does not address the problem of deterring poaching by outsiders.

assistance in monitoring. Interestingly, joint investment in monitoring by CPR users and the government led to negative average returns to poaching, leading the authors to wonder whether this outcome would persist in real settings.

Our experiments were designed to investigate the difficulty facing CPR users in raising a sufficient deterrent against poaching found in Chávez et al. (2018). In Chávez et al. (2018) subjects could communicate between periods, but they made their own individual independent choices of investing in monitoring. In practice, CPR groups use a variety of coordination devices to overcome freeriding incentives. In addition, group choices concerning monitoring are likely to be affected by the stringency of government sanctions on poaching. Our design includes a no-enforcement baseline treatment, plus 2×2 co-enforcement treatments that consider two fine levels (low or high) and two different mechanisms for TURF members, or insiders, to determine monitoring investments (voluntary individual contributions or voting on mandatory uniform contributions). If insiders in our experiments have difficulty investing enough in monitoring to deter outsiders, as they did in Chávez et al. (2018), then voting should lead to greater monitoring investment and deterrence because voting helps coordinate individual choices and eliminates free-riding incentives. Likewise, a higher fine should lead to more deterrence because the amount of monitoring necessary to deter a risk-neutral poacher would be lower.

The results of our experiments have important implications for our understanding of co-enforcement of access to common pool resources. We found that poaching is significantly lower in all co-enforcement treatments relative to the baseline treatment that involves no enforcement against poaching. This result suggests that co-enforcement of common pool resource use rights can successfully limit outsider encroachment. In response to lower poaching, insiders increased their harvests and the combination of lower poaching and increased harvests resulted in higher harvest earnings for insiders. However, the insiders' investments in monitoring tended to offset their gains in harvest earnings so that their net earnings in the co-enforcement treatments were not consistently higher than their baseline earnings.

Although there were pronounced differences in insider monitoring investments among the treatments, levels of poaching were not sensitive to differences in marginal expected sanctions. Under both low fine treatments, the insiders failed to invest enough in monitoring to lift average expected poaching sanctions above the marginal value of poaching, although voting led to higher monitoring investments on average. However, with the high fine, average investments in monitoring with and without voting were sufficient to deter optimizing, risk-neutral poachers. Despite this, outsiders continued to poach under the high fine treatments, and average earnings were negative as a result. However, we find a conspicuous gender effect—poaching earnings for males in the high fine treatments were negative, but poaching earnings for females were statistically indistinguishable from zero. While we doubt that negative poaching earnings could persist for long in real settings, we fail to find evidence that all subjects are responsive to the range of changes in monitoring levels and sanctions in our experiments.

The rest of this paper proceeds in the following way. In section 2 we describe the design of our experiments, including the theoretical benchmarks for each treatment, and the procedures we used to implement our experiments. We present the results of the experiments in section 3 and conclude in section 4.

2. Experimental Design, Treatments, Theoretical Benchmarks and Procedures

The objective of our research is to study the co-enforcement of access to common pool resources using lab-in-field experiments conducted with members of local TURFs in Chile. In all of our treatments, except in a baseline treatment, resource users invested in monitoring for poaching while sanctions for poaching were exogenous as if applied by government authorities. Treatments varied according to the level of the poaching sanction and whether resource users made individual independent investments in monitoring or they voted on a mandatory common investment. The main questions of the experiments are concerned with whether the insiders, backed by external sanctions, could coordinate investments in monitoring well enough to deter poaching by the outsiders.

2.1 Experimental design, treatments and theoretical benchmarks

Our experimental design is a modified version of that used in Chávez et al. (2018). In each treatment, six individuals were divided into two groups of three. The assignment of individuals to the two groups was random and remained fixed throughout the session. We call one group the insiders and the other group the outsiders throughout the paper, but we avoided these terms in the experiments. The experiments were framed as managing the exploitation of Chilean wild abalone, or *loco*, from two zones or stocks of *loco*. The insiders had harvest rights to the blue zone and the outsiders had harvest rights to the yellow zone. The focus of this paper is on harvesting and monitoring activity in the blue zone. The yellow zone simply provided outsiders with an outside option to earn money without resorting to poaching from the blue zone. In the instructions, group names were associated with the zone color. Subjects were told in Spanish: "The blue locos belong to the blue participants, and only the 3 blue participants have the right to harvest blue locos. Similarly, the yellow locos belong to the yellow participants, and only the 3 yellow participants have the right to harvest yellow locos."[5] However, it was possible for the outsiders to harvest (poach) from the blue zone: "Although the blue locos belong to the blue participants, it is possible for yellow participants to poach blue locos. Blue participants cannot poach yellow locos." The insiders could not poach from the yellow zone. In each treatment, at the start of every round the insiders were able to communicate with each other. The outsiders were not able to communicate with each other or with the insiders, nor were they able to hear what the insiders discussed.

The resource in both zones evolved over time according to a stock dependent growth function and aggregate harvests. The growth rate in both zones was 10% of the remaining stock in a period in discrete units; that is, the stocks grew by one unit for every 10 units of *loco* that were left in the zone. The insiders had access to the more abundant stock of *loco*—the initial stock in the blue zone was 100 units while the initial stock in the yellow zone was 55 units. Harvest capacity for each individual harvester was six units per period, and the amount received for each harvested *loco* was a constant 200 Chilean pesos. Each session consisted of two independent stages. When stage 1 ended, we reset the exercise and started the games over again in stage 2 with a new period 1. Each stage lasted a maximum of 15 periods, but a zone was closed earlier if its stock fell below a critical value. This critical value was 40 units in the blue zone and 20 units in the yellow zone. These critical values were chosen so that individuals could harvest at capacity in the last period before the zone was closed. The critical level in the blue zone was higher because in most of our treatments both insiders and outsiders could harvest in the blue zone. We say that a zone or stock was depleted if it fell below its critical level. The last period in which a zone was open is referred to as the terminal period.

In Table 1, we present theoretical benchmark equilibria for each treatment. (The derivations of these benchmarks are in section 1 of the online appendix). We present cooperative

[5] The Spanish instructions used in the experiments, and an English translation, are available in section 2 the online appendix. **Reviewers: We have included the online appendix with this submission.**

and non-cooperative benchmarks for insiders and non-cooperative benchmarks for the outsiders. In a cooperative outcome, insiders in the blue zone coordinate their harvest and monitoring strategies to maximize the joint payoffs of the group. In a non-cooperative outcome, groups are not able to coordinate their decisions. We do not present cooperative harvest strategies by the outsiders mainly because we do not give them a mechanism to coordinate their harvests, such as the ability to communicate. In Table 1 we include theoretical benchmarks of symmetric individual harvests by insiders and outsiders over all periods, symmetric poaching by the outsiders in the blue (insider) zone, terminal periods in both zones, minimum symmetric monitoring costs when the insiders could invest in monitoring, and finally symmetric individual payoffs.

<Table 1 here>

T1. Baseline. There was no monitoring or sanctions for poaching in this treatment. Therefore, the outsiders could harvest from the blue zone without any consequences. The purpose of this treatment was to establish a baseline level of insider harvests and outsider poaching in the absence of enforcement of CPR access.

While communication is known to promote more cooperative harvests in CPR environments without poaching (Ostrom and Walker 1991, Ostrom 2006), Schmitt et al. (2000) and Chávez et al. (2018) show that undeterred poaching largely destroys the ability of groups to use communication to coordinate harvests. Consequently, there is no incentive for the insiders to limit their harvests to conserve the blue resource in the Baseline treatment, and they would harvest to capacity until their zone was depleted. The outsiders would first harvest from the blue zone and then, after that zone was depleted, they would harvest to capacity in the yellow zone until it was depleted. Consequently, the blue zone would be depleted in two periods and the yellow zone would be depleted in five periods.

In the four co-enforcement treatments, described below, outsiders faced random monitoring provided by the insiders and exogenous sanctions for poaching in the blue zone. The treatments vary by provision rule (individual contributions or group vote) and fine (low or high).

T2. Individual contributions to monitoring/Low fine (Indiv:Low Fine). In each round, each insider made an independent decision to invest in monitoring probabilities applied to each outsider. The schedule of monitoring investments and probabilities for the group of insiders is presented in Table 2. The marginal cost of achieving a higher monitoring probability was 100 pesos. Thus, for example, if the insiders collectively invested 400 pesos, then each outsider was independently monitored with probability 22.2%. Each insider could invest up to 300 pesos in 100-peso increments. If an insider was monitored, then he or she was fined 650 pesos per unit poached.

<Table 2 here>

Given the 650 pesos per unit sanction, to make the expected per unit sanction exceed the value of a *loco* of 200 pesos, the insiders needed to collectively invest 600 pesos to make the monitoring probability 33.3%. Since the individual contributions were voluntary and provide a second-order public good, there were incentives for the insiders to free-ride and not contribute. If the insiders failed to coordinate their individual contributions by collectively investing at least 600 pesos in a period, then the linearity of the expected sanction and the value of poaching implies that risk-neutral outsiders would not be deterred and would harvest at capacity in the blue zone. In turn, the insiders would not invest anything in monitoring if they knew the outsiders would not be deterred. If the insiders were unable to deter the outsiders, then this would destroy the motivation for the insiders to limit their harvest to conserve the resource. As a result, the outcomes in this treatment would be identical to those in the Baseline treatment. In fact, since an individual insider could not invest the 600 pesos necessary to deter the outsiders in a period, the Baseline outcome is a subgame perfect Nash equilibrium for this treatment.

However, under the assumption of risk-neutral poachers, there are also multiple subgame perfect Nash equilibria in which the insiders invest just enough in monitoring to deter the poachers. In fact, any combination of monitoring investments that sums to 600 pesos while limiting individual investments to 300 pesos is a Nash equilibrium combination of monitoring investments in a particular period. To see why, consider an outcome in which the insiders are collectively investing 600 pesos in monitoring in a period. From this outcome, no insider is motivated to invest more in monitoring because the outsiders would already be deterred and the extra investment would not produce an extra benefit. Moreover, no insider is willing to contribute less because then the outsiders would not be deterred at all. They would poach at capacity producing a loss for the insiders of 18 *locos* valued at 3,600 pesos. Thus, an insider who reduces his or her investment saves at most 300 pesos, but their share of the poaching loss would be 1,200 pesos. Since no individual insider is motivated to change their monitoring investment when the sum of insider investments is 600 pesos, full deterrence of poaching in a period can be a component of a subgame perfect equilibrium.

The entries in Table 1 for this treatment assume that the insiders deter the outsiders in all periods but the last with symmetric 200-pesos per person per period investments in monitoring. We present outcomes in which the insiders are also able to coordinate their harvests to maximize their joint payoffs and when they are not able to coordinate their harvests. Given the deterrence of the outsiders, non-cooperative subgame perfect harvests in all of our co-enforcement treatments involve the insiders harvesting at capacity in their blue zone until depletion in the sixth period. There would be enough of the blue stock remaining in the sixth period to allow both the insiders and outsiders to harvest at capacity, so there would be no reason for the insiders to invest in monitoring in the last period. Thus, the insiders would deter the outsiders for only five periods at a total cost of 1,000 pesos for each insider.

However, given that the insiders could communicate with each other before each period, they may be able to follow a cooperative harvest strategy. Coordinating their harvests requires that they maintain the stock that produces maximum sustained yield until the last several periods in which they harvest at capacity so that the stock falls below its critical level after period 15. With this strategy, there would be sufficient stock remaining in the final period so that both insiders and outsiders could harvest to capacity in the blue zone. Thus, the insiders would deter the outsiders for only fourteen periods at a total cost of 8,400 pesos, or 2,800 pesos for each insider.

Whether the insiders coordinate their harvests or not, the outsiders would harvest at capacity in their own zone, depleting it in three periods. Since the insiders would not monitor the outsiders in the final period of harvests from the blue zone, the outsiders would poach to capacity in that last period. Thus, regardless of whether the insiders coordinate their harvests, if they deter the outsiders until the final active period of the blue zone, each outsider would harvest 18 units from their yellow zone in three periods and an additional six units from the blue zone. The only difference is that the outsiders would postpone their poaching to period 15 when the insiders coordinate their harvests.

The payoffs in Table 1 for this treatment reveal that the insiders would always be significantly better off if they could deter the outsiders. Specifically, if the insiders coordinated both their monitoring efforts and harvests they would earn 3.4 times more than under uncontrolled poaching. Even if the insider were only able to coordinate monitoring effort but not harvests, they would earn 2.6 times more under uncontrolled poaching. Once again, there is no value to the insiders from coordinating their harvests if they do not simultaneously deter the outsiders.

That there are subgame perfect outcomes in which insiders invest enough in monitoring to deter risk-neutral poachers suggests that insiders in our experiments will invest in monitoring in this treatment. However, that there are multiple equilibria in which the outsiders are deterred as well as an outcome in which the insiders do not invest in monitoring suggests that the insiders may have difficulty coordinating their contributions to monitoring. Of course, the insiders might be able to use their ability to communicate to overcome any coordination problems. Success in deterring the outsiders may allow the insiders to more effectively coordinate their harvests as well, leading to higher insider harvests in the blue zone and the resource lasting longer relative to the no-enforcement baseline.

T3. Individual contributions to monitoring/High fine (Indiv:High Fine). This treatment is the same as Indiv:Low Fine except that the poaching sanction was 1,300 pesos per unit. Given the monitoring schedule in Table 2, investing enough in a period to make the monitoring probability 16.7% would lift the expected marginal sanction above the marginal value of a loco (i.e., 217 pesos versus 200 pesos). Doing so would cost the insiders 300 pesos collectively. All of the benchmark equilibria in Table 1 for this treatment are the same as for Indiv:Low Fine, except that monitoring costs would be 50% lower if the insiders invested enough to deter the outsiders, and insider payoffs would be correspondingly higher.

However, there is an important difference in potential equilibria with the high fine in this treatment as opposed to the low fine of Indiv:Low Fine. The outcome in which each insider invests nothing in monitoring in periods before the last active period of the blue zone is no longer a component of a subgame perfect equilibrium. The reason is that it only takes 300 pesos from the insiders collectively to deter the outsiders in a period with the high fine. So, starting at an outcome of zero monitoring investments and maximum poaching, each of the insiders would be motivated to contribute their limit of 300 pesos to eliminate poaching.

Since the outcome in which all insiders contribute nothing to monitoring in a period is no longer a subgame perfect outcome, we expect the insiders in this Indiv:High Fine treatment to invest enough in monitoring to deter the outsiders. Thus, if the insiders have difficulty deterring the outsiders consistently with a low fine, then we expect more effective deterrence with a high fine. In turn, better deterrence may lead to more sustained and higher insider harvests in the blue zone.

T4. Vote for monitoring/Low fine (Vote:Low Fine). Monitoring in some TURFs is voluntarily provided by individuals, but others decide on contributions to monitoring by voting. This may help alleviate the coordination and free-riding challenges associated with voluntary contributions. Therefore, in the Vote:Low Fine treatment, the insiders decide on mandatory uniform contributions to monitoring each period via majority rule voting. The monitoring probabilities and associated costs are shown in Table 2, with each higher level of monitoring costing each insider 100 pesos. The monitoring probability that was implemented was determined by majority rule, and each insider paid an equal share of the monitoring cost regardless of how they voted. Ties, which occurred only if each insider voted for a different contribution to monitoring, were resolved by implementing the median vote. In the Vote:Low Fine treatment, the sanction for poaching was the low per-unit fine of 650 pesos. The expected per unit sanction exceeded the value of a *loco* if the insiders voted to implement the 33.3% monitoring probability, costing each of them 200 pesos. Otherwise, risk-neutral poachers would not be deterred.

Note from Table 1 that the benchmarks for the Vote:Low Fine (T4) are the same as those for Indiv:Low Fine (T2). However, voting on funding monitoring causes a major difference between the treatments. There are now only two subgame perfect monitoring outcomes in a period. Zero investments and the outcome in which each insider invests 200 pesos are still potential components of a subgame perfect equilibrium. All the outcomes in which the insiders deter the outsiders but invest unequal amounts are eliminated. Moreover, while all insiders voting for zero investment in monitoring can be a subgame perfect outcome in a period, it seems to be an unlikely outcome. An individual’s vote for a common investment of 200 pesos weakly dominates a vote for zero investment for all combinations of votes by the others that lead to a monitoring probability less than 33.3%. This is because the outsiders will not be deterred regardless of the individual’s vote. However, a vote for a uniform investment of 200 pesos strictly dominates a vote for zero investment if the others also vote for a common investment of

200 pesos. In other words, it never hurts an insider to vote for an investment that eliminates the motivation for poaching, but such a vote is strictly beneficial if all the other insiders vote for the same thing.

Comparing the results of the two low fine treatments allows us to test the effect of voting for monitoring investments on the ability of the insiders to deter the outsiders, given the low fine for poaching. If insiders under Indiv:Low Fine have difficulty coordinating their monitoring investments to make the expected poaching sanction high enough to deter risk-neutral poachers, we expect that voting will help them coordinate their investments more effectively in Vote:Low Fine for two reasons. First, the voting procedure eliminates the possibility of unequal investments in monitoring, and second, it makes zero insider investments in monitoring an unlikely outcome.

T5. Vote for monitoring/High fine (Vote:High Fine). This treatment is the same as Vote:Low Fine except that the fine was 1,300 pesos per loco. The expected per unit sanction exceeded the value of a *loco* if the insiders voted to implement the 16.7% monitoring probability, costing each of them 100 pesos. Like Vote:Low Fine, both zero investment and the uniform investment of 100 pesos to deter the outsiders in a period are subgame perfect outcomes, but the zero-investment vote is dominated by the 100-peso per insider vote, as in Vote:Low Fine. The benchmarks in Table 1 for Vote:High Fine differ from those for Vote:Low Fine only in that insiders would spend less on monitoring. The benchmarks for Vote:High Fine are identical to Indiv:High Fine, which has insiders making individual contributions to monitoring with the high fine. With a high fine, the zero-monitoring outcome in a period is not a subgame perfect outcome with individual contributions (Indiv:High Fine), and not a likely outcome with voting (Vote:High Fine). In addition, voting in this treatment eliminates the possibility, which arises with individual contributions, that deterrence is achieved with unequal investments.

Recall that we do not expect insiders to fail to deter the outsiders in Vote:Low Fine. However, if the insiders in Vote:Low Fine cannot deter the outsiders, the insiders should do better in Vote:High Fine, which has a lower monitoring threshold to deter poaching. In addition, if insiders do not invest enough in monitoring under Indiv:High Fine because of free-riding and coordination problems, then insiders in Vote:High Fine should have less difficulty achieving deterrence with the voting process.

Our experimental design allows us to examine the effectiveness of co-enforcement to deter encroachment on common pool resources. Our co-enforcement treatments vary the level of sanction provided by an external authority and the manner in which CPR users choose investments in monitoring for poaching—insiders either make individual investments in monitoring or they vote for a uniform investment. The following summarizes our expected results.

Expected result 1. In the four co-enforcement treatments, the insiders have ample opportunity and incentive to choose monitoring investments that would fully deter risk-neutral poachers. We therefore expect that insiders will invest at least enough to achieve full deterrence.

Expected result 2. If there are differences in deterrence among the co-enforcement treatments, we expect that voting on monitoring investments will lead to greater investments in monitoring and greater deterrence relative to not voting. Likewise, the high fine will lead to higher monitoring levels and greater deterrence than the low fine.

Expected result 3. Relative to the Baseline treatment, poaching in the four co-enforcement treatments should be lower. Less poaching should be associated with better coordination of harvests by the insiders: hence, relative to the Baseline treatment, the blue resource should last longer and insider harvests should be greater in the co-enforcement treatments.

Expected result 4. The combination of lower poaching and higher insider harvests in the four co-enforcement treatments will lead to higher harvest earnings for the insiders relative to the Baseline. However, their investments in monitoring will erode some of these gains.

2.2 Experimental Procedures

The experiments were conducted with members of TURFs under the MEABR system in the Los Lagos region in southern Chile. We recruited subjects from TURFs operating in the sample area. In all, 234 subjects were recruited from the following communities: Anahuac, Isla Tenglo, Pelluco, La Arena, Sotomó, Amortajado, Carelmapu, Pureo, Bahía San Antonio, Contao, Quildaco, Tentelhue, El Manzano, Punta Quillón, Pichicolo, Punta Pichicolo, and Chumeldén. We distributed the experimental treatments across the communities to avoid concentrating particular treatments in particular places. A summary of the number of subjects and groups in each treatment is contained in Table 3.

As subjects arrived, they signed consent forms and were randomly assigned to groups of six, with three subjects in the blue group (the insiders) and three subjects in the yellow group (the outsiders). No more than two groups of six participated in a single session. At the beginning of each session, the experimenter read the instructions aloud with PowerPoint slides highlighting the key points. We then conducted two practice rounds to help the subjects become familiar with the procedures. Subjects had to answer control questions to make sure they were ready to participate in the experiments. The experiments were conducted with pen and paper. Although the insiders and outsiders of each group of six were separated so they could work in private, the blue and yellow resource stocks were displayed on a board that was visible to all.

<Table 3 here>

For each of the four co-enforcement treatments, experiments proceeded as illustrated in Figure 1. At the beginning of each round, the insiders left the room to communicate with each other about any aspect of the activity for a maximum of three minutes. Outsiders remained seated in silence. After the communication stage, all the subjects wrote down their decisions in private. Both insiders and outsiders decided how many *locos* to harvest. The insiders could only harvest from the blue zone, whereas outsiders could harvest from both zones, subject to the individual harvest limit of six *locos* total across both zones. During this decision stage, the insiders also chose their monitoring investments. In the Indiv:Low Fine and Indiv:High Fine treatments, the insiders independently chose their investments in monitoring, while in the Vote:Low Fine and Vote:High Fine treatments the insiders voted on a uniform investment in monitoring. After the harvest and monitoring decisions were recorded, total harvests and monitoring investments were announced to all subjects, the harvests in each zone were removed from the display board.

<Figure 1 here>

The experiments then proceeded to the monitoring and sanctioning stage. Monitoring of individual outsiders was determined by drawing a chip out of a bag (with replacement). The bag always contained 18 chips, with some combination of red and green chips. The combination of red and green chips in the bag was determined by the number of red chips "purchased" by the insiders in the previous stage. Outsiders took turns drawing a chip from the bag, and the poaching decision of an outsider was monitored if that individual drew a red chip. For treatments Indiv:Low Fine and Indiv:High Fine, in which the insiders made individual decisions about investing in monitoring, each insider could purchase up to three red chips at a cost of 100 pesos per red chip. This process produced alternative levels of monitoring investments and probabilities shown in Table 2.

To determine monitoring in the Vote:Low Fine and Vote:High Fine treatments, each blue participant voted on how many red chips each person in the blue group would purchase (0 to 3 red chips). The number of red chips that received the most votes was the winner, and each person in the blue group bought that number of red chips regardless of how that person voted. If there was a tie then the median vote was implemented. This process produced the monitoring probabilities in Table 2, with each higher level costing 300 pesos collectively (100 pesos for each insider).

If an outsider was discovered to have poached in the blue zone in Indiv:Low Fine and Vote:Low Fine, a sanction of 650 pesos per unit of poached loco was deducted from that subject's earnings. The marginal sanction was 1,300 pesos in Indiv:High Fine and Vote:High Fine.

At the end of the session, participants were paid their earnings in cash. The exchange rate was 1:1; they received one Chilean peso for each peso earned in the experiment. Average earnings were 10,946.8 pesos (σ = 2,479.9), which was close to the daily minimum wage at the time of the experiments.

3. Results

3.1 Subject characteristics

The majority of our 234 participants were male (57%). Their mean age was about 49 years old (σ = 14.3) with about 8 years of formal schooling (σ = 3.4). On average, participants lived in their village for about 39 years (σ = 17.6). The majority of participants were the main contributors to their family incomes (68%). Mean monthly family income was about 281,000 Chilean pesos (about US$425 given the exchange rate at the time); only 11% had monthly incomes above 450,000 Chilean pesos (about US$680). We also asked about the participant's main role in their union: 35% were fishermen or crew members, 12% were divers, 9% were small-scale aquaculturists (e.g., mussel seed collectors, mussel fattening), and 24% were shore collectors (seaweed and seafood collectors). The remaining 20% reported that they were dealers of marine products, independent laborers, administrators and other roles. The mean distance between the location of the participants' houses and their TURF was about 2.5 miles (4 km.): 52% of participants reported that they are able to observe the TURF from their houses.

Participants reported that poaching in their TURF was an important problem. The mean response on a scale from 1 to 10 from "poaching is an irrelevant problem" to "poaching is a very relevant problem" was 6.9. About 66% of participants believed that both the fishers' union and the government are jointly responsible for preventing poaching in the TURFs. However, participants reported that the monitoring efforts of the National Fisheries Service and the Navy were not very effective. The mean response on a scale from 1 to 10 that patrolling by the government is "ineffective" to "very effective" was 4.1. In contrast they reported that the monitoring efforts of their union were more effective. In this case the mean response was 5.9.

About 90% of the participants reported that their organizations actively monitored their TURF, and the majority reported that TURF members patrolled their management area. A significant amount of monitoring is done by members at their own cost (45%), while 27% of participants reported that their union pays for monitoring. About 65% of participants indicated that the decisions regarding monitoring (e.g., monitoring effort, frequency of patrolling, etc.) are made via discussions and votes in union meetings, while 15% of participants reported that the union leaders make these decisions. We also asked the participants what would happen to someone caught poaching. 25% of the participants responded that the poachers would be reported to the authorities, but would not be sanctioned; 46% reported that the poacher would be reported to the authorities and receive some form of sanction; 12% responded that nothing would happen, and 15% reported that there might be some other minor consequence. These results suggest that the TURF members in our study region consider poaching to be a relevant problem, but they are not confident about the effectiveness of government monitoring and sanctioning efforts. Moreover, they actively patrol their own areas, using different mechanisms for making decisions about monitoring.

TURF members' concerns about the problem of poaching and the ineffectiveness of government monitoring and sanctioning efforts to deter poaching are consistent with the study by Chávez et al. (2018) who surveyed TURF members closer to Concepción, Chile (north of our study region). Davis et al. (2017) also found these same concerns with a survey of TURF members closer to Valparaiso, Chile (even farther north of our study region).

3.2 Experiment results

Our presentation of the experiment results focuses on six outcome variables: number of periods the blue zone was open; individual insider harvests of the blue resource aggregated over all rounds that the blue zone was open; individual insider earnings over all rounds; individual outsider poaching of the blue resource over all rounds; individual outsider earnings from poaching over all rounds, and average insider investments in monitoring per round the blue resource was open. Table 4 presents conditional estimates of the individual-level treatment effects of all the outcome variables, except the terminal periods for the blue resource. Models 1-4 use a linear random effects model with standard errors clustered at the group level, while Model 5 uses a random effects tobit model. All models include controls gender, age, years of formal schooling and community fixed effects. We also control for possible differences between stages, and find that the stage effects are not statistically significant. Hypotheses about treatment effects were tested using the regression models in Table 4.[6]

<Table 4 here>

We use Figures 2-7, which combine data from both stages, to visualize our results. Figure 2 contains the average number of rounds the blue resource was open by treatment. Figures 3-6 contain estimates of individual insider harvests and earnings, and individual outsider poaching and net earnings from poaching using linear random effects models with only treatment dummy variables and standard errors clustered at the group level. Figure 7 contains estimates of individual insider investments in monitoring per round from a tobit model with only treatment dummy variables and clustered standard errors. We detected a significant gender effect on outsider poaching and poaching earnings, so the figures contain estimates from separate regressions for males, females, as well as all subjects combined. The figures contain squares that show the cooperative and non-cooperative benchmarks by treatment. The cooperative benchmark assumes that insiders perfectly coordinate both their harvest and enforcement decisions (except

[6] We also ran several alternatives to the models in Table 4 and found that our conclusions about treatment effects were robust across these alternative specifications. These alternative regressions include, in some cases, individual perceptions about the problem of poaching and effectiveness of union efforts to control it. The results of these estimations are in section 3 of the online appendix.

in the Baseline treatment which only has a harvesting decision). The non-cooperative benchmark assumes the insiders do not coordinate their actions, and as a result, they fail to deter the outsiders from poaching. There is no cooperative benchmark in the Baseline treatment—in absence of the ability to deter poaching there is no incentive for the insiders to coordinate their harvest decisions.

<Figures 2-7 here>

Let us first consider the Baseline treatment. Recall without enforcement that there is no incentive for the insiders to coordinate their harvests. Consequently, if both insiders and outsiders were to harvest at maximum capacity, then the blue resource would only last 2 periods (Table 1). Instead, Figure 2 reveals that the blue resource lasted about 6.9 periods (on average, about 8.3 periods in stage 1 and 5.5 periods in stage 2). Figures 3 and 4 suggest that the total amount harvested and earnings by individual insiders for stages 1 and 2 combined were somewhat higher than the non-cooperative benchmarks. Likewise, Figures 5 and 6 reveals that poaching levels and net earnings from poaching in the Baseline treatment were also slightly higher than the non-cooperative benchmarks. These are roughly the same patterns reported by Chávez et al. (2018).

Expected result 1. Recall that we expected that the co-enforcement treatments would provide the insiders with the opportunity and incentive to invest sufficient amounts in monitoring to deter risk-neutral poachers. Figure 7 shows positive average monitoring investments in each of the four co-enforcement treatments. In three of the four co-enforcement treatments, only about 5-10 percent of the group outcomes resulted in zero monitoring. The only exception was Indiv:Low Fine treatment, in which zero investment occurred 25% of the time that the blue zone was open. Despite these incidences of zero monitoring investments, the main message here is that the insiders were willing to make significant individual contributions to monitoring in Indiv:Low Fine and Indiv:High Fine treatments, and to vote for significant levels of monitoring in Vote:Low Fine and Vote:High Fine treatments.

However, Figure 5 shows that the outsiders were not deterred by the insiders' monitoring investments. This is not necessarily due to the failure of the insiders to invest sufficient amounts in monitoring. Theoretically, a risk neutral poacher would be deterred in each round of the two high fine treatments (T3 and T5) if the insiders invested an average of one unit in monitoring per round. Figure 7 shows that the average investment exceeded this level in the high fine treatments. However, in the two low fine treatments (T2 and T4) in which the cost to fully deter risk-neutral poachers doubled, the average investment necessary to deter a risk-neutral poacher is two units. In Figure 7 we see that the insiders were unable to reach this threshold. Despite the failure to deter poaching, it is clear that the high exogenous sanction allowed the insiders to lift the expected poaching sanction above what would deter an optimizing, risk-neutral poacher.

Expected result 2. Recall that we expected that if there were differences among the co-enforcement treatments—or more generally that insiders had difficulty deterring the outsiders—that the higher fine and voting would lead to higher monitoring investments. We do not observe these effects consistently. From Model 5 of Table 4, especially the hypothesis tests for treatment effects, we observe that monitoring investments were higher with the high fine when insiders made individual investments ($p = 0.000$, T2 v. T3). However, we fail to reject the hypothesis that monitoring investments were equal under the high fine and low fine when insiders voted on these investments ($p = 0.399$, T4 v. T5). Likewise, voting led to significantly higher monitoring investments under the low fine ($p = 0.011$, T2 v. T4), but individual investments were significantly higher than voting investments under the high fine ($p = 0.000$, T3 v. T5).

Expected result 3. While it is clear that the insiders had difficulty deterring the outsiders, as expected poaching was significantly lower in each of the co-enforcement treatments relative to the no-enforcement Baseline (Figure 5 and Model 3 in Table 4). Thus, our results suggest that co-enforcement of user rights to common pool resources can reduce outside encroachment. Moreover, the reduction in poaching in the co-enforcement treatments was accompanied by an increase in harvests by the insiders (Figure 3 and the treatment coefficients for Model 1 in Table 4), which is consistent with what we expected.

Expected result 4. Lower outsider poaching and higher insider harvests imply higher harvest earnings for the insiders in the co-enforcement treatments, but we expect that some of these gains would be offset by the insider investments in monitoring. In fact, Model 2 of Table 4 shows that insider earnings tended to be higher in the co-enforcement treatments than in the Baseline treatment, but the difference is not statistically significant for the two voting treatments (T4 and T5) and only weakly significant in the Indiv:High Fine treatment. Only the Indiv:Low Fine treatment (T2) shows unequivocally higher insider earnings than the Baseline treatment (T1). We reject the hypothesis that insider earnings in all four co-enforcement treatments were equal (T2=T3=T4=T5, $p = 0.046$). However, if we omit the Indiv:Low Fine treatment, we cannot reject that insider earnings are equal in the other three co-enforcement treatments (T3=T4=T5, p = 0.38) and we also fail to reject the hypothesis that insider earnings in the other co-enforcement treatments jointly equaled those in the no-enforcement Baseline treatment (i.e., T1=T3=T4=T5, p = 0.30). Thus, with the exception of one co-enforcement treatment, insider investments in monitoring offset nearly all of their gains from lower poaching.

Now let us look more closely at our poaching results. While poaching was lower in each co-enforcement treatment relative to the Baseline treatment (T1), levels of poaching were not very responsive to differences in enforcement across these treatments. Specifically, Model 3 of Table 4 shows that we cannot reject the hypothesis that the quantity poached by the outsiders is equal across the four co-enforcement treatments (T2=T3=T4=T5, p = 0.149). Insider harvests are also equal across co-enforcement treatments (p = 0.40, Model 1 of Table 4). This unresponsiveness in poaching decisions to changes in expected sanctions as well as the low levels of investment in monitoring by the insiders in the two low fine treatments noted above are the reasons that the insiders were not able to fully deter poaching in the co-enforcement treatments.

However, recall in the high fine treatments that insiders were able to invest enough in monitoring on average to lift the expected poaching sanction above the unit value of a *loco*. The persistence of poaching in these treatments implies that the average return to poaching must be negative; that is, the outsiders would lose money on average in the Indiv:High Fine and Vote:High Fine treatments. This is exactly what we observe in Figure 6, but note further that negative earnings in these high fine treatments were largely restricted to males; female earnings from poaching were statistically indistinguishable from zero in these treatments. The regression results in Model 4 of Table 4 provide additional evidence of this gender effect. In contrast, note from Figure 6 that poaching earnings were not statistically different from zero in the Vote:Low Fine treatment for both males and females. Poaching earnings were somewhat higher than zero in the Indiv:Low Fine treatment, especially for females. The higher poaching earnings under the low fine with individual contributions versus voting (T2=T4, p = 0.077, Model 4 of Table 4) were primarily due to the significantly higher levels of monitoring in the Vote:Low Fine treatment relative to the Indiv:Low Fine treatment (T2=T4, p = 0.011, Model 5 of Table 4). The main lesson we take from this analysis is that, except when insiders made individual contributions to monitoring under the low fine, the insiders were able to eliminate the average gains from poaching. While this was not enough to deter the outsiders in our experiments, eliminating the gains to poaching is likely to be an effective deterrent in real settings.

4. Conclusion

We have presented the results of framed, lab-in-field experiments that were designed to investigate the co-enforcement of limiting access to common pool resources. Our experiments, conducted with members of Chile's TURF system, featured an exogenous sanction for poaching, as if the sanction was imposed by a government authority, but monitoring was the responsibility of CPR users.

Our results suggest that co-enforcement can work to limit encroachment: given exogenous sanctions for poaching, CPR groups are willing to invest in monitoring and the combination of exogenous sanctions and community monitoring can reduce poaching. While co-enforcement can limit encroachment, community investments in monitoring may offset of large portion of their gains from reduced poaching. Co-enforcement promotes more efficient use of a common pool resource, but the inefficiency of potential encroachment manifests itself in reduced welfare for CPR users as they defend their resource against poachers. Whether CPR users are better off investing in monitoring will depend upon many factors including the severity of the poaching problem, the ability of TURF users to coordinate their actions, the difficulty and costs of monitoring, and the availability of low-cost but effective monitoring technology that can reduce the investment needed to deter encroachment. Because monitoring is an on-going recurring expense, finding ways to reduce costs and improve effectiveness will be critical for the long-run viability of TURFs.

We did not find that a higher sanction led to consistent changes in monitoring investments. However, monitoring investments under the high fine were more than sufficient to deter a payoff-maximizing, risk-neutral poacher. This result suggests that strict government sanctions applied efficiently can motivate, and are necessary to motivate, sufficient group monitoring efforts. We also did not find that voting on monitoring versus making individual contributions to monitoring led to consistent changes in monitoring investments, so we cannot say anything about the effectiveness of alternative rules for making defensive decisions within a group of CPR users.

While a high sanction allowed insiders to push the marginal expected poaching sanction above the marginal benefit of poaching, poaching was not eliminated. In fact, poaching was not responsive to changes in marginal expected sanctions among the co-enforcement treatments. While co-enforcement did not eliminate poaching, it did eliminate the gains from poaching in all but one treatment. We wonder whether poaching would persist in real settings under these conditions. If poachers would not tolerate zero or negative returns for long in real settings, eventually turning to more productive pursuits, then our results about the effect of co-enforcement in deterring poaching are stronger, especially when the government applies high sanctions consistently.

Finally, the result that poaching choices were not responsive to changes in expected sanctions suggests that much more dramatic modifications to enforcement are necessary to change behavior. These changes might come from discrete changes in monitoring technologies; for example, the adoption of searchlights or radar that make detection of encroachers in relatively small areas virtually certain. Discrete changes may also involve the provision of sanctions, including modifications of procedures used to prosecute and penalize detected poachers. These may be important lessons for policy as well as future research into what reforms are necessary to enforce access to common pool resources.

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6. Tables

Table 1: Equilibrium benchmarks. Symmetric individual harvests, terminal periods in both zones, monitoring costs and payoffs.

Treatment	Total harvested[a]	Total poached	Terminal period	Monitoring costs (pesos)	Payoffs (pesos)
T1. Baseline	There is no incentive for the insiders to coordinate their harvests in this treatment.				
Noncoop insiders	12	-	2	-	2,400
Noncoop outsiders	30	12	5	-	6,000

Treatment	Total harvested[a]	Total poached	Terminal period	Monitoring costs (pesos)	Payoffs (pesos)
T2 and T4. Low Fine	All outcomes here assume that the insiders deter the outsiders in all periods but the last with symmetric 200 pesos, per-period investments in monitoring. If the insiders do not deter the outsiders, then the benchmarks are the same as in the Baseline treatment.				
Coop insiders	54.3	-	15	2,800	8,060[b]
Noncoop insiders	36	-	6	1,000	6,200[b]
Noncoop outsiders	24	6	3	-	4,800

Treatment	Total harvested[a]	Total poached	Terminal period	Monitoring costs (pesos)	Payoffs (pesos)
T3 and T5. High Fine	All outcomes here assume that the insiders deter the outsiders in all periods but the last with symmetric 100 pesos, per-period investments in monitoring. If the insiders do not deter the outsiders, then the benchmarks are the same as in the Baseline treatment.				
Coop insiders	54.3	-	15	1,400	9,460[b]
Noncoop insiders	36	-	6	500	6,700[b]
Noncoop outsiders	24	6	3	-	4,800

[a] For outsiders, this includes harvest of yellow locos plus the blue locos poached.
[b] Harvest payoff less share of monitoring costs.

Table 2: Schedule of Monitoring Investments and Probabilities

Monitoring Investments (pesos)		
Individual T2, T3	Voting T4, T5	Monitoring Probability
0	0	0.0%
100		5.6%
200		11.1%
300	300	16.7%
400		22.2%
500		27.8%
600	600	33.3%
700		38.9%
800		44.4%
900	900	50.0%

Table 3: Number of subjects and groups by treatment

Treatments	TURF members	
	Groups	Subjects
T1. Baseline	8	48
T2. Indiv:Low Fine	8	48
T3. Indiv:High Fine	8	48
T4. Vote:Low Fine	7	42
T5. Vote:High Fine	8	48
Totals	39	234

Table 4. Estimation of individual-level treatment effects

	(1) Insider Harvest	(2) Insider Earnings	(3) Outsider Poaching	(4) Outsider Net Earnings from Poaching	(5) Average Monitoring
Constant	14.90***	3208.07***	25.69***	4723.39***	0.75***
	(3.76)	(538.32)	(3.73)	(970.39)	(0.27)
Treatments					
T1. Baseline	Omitted	Omitted	Omitted	Omitted	
T2. Indiv:Low Fine	10.45***	1348.22***	-11.44***	-3291.85***	Omitted
	(2.81)	(466.67)	(2.09)	(682.16)	
T3. Indiv:High Fine	13.45***	773.12*	-9.25***	-6291.77***	0.87***
	(3.84)	(453.11)	(2.14)	(935.45)	(0.17)
T4. Vote:Low Fine	10.28***	750.45	-10.20***	-4159.79***	0.40**
	(3.10)	(514.19)	(2.34)	(677.92)	(0.16)
T5. Vote:High Fine	6.69**	239.96	-5.86**	-4779.18***	0.25
	(3.05)	(438.11)	(2.51)	(532.32)	(0.17)
Stage 2	-0.53	-2.56	-1.47*	-293.91	0.00
	(0.61)	(142.42)	(0.85)	(308.96)	(0.06)
Participant characteristics					
Male	2.19	8.78	-1.41	-1312.92***	0.17
	(1.33)	(173.87)	(1.94)	(374.28)	(0.12)
Age	-0.01	-3.41	-0.08	-0.32	0.00
	(0.06)	(6.85)	(0.05)	(9.82)	(0.00)
Years of formal schooling	0.11	23.66	-0.22	3.31	-0.00
	(0.20)	(28.47)	(0.27)	(56.52)	(0.02)
N	234	234	230	230	186

Hypothesis tests for treatment effects (χ^2 test)

T1=T2	0.001***	0.006***	0.000***	0.000***	
T1=T3	0.001***	0.096*	0.000***	0.000***	
T1=T4	0.002***	0.153	0.000***	0.000***	
T1=T5	0.034**	0.587	0.025**	0.000***	
T2=T3	0.461	0.151	0.305	0.001***	0.000***
T2=T4	0.937	0.086*	0.491	0.077*	0.011**
T2=T5	0.194	0.010***	0.023**	0.006***	0.148
T3=T4	0.452	0.960	0.681	0.026**	0.007***
T3=T5	0.123	0.200	0.144	0.048**	0.000***
T4=T5	0.265	0.287	0.088**	0.263	0.399
T2=T3=T4=T5	0.400	0.046**	0.149	0.007***	0.000***

Models include fixed effects for community.

7. Figures

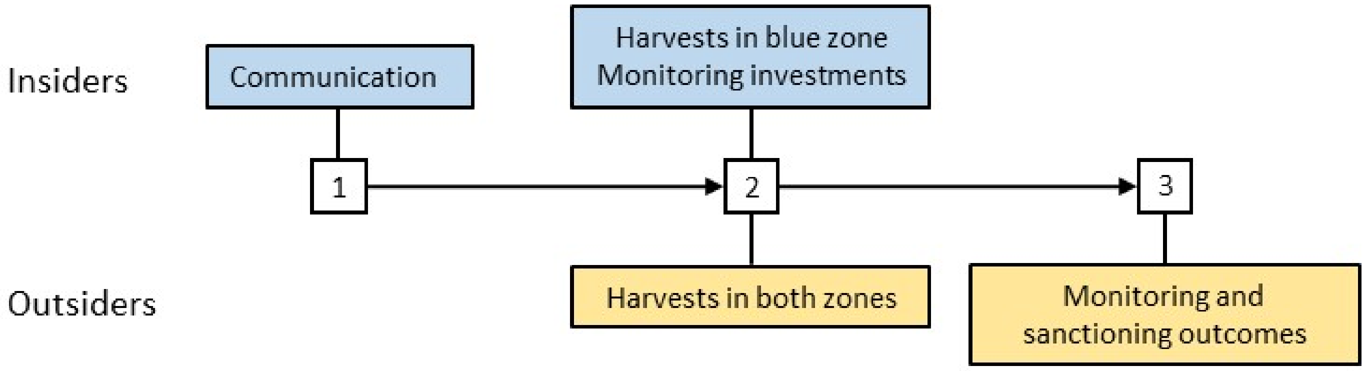
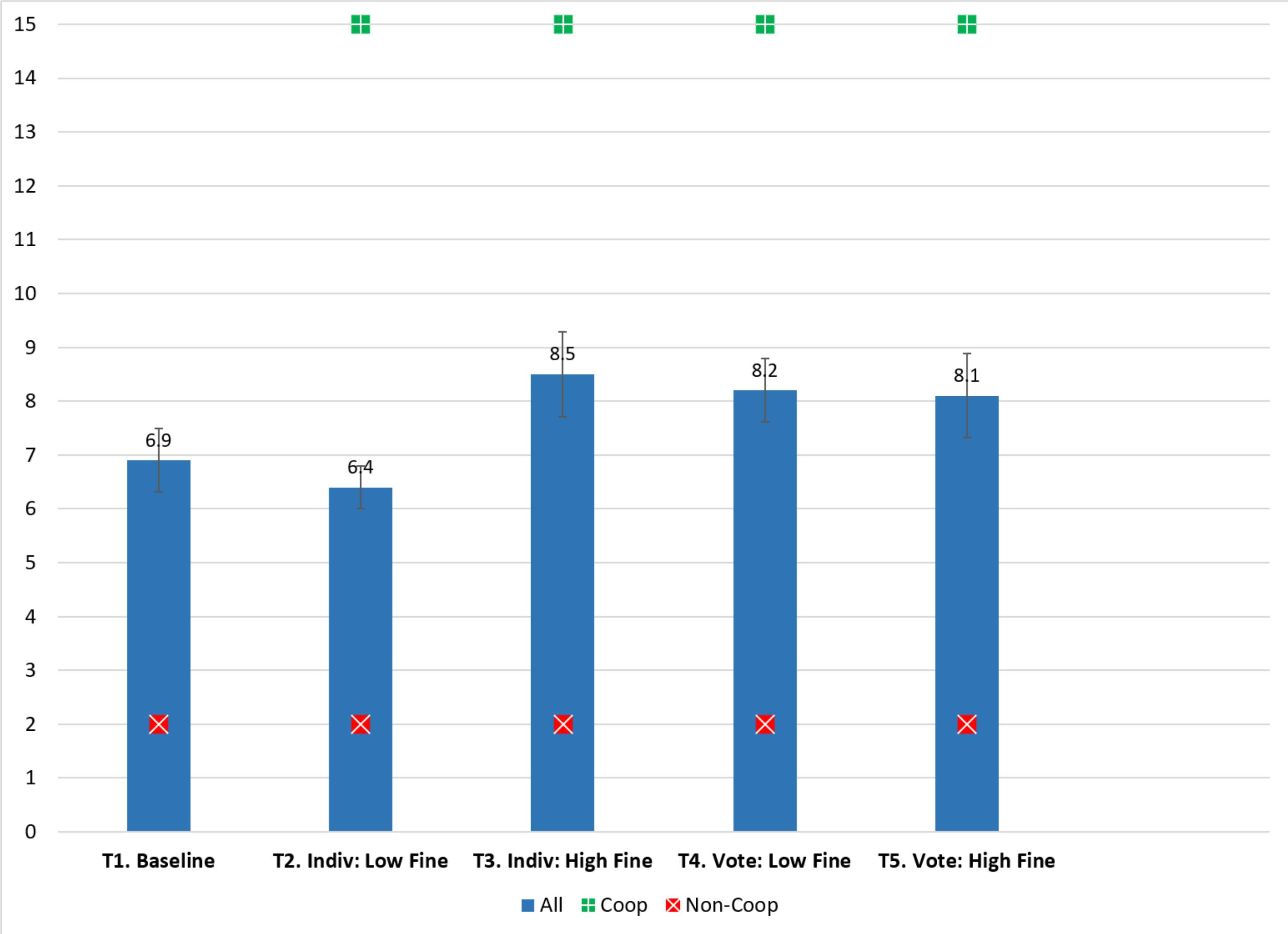


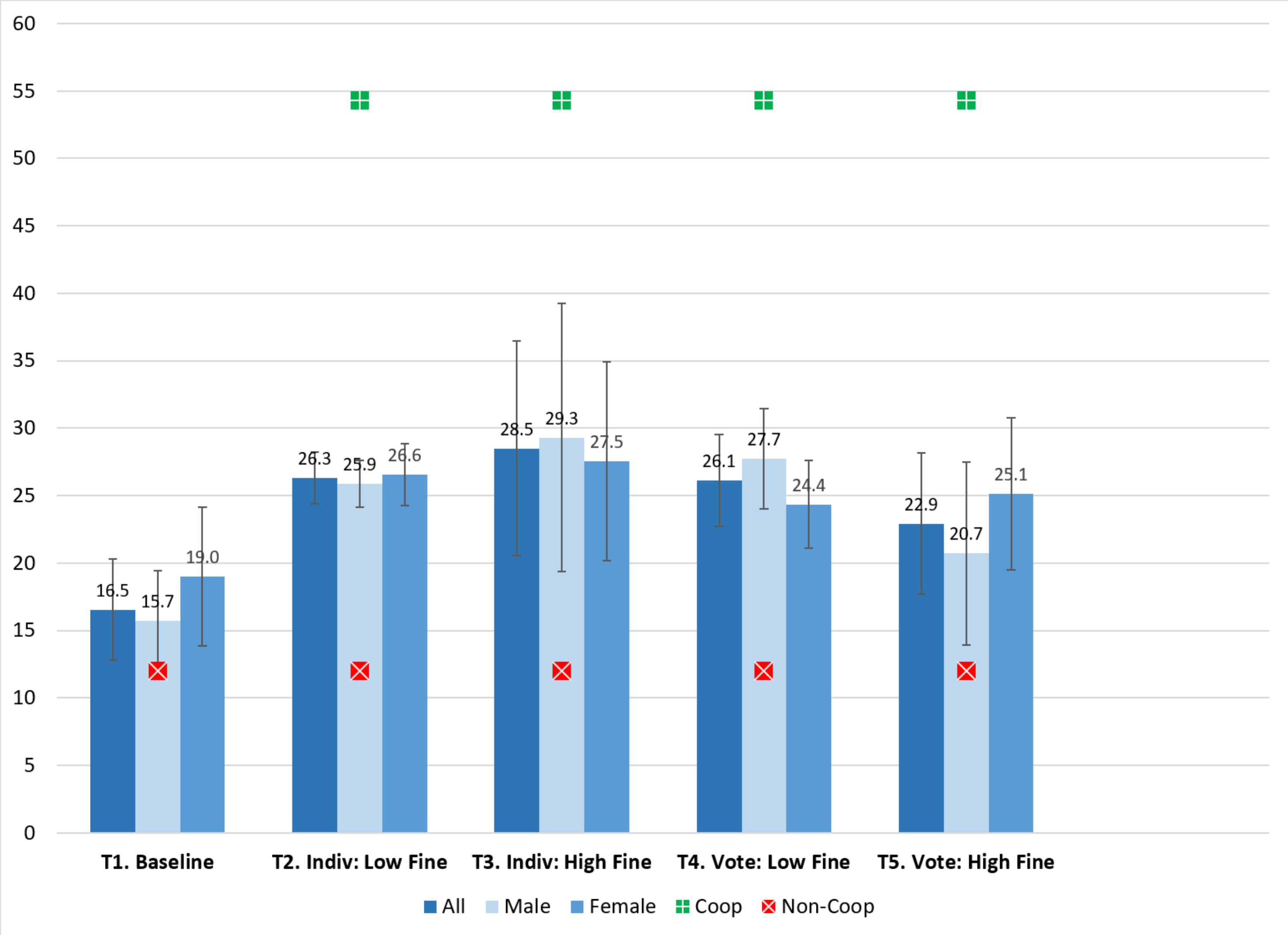
Figure 1: Period stages. Insiders are above the time line, outsiders are below.

Figure 2: Blue zone mean terminal periods



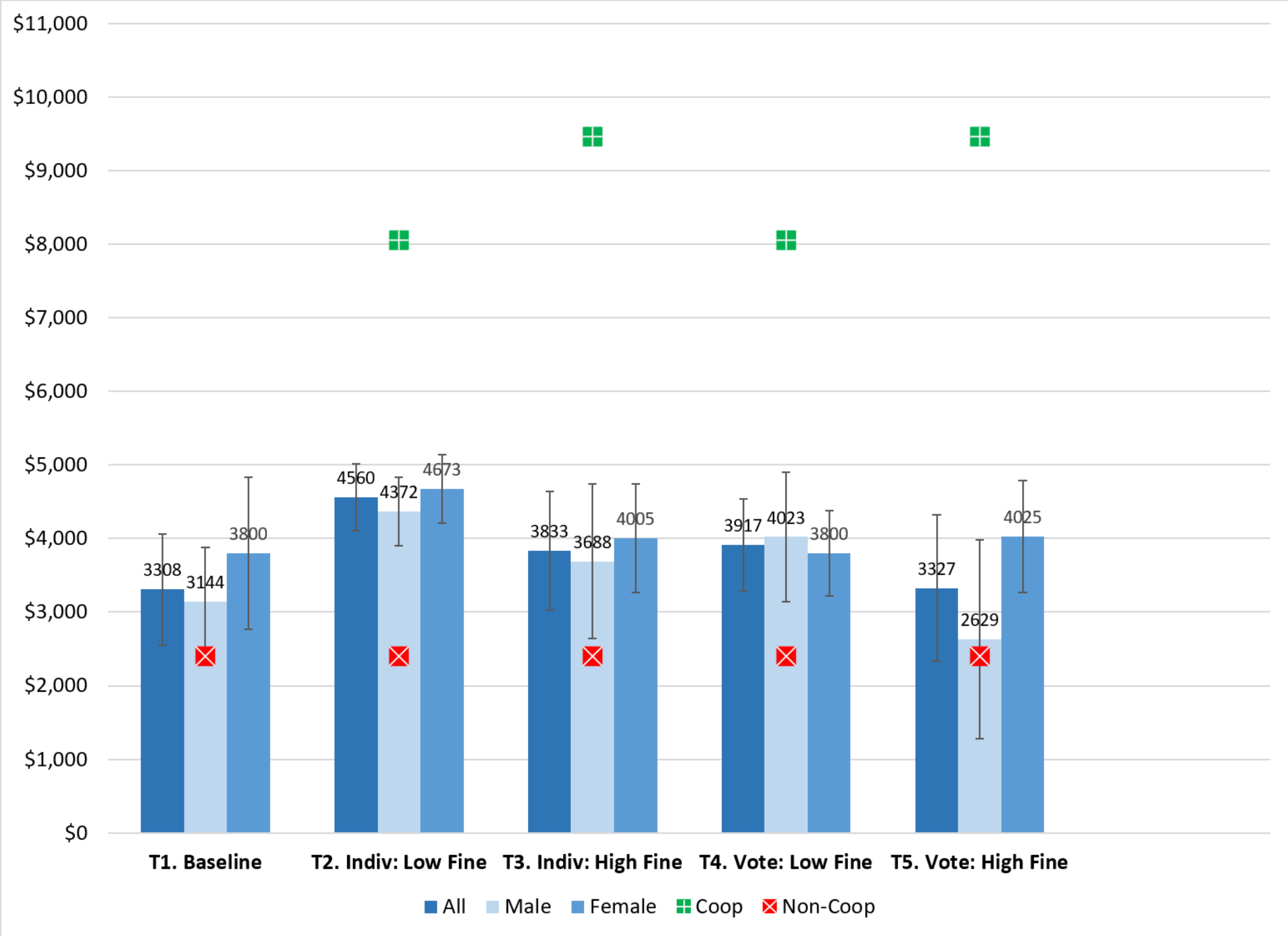
Error bars show 95% confidence intervals. The squares denoted Coop and Non-coop reference the cooperative and non-cooperative outcomes.

Figure 3: Insider mean individual cumulative harvests



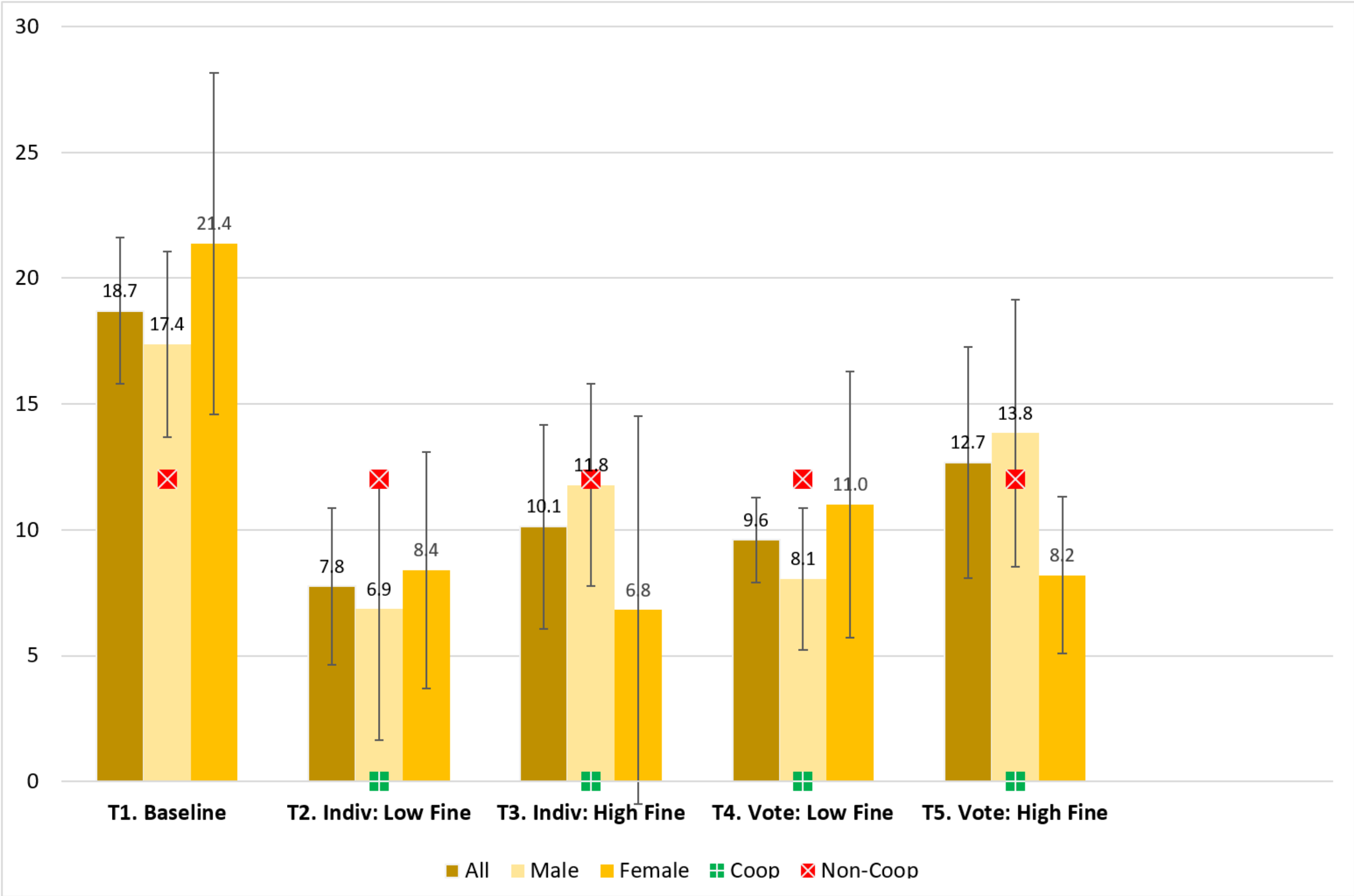
Error bars show 95% confidence intervals. The squares denoted Coop and Non-coop reference the cooperative and non-cooperative outcomes.

Figure 4: Insider mean individual cumulative earnings



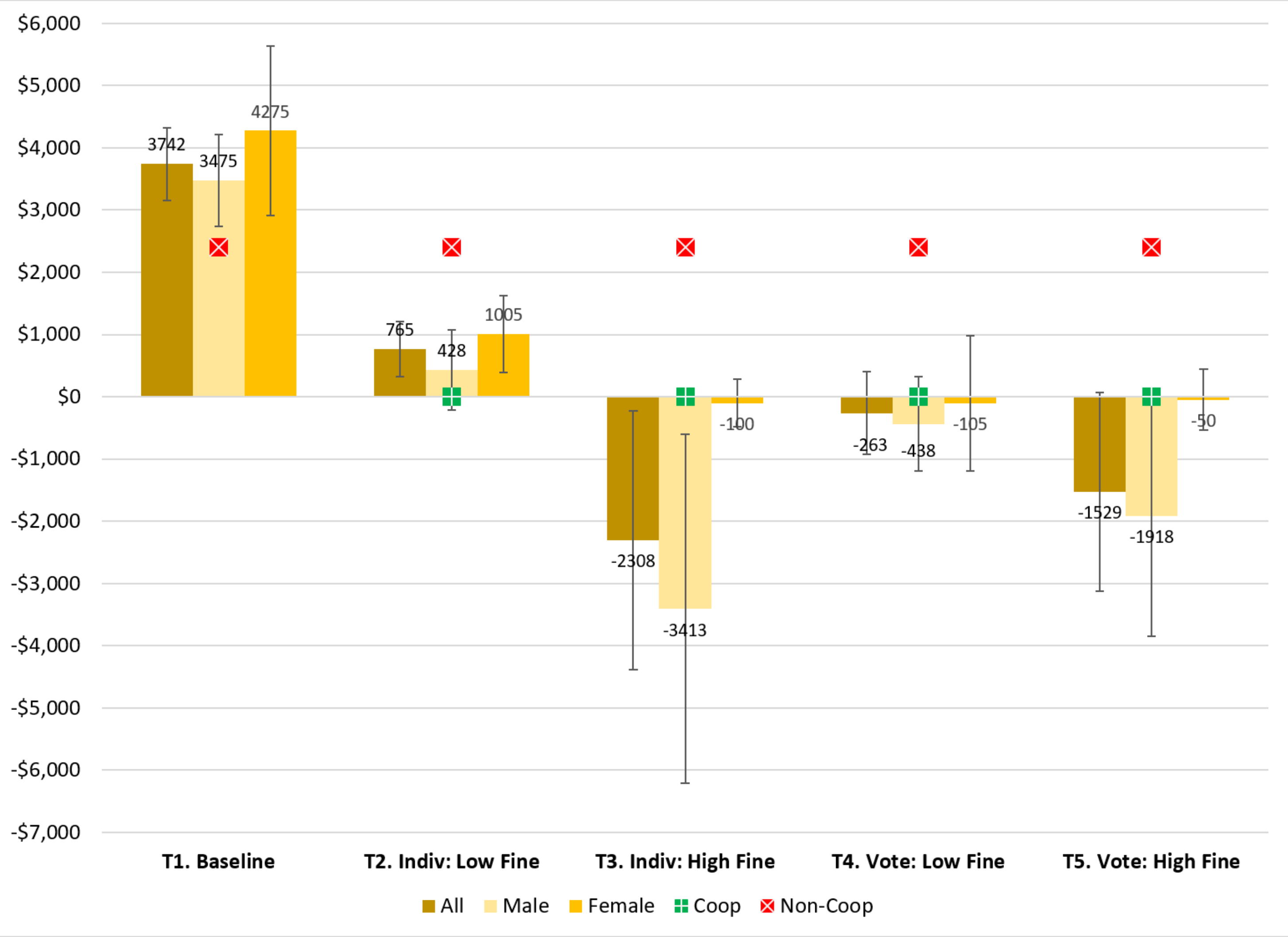
Error bars show 95% confidence intervals. The squares denoted Coop and Non-coop reference the cooperative and non-cooperative outcomes.

Figure 5: Outsider mean individual cumulative poaching



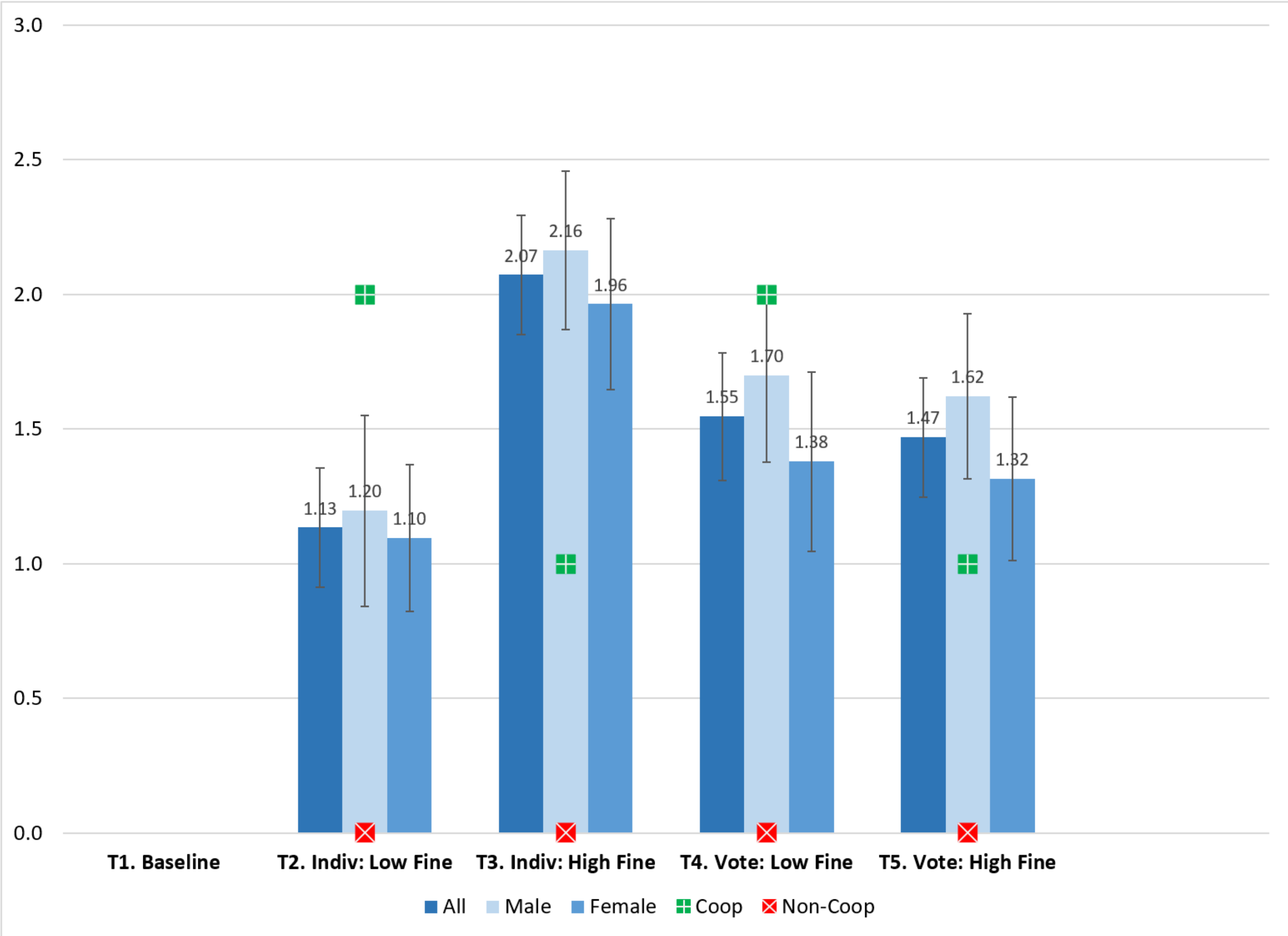
Error bars show 95% confidence intervals. The squares denoted Coop and Non-coop reference the cooperative and non-cooperative outcomes.

Figure 6: Outsider mean individual cumulative net earnings from poaching



Error bars show 95% confidence intervals. The squares denoted Coop and Non-coop reference the cooperative and non-cooperative outcomes.

Figure 7: Insider mean individual monitoring per period



Error bars show 95% confidence intervals. The squares denoted Coop and Non-coop reference the cooperative and non-cooperative outcomes.

Online Appendix

1. Demonstrations of theoretical benchmarks in Table 1.

In this appendix we demonstrate the equilibrium benchmarks that presented in Table 1. Recall the fundamentals of stocks and harvesters. The initial insider stock is 100 units, and the stock is "depleted" if it falls below the critical level of 40 units. The initial outsider stock is 55 units, and the stock is depleted if it falls below 20 units. The growth rate is 10% (in discrete units) in both zones. There are three harvesters in each zone, and harvest capacity is six units per harvester per period. There are 15 periods. Below we present group-level harvests. In Table 1 are symmetric individual harvests.

T1. Baseline

In this treatment the outsiders can freely poach from the insider zone. In this case there is no incentive for the insiders to attempt to conserve the resource. Therefore, they harvest at capacity in their zone until the stock is depleted. The outsiders also harvest at capacity in every round, but they poach in the insider zone until it is depleted, and then they harvest in the outside zone until it is depleted.

	Insider non-cooperative harvest of inside zone		Outsider non-cooperative harvest of outside zone	
Period	Inside stock at start of period	Aggregate harvest in inside zone during period	Outside stock at start of period	Aggregate harvest in outside zone during period
1	100	18+18 (outsiders)	55	0
2	64+6=70	18+18 (outsiders)	55	0
3	34-stock is depleted	Total harvest by insiders = 36	55	18
4			37+3=40	18
			22+2=24	18
			6-stock is depleted	Total = 90 (36 in inside zone, 54 in outside zone)
	Inside zone is depleted after 2 periods.		Outside zone is depleted after 5 periods. Outsiders harvest an extra 36 units in the first two periods in the inside zone, then move to their zone in the 3^{rd} period and harvest additional 54 units over the next three periods.	

To show that it is better for the outsiders to harvest in the inside zone and then in the outside zone instead of the reverse, the following is a demonstration of non-cooperative harvests if the outsiders deplete their zone first before moving to the inside zone. Notice that total harvests of the outsiders are lower with this strategy.

	Insider non-cooperative harvest of inside zone		Outsider non-cooperative harvest of outside zone	
Period	Inside stock at start of period	Aggregate harvest in inside zone during period	Outside stock at start of period	Aggregate harvest in outside zone during period
1	100	18	55	18
2	82+8=90	18	37+3=40	18
3	72+7=79	18	22+2=24	18
4	61+6=67	18+18 (outsiders)	6-stock is depleted	Outsiders move harvest to inside zone
5	31-stock is depleted	Total harvest by insiders = 72		Total harvest by outsiders = 72
	Inside zone is depleted after 4 periods.		Outside zone is depleted after 3 periods. Outsiders harvest an extra 18 units in the inside zone in the 4th period.	

T2, T3, T4, T5. Co-enforcement

Whether the insiders coordinate their harvest to maximize their joint payoffs or not, they are better off deterring the outsiders from poaching. Hence, in Table 1 we present equilibrium benchmarks for when the insiders coordinate their harvests and when they do not, given that the outsiders are deterred.

Note in the following that there are 52 units of the inside stock available at the start of period fifteen. Hence, both groups can harvest at capacity in that period. There is no incentive for the insiders to deter poaching in the last period—they harvest to capacity and any remaining stock has no value after the final period is over. Since the outsiders know that insiders will not try to defend their zone in the last period, they will poach at capacity in the last period.

Cooperative benchmark

	Insider cooperative harvest of inside zone		Outsider non-cooperative harvest of outside zone	
Period	Inside stock at start of period	Aggregate harvest in inside zone during period	Outside stock at start of period	Aggregate harvest in outside zone during period
1	100	10	55	18
2	90+9=99	9	37+3=40	18
3	90+9=99	9	22+2=24	18
4	90+9=99	9	6-stock is depleted	
5	90+9=99	9		
6	90+9=99	9		
7	90+9=99	9		
8	90+9=99	9		
9	90+9=99	9		
10	90+9=99	9		
11	90+9=99	18		

12	81+8=89	18		
13	71+7=78	18		
14	60+6=66	18		
15	48+4=52	18 + 18(outsiders)		
	16 units at end of round so stock is depleted.	Total harvest= 163.		Total harvest by outsiders = 72, 54 in their zone and 18 in the insider zone.

The non-cooperative benchmark is below. Here the insiders are not able to coordinate their harvests, but they can coordinate their investment in monitoring to deter the outsiders. Note that insiders harvest to capacity in the fourth round, even if they don't deter the outsiders, and the stock is depleted in this round whether the outsiders are deterred or not. Therefore, the insiders will not defend their resource in the fourth period

Non-cooperative benchmark

	Insider cooperative harvest of inside zone		Outsider non-cooperative harvest of outside zone	
Period	Inside stock at start of period	Aggregate harvest in inside zone during period	Outside stock at start of period	Aggregate harvest in outside zone during period
1	100	18	55	18
2	82+8=90	18	37+3=40	18
3	72+7=79	18	22+2=24	18
4	61+6=67	18	6-outside stock is depleted	
5	49+4=53	18		
6	35+3=38	18+18 outsiders		
7	2-stock is depleted	Total harvest= 108.		Total harvest by outsiders = 72, 54 in their zone and 18 in the insider zone.

2. Instructions

2.1 Instructions-English version

<Slide 1>
Welcome and thank you for agreeing to participate!!
<*Introduce yourself and your assistants*.>

Today's decision-making exercise will take no more than 3 hours to complete. At the end of the exercise, you will be paid in cash. You have already earned $3,000 for agreeing to participate. That money is yours to keep. You will now be given an opportunity to earn more money.

<Slide 2>
Before we explain the instructions, we have a few simple rules:

- Please make sure you turn off all cell phones, pagers, etc. <*pause*>
- Please do not talk with any other participants during the exercise.
- If you have a question, please raise your hand.
- If you fail to follow these instructions, you will be asked to leave and forfeit any money earned.
- We hope that you are able to remain until the exercise ends. However, if you must leave before the exercise ends, you may keep the $ 3,000 for showing-up, but you will forfeit any additional money earned.

Any money you earn today and any decisions you make will be private. We will never tell anyone else in the exercise or outside of the exercise how much you've earned or what you decided in the exercise. In order to keep your information private please do not talk about your earnings or decisions with another participant.

You may have heard about this exercise from someone else. Although some parts may be similar to what other people have done, there may also be some differences. The instructions are very important as they explain the details of the exercise. Please pay careful attention to the instructions.

<Slide 3>
<u>Context</u>: Today's exercise is based on a loco fishery. Many aspects will be similar to your Management Area. Some parts will be different, but that is ok, it is part of the exercise.

<Slide 4>
<u>Activities & Rounds</u>: Today's exercise includes two completely independent activities. In each activity you will be asked to make the same type of decisions many times. You can think of these repeated decisions as years or seasons. Each activity will last <u>at most</u> 15 rounds. When Activity 1 ends, we will reset the exercise and start over again Activity 2 with a new round 1. The two activities are completely separate. Activity 2 will follow the same rules as Activity 1.

<Slide 5>
<u>Groups</u>: The 12 (6) participants in the room today have been randomly divided into 2 (1) separate groups of 6 people using the Participant ID Cards that you selected. In each group of 6, the 3 people with yellow cards will be called the Yellow Participants, and 3 people with

blue cards will be called the Blue Participants. The participant ID card shows your Group Number, Participant Number, and whether you will be a Yellow or a Blue Participant.

<*Slide 6*>
Resource: On the board, there are two zones (blue and yellow). Each magnet represents 1 loco. The blue zone starts with 100 blue locos, and the yellow zone starts with 55 yellow locos. Each round, you will decide how many locos to harvest. The blue locos belong to the blue participants, and only the 3 blue participants have the right to harvest blue locos. Similarly, the yellow locos belong to the yellow participants, and only the 3 yellow participants have the right to harvest yellow locos.

<*Slide 7*>
Harvest capacity: Each person can harvest at most 6 locos each round. You do not have to harvest all 6 locos. You may harvest 0 or 1 or 2 or 3 or 4 or 5 or 6. It is up to you to decide how many locos to harvest.

Loco price: You will be paid $200 in cash for each loco you harvest.

Growth of loco quantity: As you know, locos reproduce. We represent this in the exercise. After everyone has decided how many locos to harvest, we will remove the locos from the board and announce how many locos are left. The units of the loco resource that are left on the board will reproduce according to the following rule:

- For every 10 locos that are left on the board, we will add 1 more loco.
- There can never be more than 100 blue locos or 55 yellow locos.

Here are some examples: <*actually remove the magnets from the board*>

- <*slide 8*>If the total harvest of blue locos is 12, that leaves 88 locos at the end of the round. <*slide 9*>At the start of the next round, we will add back 8 locos, which means the new round begins with 96 locos. Are there any questions?
- <*slide 10*>If the total harvest of blue locos is 6, that leaves 94 blue locos at the end of the round. <*slide 11*>At the start of the next round, we cannot add back all 9 locos because that would be more than 100<*show on the board*>. Instead, we will add 6 so the new round begins with 100 <*slide 12*> Are there any questions?
- The yellow zone works the same way, except that the limit is 55.

<*slide 13*>
Fishery closure: In order for the blue loco fishery to remain open, there has to be at least 40 blue locos left on the board. <*slide 14*> At the end of the round, if there are fewer than 40 blue locos, then the blue zone will be closed for the rest of the current activity. <*slide 15*> Similarly, if there are fewer than 20 yellow locos remaining in the yellow zone, then the yellow zone is closed and will not reopen for the rest of the current activity. It is possible for one zone to be open while the other is closed.

<*slide 16*>
Communication: At the start of each round, the blue participants will have 3 minutes to talk with each other. They may discuss any aspect of the activity. They cannot use foul language, threaten other participants or make promises of side-payments. The 3 yellow participants must sit quietly and wait.

<*slide 17*>

Poaching: Although the blue locos belong to the blue participants, it is possible for yellow participants to poach blue locos. Blue participants cannot poach yellow locos.

End here for T1-Baseline (Poaching without enforcement)

<*slide 18*>
Local monitoring: The blue participants can monitor the blue zone. If a yellow participant is caught poaching blue locos, then that person must pay a fine of $650 (or $1300) for each blue loco poached.
<*slide 19*> Here's how it will work. I have 10 (4) bags. Each bag has18 chips. Some chips are red, and some are green. Each bag has a different number of red and green chips.

<*slide 20*>The yellow participants will take turns drawing a chip from one of the bags. If the chip is red, then the person is inspected and will pay a fine for each blue loco harvested. If the chip is green, then the person is not inspected and does not a pay a fine. The chip will then be returned to the bag, and we will repeat the process with each yellow participant. <*slowly go through slides 21-25 and explain the examples.*>

<*slide 26*>
<*no vote*> In each round the blue participants will need to decide how much they want to spend on monitoring the blue zone. Consequently, the blue participants determine how many of the chips will be red. Each blue participant can purchase red chips. Each chip costs $100. The more red chips that the blue participants buy, the more likely it is that the yellow participants will be inspected. Each blue participant can purchase 0 or 1 or 2 or 3 red chips.
There will always be 18 chips in the bag. The total number of red chips will always be between 0 and 9, the rest will be green. <*slide 27*> For example, if Participant 1 buys 3 red chips, Participant 2 buys 0 red chips and Participant 3 buys 1 red chip, <*slide 28*> then the blue participants purchased a combined total of 4 red chips. The other 14 chips in the bag will be green.

<*slide 26*>
<*yes vote*> In each round the blue participants will need to decide how much they want to spend on monitoring the blue zone. Consequently, the blue participants determine how many of the chips will be red. This will be determined by a group vote. Each blue participant will vote on the number of red chips that each person in the blue group will buy. Each chip costs $100. The more red chips that the blue participants buy, the more likely it is that the yellow participant will be inspected. Each blue participant will vote on whether each person in the blue group will purchase 0 or 1 or 2 or 3 red chips.
The number of red chips that receives the most votes will be the winner, and each person in the blue group will buy that number of red chips regardless of how the person voted. If there is a tie (which will only happen if each person votes for a different number), then the middle vote will be the winner. For example, if the votes are 0, 3 and 1, then 1 is the middle vote and each blue participant will buy 1 red chip.
< *slide 27*> Here are some other examples.
There will always be 18 chips in the bag. The total number of red chips will always be 0, 3, 6 or 9, the rest will be green.

<*slide 28*>

Decision Card: Each person has a stack of Decision Cards, one card for each round. At the start of each round, use this card to record your decision about how many locos you will harvest.
<*if local monitoring no vote*>The blue participants will also indicate how much monitoring they will purchase.
<*if local monitoring with vote*>The blue participants will also indicate their vote for how much monitoring the group will purchase.
We will collect the Decision Cards and announce the results.

<*slide 29*>
Record Sheet: Use the Record Sheet to keep track of your decisions and earnings each round. When you submit your decisions, also write your decisions on the Record Sheet.

Summary:

- You have to decide how many locos to harvest. You can harvest up to 6 locos in each round.
- You will receive $200 for every loco you harvest.
- At the start of each round, 1 loco will be added for each 10 locos on the board, up to a limit of 100 in the blue zone and 55 in the yellow zone.
- Although the blue locos belong to the blue participants, it is possible for yellow participants to poach blue locos.
- If there are less than 40 blue locos, then the blue zone will be closed for the rest of the corresponding activity. If there are fewer than 20 yellow locos, then the yellow zone will be closed for the rest of the corresponding activity.
- The blue participants can communicate with each other. The yellow participants cannot communicate.
- At the end of each round, we will announce all the results before proceeding to the next round.
- In each activity, there will be at most 15 rounds. An activity will end before that if both zones are closed.
- <*If local monitoring*> The blue participants can pay to monitor the blue zone. If they catch a yellow participant with blue locos, then the person must pay a fine of $650 ($1300) for each blue loco.
- <*If voting*> The blue participants can vote on how much to monitor the blue zone. If they catch a yellow participant with blue locos, then the person must pay a fine of $650 ($1300) for each blue loco.

We will start with two practice rounds. These practice rounds will not count for your earnings. Is everyone ready to begin the practice round? <*pause*>

And remember, now that we have started, please do not talk to anyone. If you have a question, please raise your hand and an assistant will come to you and help you.

2.1 Instructions-Spanish version

<Diapo 1>
Bienvenidos y gracias por aceptar participar en esta actividad!!
<Preséntese Usted y sus asistentes>

El ejercicio de toma de decisiones que realizaremos el día de hoy no tomará más de 3 horas en ser completado. Al final del ejercicio, se le pagará en dinero en efectivo. Usted ha ganado $3.000 por aceptar participar. Ese dinero es para usted. Le daremos ahora una oportunidad de ganar más dinero.

<Diapo 2>
Antes de explicar las instrucciones, tenemos algunas reglas simples:

- Por favor asegúrese de apagar su teléfono celular, y otros aparatos electrónicos <*pausa*>
- Por favor, no hable con ningún otro participante durante el ejercicio.
- Si usted tiene una pregunta, por favor levante la mano.
- Si usted no sigue las instrucciones, le pediremos que se retire y podría perder el dinero ganado.
- Esperamos que pueda quedarse hasta que el ejercicio concluya. Sin embargo, si Usted debe retirarse antes que el ejercicio concluya, Usted puede mantener los $ 3.000 por haberse presentado el día de hoy, pero perderá cualquier monto de dinero adicional que haya ganado.

Cualquier monto de dinero ganado hoy así como cualquier decisión que tome serán privadas. Nosotros nunca revelaremos a otros participantes en este ejercicio o fuera del ejercicio cuánto ganó o qué decisiones tomó durante el ejercicio. Con el propósito de mantener la información en privado por favor no hable con otros participantes respecto a sus ganancias o decisiones.

Usted puede haber escuchado sobre este ejercicio de parte de alguna persona. Aunque alguna parte de este ejercicio puede ser similar a lo que han hecho otras personas, podrían existir también algunas diferencias. Las instrucciones son muy importantes porque explican los detalles del ejercicio. Por favor, ponga cuidadosa atención a las instrucciones.

<Diapo 3>
Contexto: El ejercicio de hoy está basado en la pesquería del Loco. Muchos aspectos serán similares a su propia Área de Manejo. Algunas partes serán diferentes, pero está bien, es parte del ejercicio.

<Diapo 4>
Actividades y Rondas: El ejercicio que desarrollaremos hoy incluye dos actividades completamente independientes. En cada actividad le pediremos tomar el mismo tipo de decisiones varias veces. Usted puede pensar en estas decisiones repetidas como años o temporadas. Cada actividad durará máximo 15 rondas. Cuando la Actividad 1 finalice, nosotros retomaremos el ejercicio iniciando la Actividad 2 con una nueva ronda 1. Las dos actividades son completamente separadas. La Actividad 2 seguirá exactamente las mismas reglas que la Actividad 1.

<Diapo 5>
Grupos: Los 12(6) participantes que están hoy en la habitación han sido divididos aleatoriamente en 2(1) grupos separados de 6 personas usando las tarjetas de identificación de participantes que Usted seleccionó.
En cada grupo de 6, las 3 personas con tarjetas amarillas serán denominadas Participantes Amarillos, y las 3 personas con tarjetas azules serán denominadas Participantes Azules. La tarjeta de identificación del participante muestra el Número de su Grupo, su Número de Participante, y si Usted será un participante Amarillo o Azul.

<Diapo 6>
Recurso: En la pizarra se presentan dos zonas (azul y amarilla). Cada magneto representa 1 loco. La zona azul comienza con 100 locos azules, y la zona amarilla comienza con 55 locos amarillos. En cada ronda, usted decidirá cuántos locos extraer. Los locos azules pertenecen a los participantes azules, y solamente los 3 participantes azules tienen el derecho a extraer locos azules. Igualmente, los locos amarillos pertenecen a los participantes amarillos, y solamente los 3 participantes amarillos tienen el derecho a extraer locos amarillos.

<Diapo 7>
Capacidad de extracción: Cada persona puede extraer como máximo un total de 6 locos por ronda. Usted no está obligado a extraer los 6 locos. Usted podría extraer 0 ó 1 ó 2 ó 3 ó 4 ó 5 ó 6. Es su decisión cuántos locos extraer.

Precio del loco: A usted se le pagará $ 200 en dinero efectivo por cada loco que extraiga.

Crecimiento de la cantidad de locos: Como Usted sabe, los locos se reproducen. Representamos esto en el ejercicio. Después de que todos hayan decidido cuántos locos extraer, sacaremos los locos desde la pizarra y anunciaremos la cantidad de locos que quedaron. Las unidades del recurso loco que queden en la pizarra se reproducirán de acuerdo a la siguiente regla:

- Por cada 10 locos que queden en la pizarra, nosotros agregaremos 1 loco.
- No podrá haber nunca más de 100 locos azules o 55 locos amarillos.

Aquí hay algunos ejemplos: *<remover realmente los magnetos desde la pizarra>*

- *<Diapo 8>* Si la extracción total de locos azules es 12, eso deja 88 locos al final de la ronda. *<Diapo 9>* Al inicio de la siguiente ronda agregaremos 8 locos, lo cual significa que la nueva ronda se inicia con 96 locos. ¿Alguna pregunta?
- *<Diapo 10>* Si la extracción total de locos azules es 6, eso deja 94 locos azules al final de la ronda. *<Diapo 11>* Al inicio de la segunda ronda no podemos agregar 9 locos porque eso implicaría tener más de 100 *<mostrar en la pizarra>*. En su lugar, agregaremos 6 para que la nueva ronda comience con 100. *<Diapo 12>* ¿Hay alguna pregunta?
- La zona amarilla funciona de la misma forma, excepto que el límite es 55.

<Diapo 13>
Cierre de la pesquería: Para que la pesquería de los locos azules se mantenga abierta, deben quedar a lo menos 40 locos azules en la pizarra. *<Diapo 14>* Si al final de una ronda hay menos de 40 locos azules, entonces la zona azul será cerrada por el resto de la actividad que esté siendo desarrollada. *<Diapo 15>* Igualmente, si quedan menos de 20 locos amarillos en la zona amarilla, entonces la zona amarilla será cerrada y no será reabierta durante la

actividad que esté siendo desarrollada. Es posible que una zona esté abierta mientras la otra está cerrada.

<Diapo 16>
Comunicación: Al inicio de cada ronda, los participantes azules tendrán 3 minutos para hablar entre ellos. Ellos pueden discutir cualquier aspecto de la actividad. Ellos no pueden utilizar lenguaje inapropiado, amenazar al resto de los participantes, ni tampoco hacer promesas de pagos laterales. Los 3 participantes amarillos deben estar sentados en silencio y esperar.

<Diapo 17>
Extracción clandestina: Aunque los locos azules pertenecen a los participantes azules, es posible para los participantes amarillos extraer clandestinamente locos azules. Los participantes azules no pueden extraer clandestinamente locos amarillos.

Finaliza aquí T1-Baseline (Poaching without enforcement)

<Diapo 18>
Vigilancia local: Los participantes azules pueden patrullar la zona azul. Si un participante amarillo es detectado extrayendo clandestinamente locos azules, entonces esta persona debe pagar una multa de $ 650 ($ 1.300) por cada loco azul extraído clandestinamente.

<Diapo 19> Así es como esto funcionará. Yo tengo 10(4) bolsas. Cada bolsa contiene 18 fichas. Algunas fichas son rojas y otras son verdes. Cada bolsa contiene un número diferente de fichas rojas y verdes.

<Diapo 20> Los participantes amarillos sacarán individualmente, y uno a la vez, una ficha desde una de las bolsas. Si la ficha es roja, entonces la persona es inspeccionada y pagará una multa por cada loco azul extraído. Si la ficha es verde, entonces la persona no es inspeccionada y no pagará multa. La ficha será devuelta a la bolsa, y nosotros repetiremos el proceso con cada participante amarillo. *<lentamente revisar las Diapos 21-25 y explicar los ejemplos>*

<Diapo 26>
<sin votación> En cada ronda los participantes azules determinarán cuánto desean gastar en vigilar la zona azul. Consecuentemente, los participantes azules determinarán cuántas fichas serán rojas. Cada participante azul puede comprar fichas rojas. Cada ficha cuesta $ 100. Mientras más fichas rojas compren los participantes azules, es más probable que los participantes amarillos sean inspeccionados. Cada participante azul puede comprar 0 ó 1 ó 2 ó 3 fichas rojas.

Siempre habrá 18 fichas en la bolsa. El número total de fichas rojas será siempre entre 0 y 9, el resto serán verdes. *<Diapo 27>* Por ejemplo, si el Participante 1 compra 3 fichas rojas, el Participante 2 no compra fichas rojas y el Participante 3 compra 1 ficha roja, *<Diapo 28>* entonces los participantes azules compraron de manera combinada o grupal un total de 4 fichas rojas. Las otras 14 fichas en la bolsa serán verdes.

<Diapo 26>
<con votación> En cada ronda los participantes azules determinarán cuánto desean gastar en vigilar la zona azul. Consecuentemente, los participantes azules determinarán cuántas fichas

serán rojas. Esto será determinado mediante la votación del grupo. Cada participante azul votará sobre el número de fichas rojas que cada persona en el grupo azul comprará. Cada ficha cuesta $ 100. Mientras más fichas rojas compren los participantes azules, es más probable que los participantes amarillos sean inspeccionados. Cada participante azul votará respecto a si cada persona en el grupo azul comprará 0 ó 1 ó 2 ó 3 fichas rojas.

El número de fichas rojas que reciba la mayoría de los votos será el ganador, y cada persona en el grupo azul comprará dicho número de fichas rojas independiente de cómo ella votó. Si existe un empate (el cual solamente ocurrirá si cada persona vota por un número diferente) entonces el voto mediano será el ganador. Por ejemplo, si los votos son 0, 3, y 1, entonces 1 es el voto mediano y cada participante azul comprará 1 ficha roja.

<Diapo 26> Aquí hay otros ejemplos.

Siempre habrá 18 fichas en la bolsa. El número total de fichas rojas será siempre entre 0, 3, 6 ó 9, el resto serán verdes.

Tarjeta de decisión: *<Diapo 28>*
Cada persona tiene un conjunto de Tarjetas de Decisión, una tarjeta por cada ronda. Al inicio de cada ronda, utilice esta tarjeta para registrar su decisión respecto a cuántos locos usted extraerá.
<Si existe vigilancia local sin votación> Los participantes azules también indicarán cuánta vigilancia comprarán.
<Si existe vigilancia con votación> Los participantes azules también indicarán su voto respecto a cuánta vigilancia el grupo comprará.
Nosotros recolectaremos las tarjetas de decisión y anunciaremos los resultados.

<Diapo 29>
Hoja de Registro: Utilice la Hoja de Registro para llevar la cuenta de sus decisiones y ganancias en cada ronda. Cuando entregue sus decisiones, escríbalas también en la Hoja de Registro.

Resumen:

- Usted debe decidir cuántos locos extraer. Usted puede extraer hasta un máximo de 6 locos en cada ronda.
- Usted recibirá $ 200 por cada loco que usted extraiga.
- Al inicio de cada ronda, 1 loco se agregará por cada 10 locos que permanezcan en la pizarra, hasta un límite de 100 en la zona azul y 55 en la zona amarilla.
- Aun cuando los locos azules pertenecen a los participantes azules, es posible para los participantes amarillos extraer clandestinamente locos azules.
- Si hay menos de 40 locos azules, entonces la zona azul será cerrada por el resto de la respectiva actividad. Si hay menos de 20 locos amarillos, entones la zona amarilla será cerrada por el resto de la respectiva actividad.
- Los participantes azules se pueden comunicar entre ellos. Los participantes amarillos no puedes comunicarse.
- Al final de cada ronda, nosotros vamos a anunciar todos los resultados antes de proceder a la siguiente ronda.
- En cada una de las actividades, existirá un máximo de 15 rondas. Una actividad podría terminar antes de aquello si ambas zonas están cerradas.

- <*Si vigilancia local*> Los participantes azules pueden pagar para vigilar la zona azul. Si ellos sorprenden a un participante amarillo con locos azules, entonces la persona debe pagar una multa de $ 650 ($ 1.300) por cada loco azul.
- <*Si votación*> Los participantes azules pueden votar respecto a cuánto vigilar la zona azul. Si ellos sorprenden a un participante amarillo con locos azules, entonces la persona debe pagar una multa de $ 650 ($ 1.300) por cada loco azul.

Nosotros vamos a empezar con dos rondas de práctica. Estas rondas de práctica no serán contabilizadas en sus ganancias. ¿Están todos listos para empezar las rondas de práctica? <*pausa*>

Y recuerden, ahora que hemos empezado, por favor no hablen con nadie. Si usted tiene una pregunta, por favor levante su mano y un asistente irá hasta usted y le ayudará.

3. Robustness checks

Table A1. Insider Harvest

	(1) Model 1	(2) Model 2	(3) Model 3	(4) Model 4	(5) Model 5
1. Poaching	0.00	0.00	0.00	0.00	0.00
	(.)	(.)	(.)	(.)	(.)
2. Indiv: Low Fine	9.77***	9.60***	10.28***	10.45***	9.81***
	(2.09)	(2.13)	(2.44)	(2.81)	(3.27)
3. Indiv: High Fine	11.96***	11.99**	13.45***	13.45***	13.44***
	(4.35)	(4.46)	(4.92)	(3.84)	(3.94)
4. Vote: Low Fine	9.58***	9.80***	9.17***	10.28***	8.01**
	(2.51)	(2.68)	(3.20)	(3.10)	(3.69)
5. Vote: High Fine	6.38*	6.09*	6.03*	6.69**	5.12
	(3.19)	(3.24)	(3.35)	(3.05)	(3.07)
Stage 2		-0.53	-0.57	-0.53	-0.57
		(0.60)	(0.67)	(0.61)	(0.68)
male		-0.73	-0.66	2.19	2.86*
		(1.34)	(1.54)	(1.33)	(1.49)
age		0.04	0.07	-0.01	0.03
		(0.07)	(0.10)	(0.06)	(0.08)
education (years)		0.03	-0.22	0.11	-0.23
		(0.25)	(0.34)	(0.20)	(0.25)
Poaching Perception			1.57		2.07*
			(1.38)		(1.14)
Union Effectiveness			-2.14		-2.77*
			(1.57)		(1.43)
Constant	16.54***	15.19***	14.39**	14.90***	14.93***
	(1.86)	(3.81)	(5.32)	(3.76)	(4.90)
Observations	234	234	176	234	176

T1=T2	0.000	0.000	0.000	0.001	0.005
T1=T3	0.009	0.011	0.010	0.001	0.002
T1=T4	0.000	0.001	0.007	0.002	0.036
T1=T5	0.053	0.068	0.080	0.034	0.104
T2=T3	0.592	0.559	0.498	0.461	0.380
T2=T4	0.921	0.923	0.670	0.937	0.513
T2=T5	0.226	0.201	0.147	0.194	0.088
T3=T4	0.581	0.613	0.398	0.452	0.208
T3=T5	0.243	0.230	0.179	0.123	0.053
T4=T5	0.307	0.256	0.377	0.265	0.403
T2=T3=T4=T5	0.592	0.562	0.440	0.400	0.145

Models 4-5 include fixed effects for community.

Table A2. Insider Earnings

	(1) Model 1	(2) Model 2	(3) Model 3	(4) Model 4	(5) Model 5
1. Poaching	0.00	0.00	0.00	0.00	0.00
	(.)	(.)	(.)	(.)	(.)
2. Indiv: Low Fine	1252.08***	1091.06**	1306.33***	1348.22***	1433.72**
	(433.88)	(412.15)	(445.37)	(466.67)	(535.04)
3. Indiv: High Fine	525.00	450.28	664.49	773.12*	752.86
	(544.15)	(534.40)	(568.27)	(453.11)	(492.94)
4. Vote: Low Fine	608.33	571.48	502.17	750.45	448.66
	(483.67)	(477.87)	(547.36)	(514.19)	(588.88)
5. Vote: High Fine	18.75	-105.92	-96.30	239.96	39.87
	(615.28)	(582.89)	(580.53)	(438.11)	(452.93)
Stage 2		-2.56	-29.55	-2.56	-29.55
		(140.83)	(146.68)	(142.42)	(148.95)
male		-533.83**	-497.94**	8.78	64.37
		(247.17)	(239.98)	(173.87)	(173.85)
age		5.62	9.76	-3.41	1.68
		(8.82)	(12.63)	(6.85)	(9.19)
education (years)		26.64	0.29	23.66	-20.35
		(41.90)	(51.50)	(28.47)	(32.67)
Poaching Perception			259.44		291.14
			(222.37)		(175.57)
Union Effectiveness			-187.50		-305.99*
			(212.78)		(152.39)
Constant	3308.33***	3277.74***	2973.62***	3208.07***	3124.35***
	(371.47)	(534.70)	(814.47)	(538.32)	(725.59)
Observations	234	234	176	234	176

T1=T2	0.006	0.012	0.006	0.006	0.011
T1=T3	0.341	0.405	0.250	0.096	0.135
T1=T4	0.216	0.239	0.365	0.153	0.451
T1=T5	0.976	0.857	0.869	0.587	0.930
T2=T3	0.119	0.146	0.207	0.151	0.111
T2=T4	0.100	0.156	0.090	0.086	0.028
T2=T5	0.028	0.018	0.012	0.010	0.003
T3=T4	0.870	0.811	0.787	0.960	0.526
T3=T5	0.428	0.362	0.255	0.200	0.086
T4=T5	0.316	0.230	0.332	0.287	0.433
T2=T3=T4=T5	0.078	0.057	0.049	0.046	0.014

Models 4-5 include fixed effects for community.

Table A3. Outsider Poaching

	(1) Model 1	(2) Model 2	(3) Model 3	(4) Model 4	(5) Model 5
1. Poaching	0.00	0.00	0.00	0.00	0.00
	(.)	(.)	(.)	(.)	(.)
2. Indiv: Low Fine	-10.96***	-11.10***	-11.07***	-11.44***	-11.18***
	(2.10)	(2.12)	(2.55)	(2.09)	(2.42)
3. Indiv: High Fine	-8.58***	-8.95***	-9.07***	-9.25***	-9.25***
	(2.47)	(2.46)	(2.22)	(2.14)	(2.05)
4. Vote: Low Fine	-9.11***	-9.40***	-10.13***	-10.20***	-12.27***
	(1.66)	(1.84)	(2.18)	(2.34)	(2.72)
5. Vote: High Fine	-6.04**	-5.82**	-4.89	-5.86**	-5.60*
	(2.68)	(2.71)	(3.24)	(2.51)	(3.08)
Stage 2		-1.47*	-1.28	-1.47*	-1.28
		(0.84)	(1.01)	(0.85)	(1.03)
male		0.12	-0.10	-1.41	-1.36
		(1.84)	(1.80)	(1.94)	(1.90)
age		-0.09*	-0.14**	-0.08	-0.12**
		(0.05)	(0.06)	(0.05)	(0.06)
education (years)		-0.19	-0.24	-0.22	-0.23
		(0.30)	(0.32)	(0.27)	(0.29)
Poaching Perception			0.45		-0.16
			(1.60)		(1.65)
Union Effectiveness			-0.06		-0.47
			(2.10)		(2.33)
Constant	18.71***	25.17***	28.11***	25.69***	28.82***
	(1.44)	(4.78)	(5.07)	(3.73)	(4.60)
Observations	234	230	180	230	180

T1=T2	0.000	0.000	0.000	0.000	0.000
T1=T3	0.001	0.001	0.000	0.000	0.000
T1=T4	0.000	0.000	0.000	0.000	0.000
T1=T5	0.030	0.038	0.139	0.025	0.077
T2=T3	0.353	0.395	0.479	0.305	0.416
T2=T4	0.298	0.320	0.732	0.491	0.697
T2=T5	0.080	0.065	0.086	0.023	0.072
T3=T4	0.809	0.847	0.682	0.681	0.266
T3=T5	0.406	0.310	0.224	0.144	0.196
T4=T5	0.212	0.169	0.131	0.088	0.062
T2=T3=T4=T5	0.355	0.313	0.356	0.149	0.234

Models 4-5 include fixed effects for community.

Table A4. Outsider Net Poaching Earnings

	(1) Model 1	(2) Model 2	(3) Model 3	(4) Model 4	(5) Model 5
1. Poaching	0.00	0.00	0.00	0.00	0.00
	(.)	(.)	(.)	(.)	(.)
2. Indiv: Low Fine	-2977.08***	-3242.90***	-2509.50***	-3291.85***	-2654.97***
	(361.65)	(488.01)	(604.65)	(682.16)	(679.41)
3. Indiv: High Fine	-6050.00***	-6035.54***	-5670.19***	-6291.77***	-6027.09***
	(1067.59)	(1031.54)	(856.80)	(935.45)	(736.10)
4. Vote: Low Fine	-4004.76***	-4164.05***	-3666.69***	-4159.79***	-4040.13***
	(436.28)	(491.22)	(613.46)	(677.92)	(698.96)
5. Vote: High Fine	-5270.83***	-5080.01***	-4878.15***	-4779.18***	-4509.93***
	(838.49)	(799.81)	(875.92)	(532.32)	(477.06)
Stage 2		-293.91	-197.78	-293.91	-197.78
		(305.45)	(304.81)	(308.96)	(309.42)
male		-1278.99***	-1141.65**	-1312.92***	-1219.76**
		(440.16)	(472.58)	(374.28)	(481.89)
age		5.79	1.81	-0.32	-1.29
		(12.56)	(16.40)	(9.82)	(13.72)
education (years)		110.17	143.12	3.31	4.60
		(73.43)	(93.81)	(56.52)	(68.23)
Poaching Perception			468.07		140.23
			(454.58)		(373.91)
Union Effectiveness			1259.81**		1483.42**
			(577.50)		(601.11)
Constant	3741.67***	3894.21***	2600.60	4723.39***	3659.18**
	(287.32)	(1091.54)	(1598.52)	(970.39)	(1372.04)
Observations	234	230	180	230	180

T1=T2	0.000	0.000	0.000	0.000	0.000
T1=T3	0.000	0.000	0.000	0.000	0.000
T1=T4	0.000	0.000	0.000	0.000	0.000
T1=T5	0.000	0.000	0.000	0.000	0.000
T2=T3	0.006	0.005	0.001	0.001	0.000
T2=T4	0.013	0.020	0.052	0.077	0.049
T2=T5	0.008	0.023	0.019	0.006	0.002
T3=T4	0.066	0.060	0.023	0.026	0.022
T3=T5	0.551	0.443	0.514	0.048	0.034
T4=T5	0.146	0.245	0.231	0.263	0.485
T2=T3=T4=T5	0.001	0.003	0.002	0.007	0.001

Models 4-5 include fixed effects for community.

Table A5. Insider Monitoring Investment (Avg per Individual per Round)

	(1)	(2)	(3)	(4)	(5)
	Model 1	Model 2	Model 3	Model 4	Model 5
2. Indiv: Low Fine	0.00	0.00	0.00	0.00	0.00
	(.)	(.)	(.)	(.)	(.)
3. Indiv: High Fine	0.94***	0.91***	1.00***	0.87***	1.07***
	(0.16)	(0.16)	(0.16)	(0.17)	(0.16)
4. Vote: Low Fine	0.41**	0.39**	0.52***	0.40**	0.55***
	(0.17)	(0.17)	(0.18)	(0.16)	(0.18)
5. Vote: High Fine	0.33**	0.29*	0.49***	0.25	0.51***
	(0.16)	(0.16)	(0.17)	(0.17)	(0.19)
Stage 2		0.00	-0.03	0.00	-0.03
		(0.06)	(0.06)	(0.06)	(0.06)
male		0.23**	0.19	0.17	0.20
		(0.11)	(0.12)	(0.12)	(0.12)
age		0.00	0.00	0.00	0.00
		(0.00)	(0.00)	(0.00)	(0.00)
education (years)		-0.00	-0.03	-0.00	-0.03
		(0.02)	(0.03)	(0.02)	(0.03)
Poaching Perception			0.08		0.10
			(0.12)		(0.13)
Union Effectiveness			-0.42***		-0.40***
			(0.12)		(0.12)
Constant	1.13***	0.96***	1.26***	0.75***	1.21***
	(0.11)	(0.25)	(0.31)	(0.27)	(0.37)
Observations	186	186	136	186	136

T1=T2					
T1=T3					
T1=T4					
T1=T5					
T2=T3	0.000	0.000	0.000	0.000	0.000
T2=T4	0.013	0.018	0.004	0.011	0.002
T2=T5	0.036	0.063	0.003	0.148	0.007
T3=T4	0.001	0.002	0.006	0.007	0.003
T3=T5	0.000	0.000	0.002	0.000	0.001
T4=T5	0.639	0.562	0.889	0.399	0.860
T2=T3=T4=T5	0.000	0.000	0.000	0.000	0.000

Models 4-5 include fixed effects for community.