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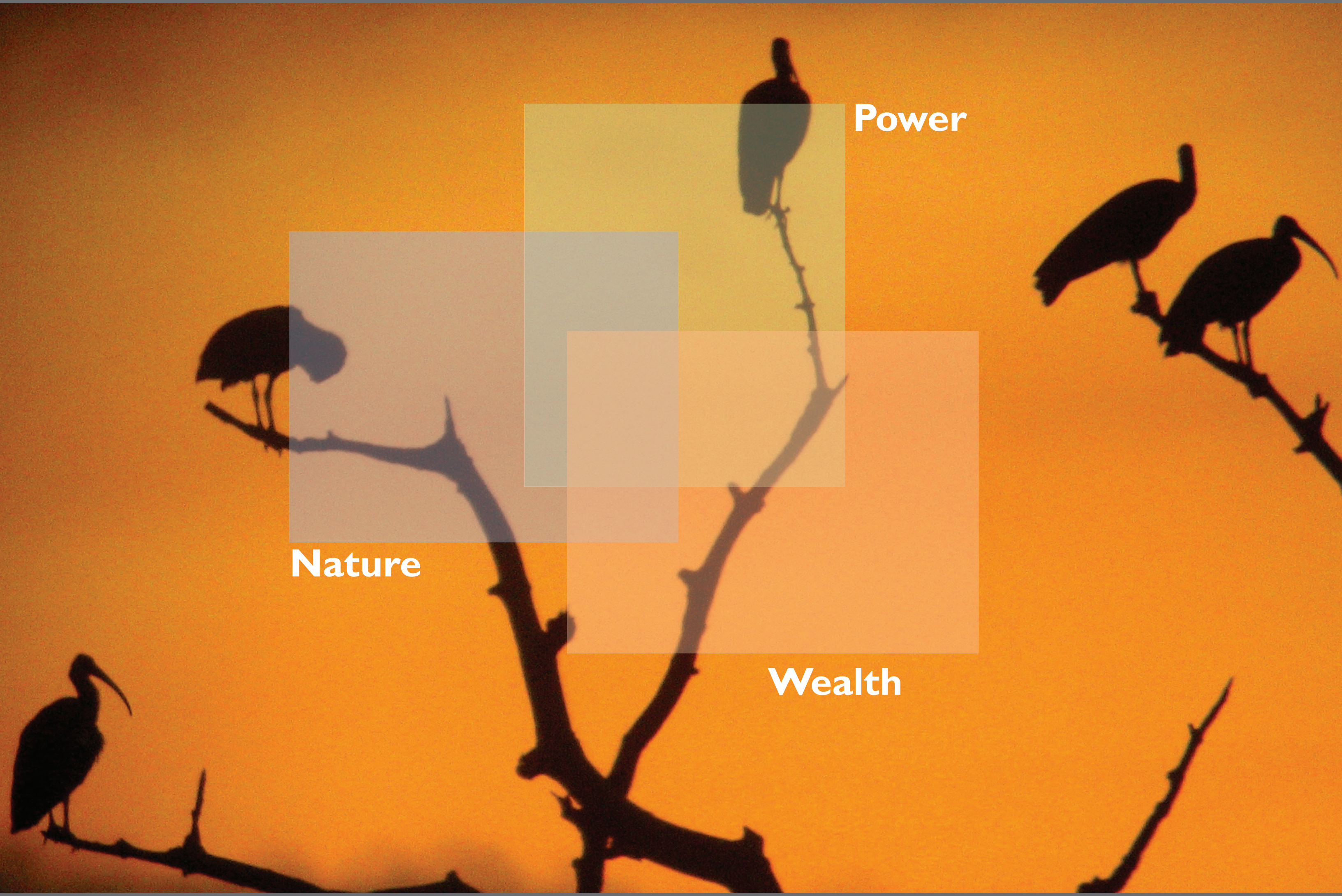

Leveling the Playing Field: The Effects of Institutional Controls on Common Pool Resource Extraction

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Case Study

Leveling the Playing Field: The Effects of Institutional Controls on Common Pool Resource Extraction

Report prepared for WCS TransLinks Program

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The Effects of Institutional Controls on Common Pool Resource Extraction

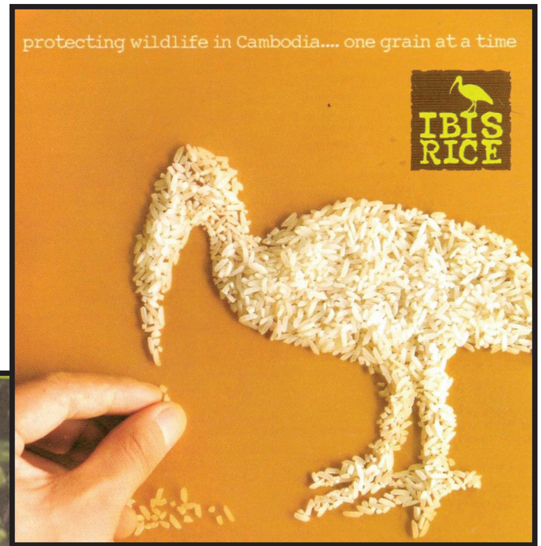
Table of Contents

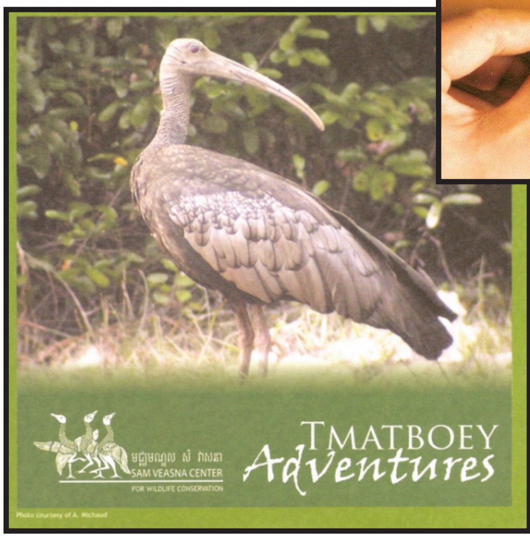
List of Figures

List of Tables

Abbreviations

AIC	Akaike Information Criterion
CPR	Common Pool Resource
FA	Forestry Administration
GLMM	Generalized Linear Mixed Model
ICDP	Integrated Conservation and Development Project
KHR	Khmer Riel
KPWS	Kulen Promtep Wildlife Sanctuary
LR	Likelihood Ratio
MoE	Ministry of Environment of the Royal Government of Cambodia
MAFF	Ministry of Agriculture, Forestry and Fisheries of the Royal Government of Cambodia
PES	Payment for Environmental Services
PG	Public Good
PLUP	Participatory Land Use Planning
PO	Pareto Optimum
PVPF	Preah Vihear Protected Forest
REDD	Reduced Emissions from Deforestation and forest Degradation
WCS	Wildlife Conservation Society





1 Executive Summary

Over 40 years ago, Hardin (1968) famously proposed two policy solutions to his ‘tragedy of the commons’: privatization and centralized government regulation. An extensive body of work since Hardin has demonstrated that there is a third potential policy intervention: facilitating collective management of the commons (Ostrom 1990, Baland & Platteau 1996). Nevertheless, the pace of degradation of common pool resources (CPRs) has accelerated. Within the past 10 years a fourth potential intervention, payments for environmental services (PES), has reached widespread acceptance. The principle of PES is to account for the externalities resulting from the degradation of service providing ecosystems. Most notably the global community is poised to embark on the most ambitious PES program proposed to date: reduced emissions from deforestation and forest degradation (REDD).

Despite the widespread interest in PES/REDD, the available evidence to guide policy is limited. Recent reviews (Wunder 2007, Ecol Econ Special Edition 2008) have tended to draw upon a small number of well-known examples. The majority of these have been implemented in cases where land is privately owned, or where governance is strong. Designing PES in the context of unclear property rights and weak institutions is challenging, and yet these are the conditions when conservation threats are greatest (Geist & Lambin 2002, Chomitz et al. 2007) and where implementing conservation is highly challenging (Barrett et al. 2001). A great deal more research is required if policy interventions are to be appropriately designed, especially for implementation of REDD. Critical research questions include whether payments should be offered individually or communally, and how payments might interact with other policies: property rights, governance, and collective action. The latter is of particular interest. While the conditions under which collective action arises and is effective are well documented (Agrawal 2001), a key research question is how collective action might be facilitated under sub-optimal conditions (Dietz et al. 2003). Payments might provide an external incentive for local people to develop collective action rules, if appropriately structured in the context of other interventions. Alternatively, payments might also crowd out incentives for collective action, leading to a poorer outcome than might otherwise have been achieved. Two very well-known examples of crowding out are the responses to offering payments to donate blood (Titmus 1970) and the fining of parents for arriving late to pick up their children after school (Gneezy & Rustichini 2000).

Although the need for evidence to inform policy is well known, the impact of environmental interventions is often not analyzed appropriately (Ferraro & Pattanyak 2006). Properly designed evaluations require comparison with the counterfactual: what would have occurred had the intervention not been implemented (Ferraro 2009), which typically requires randomized control trials or matched control samples, implemented over a long time frame (eg. Andam et al. 2008, Linkie et al. 2008). These may be costly to implement and provide evidence over too long a timeframe to guide current policy, but are extremely important. Behavioural economic games provide an alternative approach that has rarely been used in the context of environmental policy in developing countries (for a notable exception see Cardenas et al. 2004). One advantage of games is that they can be implemented in a controlled environment, and used to test for interactions between multiple policy interventions. Of course the extent to which the framing of the games can be generalized to reality determines the validity of the findings.

In this study a simple behavioral game was used to measure the response of groups of Cambodian farmers to a range of different policy interventions in a CPR dilemma, including enforcement, provision of individual and communal incentives, and opportunities for collective action. The farmers were put into groups made up of other residents of their village. Each individual within the group was able to extract from a shared resource up to their entitlement with the payoffs for the game structured so that the group optimum was reached if all subjects chose not to extract from the CPR. Individual optimums were reached if a subject chose to extract all of their entitlement. Various penalties and bonus payments were employed to mimic the different policy interventions considered. The game was implemented over a relatively short time period, and provided valuable evidence as to possible responses of individuals to the range of policy interventions.

The findings of the study provided no evidence to support the hypotheses that social peer pressure or weak external enforcement of no-take rules reduces extraction in the context of the commons dilemma. Increasing external enforcement penalties, however, was found to reduce extraction. Of the incentive structures considered, providing payments to collective groups resulted in greater reductions in extraction than giving individual payments, provided that the harvest threshold below which payments were awarded was sufficiently different from base extraction levels. The greatest reductions were observed for the institutional conditions which encouraged the highest levels of self-regulation within each user group. Not only did these conditions result in lower harvest levels but they were also found to interact with group decision-making to lower extraction further and to induce a level of cooperation that was robust to institutional change. For groups given the opportunity to allocate individual bonus payments within the group, aggregate payoffs came closest to the collective optimum and extraction reductions were the most cost effective of any intervention considered.

The study findings demonstrate the importance of considering how the institutional conditions associated with various policy interventions affect the behavioral response of resource users, particularly with regards to how they interact with existing collective action and social norms. The response of subjects to the conditions considered in the CPR game provides clear lessons for the design of future interventions. Firstly, it is important to recognize the risk that imposing external policies on resource users, whether through enforcement or the provision of payments, may result in crowding out existing informal mechanisms for collective action. In some cases this could result in the breakdown of extraction controls leading to further degradation of the resource. Alternatively, crowding out may simply reduce the cost effectiveness of policy investments. Implementing policies which encourage self-organization of user groups, such as the determination and regulation of a local system of rules regarding resource extraction, are more effective at controlling behavior than those imposed by external bodies.

The utilization of economic experimental games within the study provided the analytical framework for the comparison of behavioral responses to multiple policy interventions. Consequently, it was possible to evaluate the relative capabilities of different interventions in encouraging local cooperation and self-organization. Such assessment is invaluable in guiding the design of future conservation policy and the allocation of resources.

2 Background

2.1 Common Pool Resources

Many of the issues surrounding the protection of natural resources can be characterized by the common pool resource problem popularized by Hardin (1968) as 'the tragedy of the commons'. In his seminal article he described the process by which users of a common pool resource are forced to overexploit the very resource on which they rely. Examples of such a process include the overexploitation of fisheries (Pauly et al. 2002), the exhaustion of ground water aquifers (Gardner et al. 1997) and the destruction of forest resources (Ostrom 1999), as well as the example used by Hardin to illustrate his point, the degradation of shared pasture.

2.1.1 The Commons Dilemma

The issues surrounding CPRs are twofold: rivalry between users, often described as subtractability since extraction by one user reduces the resource available to others, and costly or impossible exclusion of other users from the resource (Ostrom et al. 1999). Due to the difficulties of exclusion from CPRs, users have little or no control over the appropriation behavior of others. The subtractability of the resource means that the actions of an individual produce an externality for others (Kollock 1998). Consequently, users of this type of resource are typically assumed to face a dilemma between maximizing their own benefit and acting in a manner consistent with the long-term management of the resource.

Until the late 1980s, many scholars advocated external controls on extractive behavior as the only solution to the commons dilemma, as it has come to be known (Ostrom 1990). These included state control, in which extraction is monitored and enforced by an external state institution, and privatization, in which access and extraction rights are controlled by a single individual or firm. Subsequently, considerable research effort has been focused on user-driven solutions. This research has taken the form of experimental measurement of human response to CPR conditions through social dilemma games (Section 2.2; Herr et al. 1997, Cardenas et al. 2000), theoretical modeling of behavioral response (McCarthy et al. 2001, Rodriguez-Sikert et al. 2008) and field observations of CPRs for which users have successfully and unsuccessfully arrived at institutions capable of coping with the issues of rivalry and non-excludability (Wade 1988, Ostrom 1990, Baland & Platteau 1996). This has led many authors to stress the importance of property rights regimes (Box 2.1; Feeny et al. 1990, Ostrom 1990, Cardenas 2008) and institutional controls on behavior (Ostrom 2003, Vatn 2007).

The need to define clear property rights to restrict use of CPRs has been emphasized repeatedly. Box 2.1 summarizes the different property rights regimes associated with access to CPRs. Open-access

Box 2.1: Property Rights Regimes (Feeny et al. 1990)

Open-access: exists in the absence of a defined property regime so that there are no limits to resource access for all individuals.

Private property: ownership of the resource rests with an individual (or company) who has the right to exclude others from accessing the resource.

Common property: access to and use of the resource is held equally by a group of independent individuals and may be recognized formally (*de jure*) or informally (*de facto*).

State property: rights of use and access are owned by the state which can then be allocated for different purposes. Can appear to be similar to common property when a community has *de facto* access to state property as a result of poor enforcement or monitoring (Cardenas 2008).

resources translate to the situation described by Hardin in which overexploitation leads to rent dissipation and possible destruction of the resource itself. The alternatives all contain some controls on both access and extraction rights whether these are enforced centrally (state property), by private individuals (private property) or by user groups (common property). Ostrom (1990) asserts that the definition of property rights, while necessary, is not sufficient to limit extraction without investment in institutions to manage and enforce those rights.

In *Leviathan*, Hobbes (1651) proposes that in order to avoid the 'state of nature', in which all individuals are at war with one another, there must be a sovereign institution to which all subjects are answerable. In other words, it is necessary to have an institution which governs everyone in order to achieve a state of cooperation. A number of institutional conditions have been proposed to facilitate the long-term sustainability of common pool resources drawing on case studies of successful management (Box 2.2). These include user-determination of rules and resource access, low-cost monitoring, graduated sanctioning and ease of enforcement (Wade 1988, Ostrom 1990, Baland & Platteau 1996).

2.1.2 Common Pool Resources vs. Public Goods

CPRs and public goods (PGs) are both characterized as N-person social dilemmas in which the actions of an individual affect the well-being of the group. The critical difference between the two is that of subtractability (Kollock 1998). In PG contexts, individuals must make a choice of whether or not to contribute to the provision of a public good such as paying the license fee for access to public television. Like CPRs, PGs are non-excludable. Unlike CPRs, however, PGs are non-rival, so that use by one individual does not diminish the amount available to other users. Whereas CPRs largely focus on goods which are already present, PGs are chiefly concerned with

Box 2.2: Design Principles for Institutional Conditions Required for Solutions to the Commons Dilemma (Ostrom 1990, Agrawal 2001)

Simple rules: users must be able to understand extraction rules. Over complicated rules are likely to be misunderstood and hence ignored.

User self-determination of rules and resource access: self-determination allows rules to be tailored to the individual characteristics of different CPRs since users are better positioned to understand requirements.

Rules easy to monitor and enforce: creating a situation where internal monitoring is a natural by-product of extraction reduces costs and increases monitoring efficiency.

Graduated sanctioning: lenient sanctioning of first time offenders avoids the risk of resentment and crowding out of compliance norms. Heavy sanctioning of repeat offenders is required to avoid breakdowns in compliance.

Monitors accountable to resource users: accountability reduces the risk of 'slacking off' whilst providing incentives for effective monitoring.

Users' authority to devise and enforce rules recognized by central government: recognition of user self-determination and self-regulation as legitimate reduces the fear that efforts to control extraction may be undermined.

providing a good which would not otherwise exist (Goetze 1994). Van Dijk and Wilke (1995) present evidence that subjects behave more equitably to the same payoff function when framed as a CPR rather than PG dilemma.

In the particular case of endangered species and landscapes, the problem is complicated by the perception that the resource in question is a global public good, therefore requiring a solution to be found for both the commons dilemma and the externality generated through use of the resource (Cardenas 2004).

2.2 Experimental Games

Experimental games have been used by social and economic researchers to investigate collective action in a wide range of contexts, of which CPRs form just one (Ledyard 1995, Henrich et al. 2005). The conclusions drawn from such games can be used to inform expectations of behavior within CPR settings. The strict control possible within these games offers researchers the opportunity to measure the responses to different institutional environments of interest (Ledyard 1995). Common results from experimental games are given in Box 2.3.

Box 2.3: Common Collective Action Findings From Experimental Games

Initial cooperation: contrary to rational choice theory, many studies have found that initial cooperation is most often between 40-60% (Ostrom 2000).

Decline in cooperation over time: in iterated games, in the absence of institutional control on behavior, cooperation tends to decline over time (Ostrom 2000).

People can be grouped into different cooperator types: cooperative behavior can be characterized by three principal types – conditional cooperators, free-riders and altruists.

Communication increases cooperation: the opportunity to communicate in collective action settings improves rates of cooperation (Ostrom et al. 1992, Cardenas et al. 2000).

Peer-pressure increases cooperation: internalization of social norms can lead to peer-pressure alone being sufficient to elicit cooperation (Rege & Telle 2004).

Enforcement can crowd out: external enforcement can undermine existing social controls on behavior, reducing cooperation (Cardenas et al. 2000).

Incentives can crowd out or crowd in: financial incentives can also be seen to undermine existing social controls on behavior but may conversely act to reinforce such controls (Deci et al. 1999).

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2.3 Study Area

2.3.1 The Northern Plains

The Northern Plains landscape of Cambodia represents some of the largest remaining intact areas of the Lower Mekong Dry Forest Ecoregion (Olson et al. 2001), dominated by deciduous dipterocarp forests. The region was identified as a conservation priority in the National Biodiversity Strategy and Action Plan (MoE 2002) and is of global importance for the conservation of rare avifauna, containing key breeding sites for threatened species such as the critically endangered white-shouldered ibis (*Pseudibis davisoni*) and giant ibis (*Pseudibis gigantea*). The landscape's forests are also known to contain many globally threatened mammal species such as Asian Elephant (*Elephas maximus*), gaur (*Bos gaurus*), dhole (*Cuon alpinus*), sun bear (*Helarctos malayanus*) and Eld's deer (*Cervus eldii*). The Northern Plains was isolated during the 1970s-90s due to ongoing civil war and conflict. Conservation activities were initiated by WCS in collaboration with the Ministry of Environment (MoE) and the Forestry Administration (FA) of the Ministry of Agriculture, Forestry and Fisheries (MAFF) in 2000, with the aim of restoring wildlife populations in the region to historical levels (WCS 2004). Activities focus on two protected areas: Kulen Promtep Wildlife Sanctuary (KPWS), managed by MoE, and Preah Vihear Protected Forest (PVPF), managed by MAFF.

Household income is a serious issue in the region, with 85% of the population estimated as living in poverty (McKenney et al. 2004). The principle livelihood activities of the communities which live within the reserve are sedentary rain-fed paddy-field rice cultivation, shifting agriculture (chamkar) and harvesting of NTFPs, notably wildlife and liquid resin from dipterocarp trees. Recent work in the area has shown that resident communities are highly dependent on forest resources (Evans 2003, McKenney et al. 2004) with one study indicating that the use and sale of these resources makes up 49% of the income of poorer

Forest cleared for paddy-field cultivation households (McKenney et al. 2004) and provides a critical safety net. Resin-tapping is particularly important because it represents one of the few stable sources of cash income, providing households with the resources to purchase goods, pay schooling costs and medical expenses, and purchase rice if household production is insufficient.

The main threats to the forest come from land clearance for cultivation, both by legal communities and immigrants to the reserve, and from the unsustainable extraction of forest resources. Land is a valuable asset and it is believed that households may be motivated to clear more land than they are able to cultivate as a means of staking claim to this resource (Dara 2008). Families will often reserve land by marking it, even if areas are not immediately cleared, and these 'land claims' are recognized by other members of the village. This forces newly formed households and arriving in-migrants to clear land further into the forest (Dara 2008). The conservation strategy implemented by MoE and the Forestry Administration (FA), with the support of WCS, recognizes the importance of designating sufficient land for community agriculture while demarcating and enforcing negotiated forest boundaries. The basic tool used to negotiate zones with local communities is participatory land-use planning (PLUP). Following the negotiation and demarcation of these boundaries a mixture of enforcement (by MoE and FA) and incentive programs are being used to ensure that communities abide by the land-use plans.

1. **Ecotourism**: Since 2004, WCS has initiated an ecotourism scheme facilitating the visits of international birdwatchers to villages within KPWS and PVPF, in partnership with a local NGO, Sam Veasna Centre for Wildlife Conservation (Clements et al. 2008). In addition to the direct benefits of some individuals within the village through employment and for services such as the provision of firewood, all tourists pay into a communal fund managed by a locally elected committee. Tourism revenue is dependent on contracts signed by the villages committing to stop hunting activities and comply with land-use agreements (Clements et al. 2008).
2. **Agri-Environment Payments (Ibis Rice)**: Under this scheme, initiated in 2007, farmers who agree not to expand agricultural land or hunt are paid a premium for certain varieties of rice. This rice is sold to a cooperative, Sansom Mlup Prey, which is able to give preferential prices by selling on to hotels and restaurants under the 'Wildlife Friendly' certification (Clements et al. in press).
3. **Birds' Nest Protection Payments**: Due to the prevalence of critically endangered bird species, WCS has initiated a scheme whereby individuals are paid under contract to protect the nests of particular species of birds. This program is an example of performance payments since contractors are paid $1.25 for every day that they protect the nest plus an additional $1.25 per day if the chicks successfully fledge (Clements et al. in press).

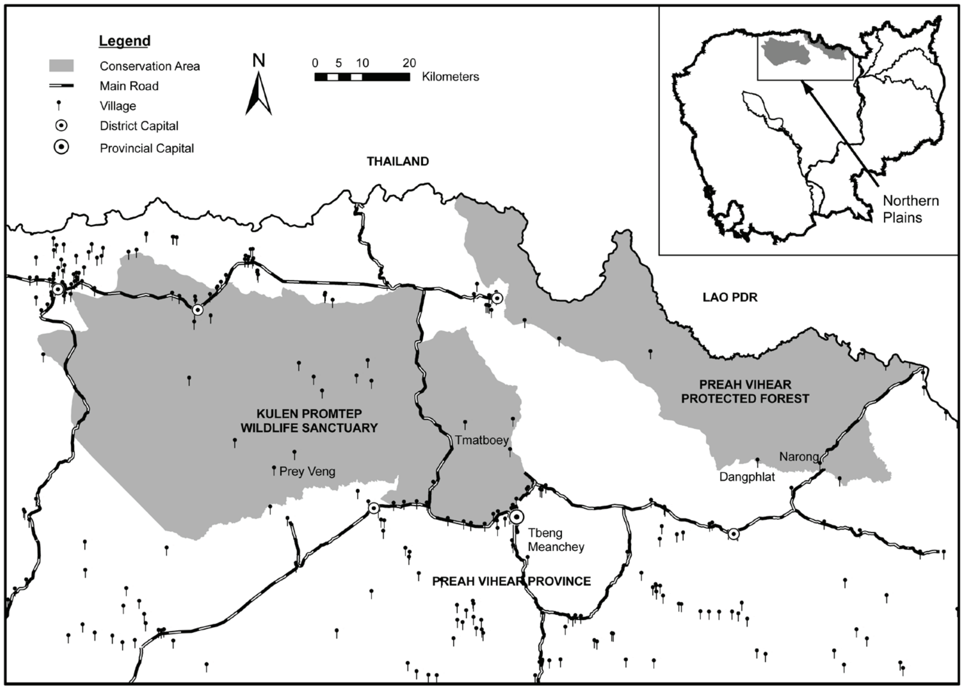

Figure 2.1: Map of study area.

2.3.2 Study Villages

There are four villages within the Northern Plains Landscape where WCS has the greatest presence: Dangplet, Narong, Prey Veng and Tmat Boey (Figure 2.1).

Governance within each village is provided by a locally-elected committee which manages PLUP agreements, a locally-elected village chief responsible for administration who also acts as an advisor to the PLUP committee, and a system of traditional village elders. Decision-making in the home is largely conducted by the family-head, generally the eldest male or his widow.

The study village populations range between approximately 350 in the smallest to 1050 in the largest. Ethnicity in the area is primarily Khmer with a small minority of Kui.

3 Methods

The following section describes the methods used for data collection and subsequent statistical analyses. The fieldwork for data collection was conducted between 17th June and 16th July, 2009. This consisted of a pilot study and subsequent data collection in each of the 4 study villages.

3.1 Data Collection

Data collection took the form of a repeated CPR game played under different treatment conditions. Since the games were played during the school holidays, all games were conducted in local classrooms. Participants were selected by the local village chief using the following guidelines:

- no more than one person from each immediate family to participate
- approximately equal proportions of men and women each day
- approximately even distribution of ages each day
- each part of the village should be sampled

In one village, Prey Veng, more than one person was allowed from each family because there were insufficient families to provide the required number of players. Members of the same family played on the same day but never in the same group. The purpose of this was to minimize contamination which can occur when a subject who has already participated in the experiment recounts the game to someone who has not yet participated. This can cause unknown effects on the results (Barr, pers. comm.).

Once participants had assembled, basic demographic information was taken and the game was explained. This explanation took approximately one hour during which time participants played one practice round and were taken through four examples (refer to Appendix 1 for greater detail). After the games had been finished for the day a short interview was conducted with individual players, who were then paid in Cambodian Riel (KHR). Payment included a participation fee of $1 per person.

3.1.1 Experiment Structure

The game was framed as a resource extraction problem familiar to all participants. It was explained that there was a communal fishing pond containing 100 fish to which all group members had access and use rights. In each round $t \in \{1, \ldots, 5\}$ player $j \in \{1, \ldots, n\}$ could withdraw a portion of their entitlement $a \in \{0, 1, \ldots, 10\}$ from the common resource. For each fish that participants harvested they received 80 KHR and for each fish left in the pond every member of the group received 12 KHR, representing the value to future harvests. Depending on the treatment played participants were subject to enforcement penalties (p) or incentive payments (ε). Payoffs were static such that for each round they were given by ***Equation 1***.

$$\pi_j = 80a_j + 12\left(100 - \sum_{i=1}^{n} a_i\right) + p - \varepsilon$$

80 subjects participated in the experiment in each of 4 study villages over the course of 4 days, such that 20 subjects played on each day. Each participant played 3 treatments: the control plus 2 others from a possible 8 (Table 3.1). The order in which the treatments were played was changed for each village such that no treatment was played more than once on the equivalent day in different villages and each treatment was played at least once in each equivalent period of a day (except the control which was played once each day). Each treatment was played in groups of n=10 with group composition systematically randomized

Table 3.1: Treatments played over the course of the experiment.

Treatment	Observations	Policy Intervention
control	32 groups of size n=10	none
peer pressure	8 groups of size n=10	social (dis)approval
weak third party enforcement	8 groups of size n=10	external enforcement
strong third party enforcement	8 groups of size n=10	external enforcement
external individual incentives	8 groups of size n=10	individual incentives
internal individual incentives	8 groups of size n=10	individual incentives
weak communal incentive	8 groups of size n=10	communal incentive
low/strong communal incentive	8 groups of size n=10	communal incentive
high/strong communal incentive	8 groups of size n=10	communal incentive

between treatments. Treatments were repeated so that each was played for 5 rounds. Decisions were marked on results sheets (Appendix 2) with assistance given to illiterate subjects.

3.1.2 Treatments

The control treatment was conducted in anonymous conditions so that participants were unaware of who else was playing in their group. Communication between players was not permitted. At the end of each round feedback was given on individual payoffs and the total extraction from the pond. In all other treatments subjects were sat in their groups and were permitted a period of discussion before they made their individual decisions. Once individual decisions had been made subjects were required to verbally feedback to other group members their individual extractions and payoffs. This was the base condition which was used to investigate the effects of peer pressure.

In the third party monitoring and enforcement treatments participants faced the possibility of incurring penalties. A 10-sided die was used to determine which player would be monitored each round. If the monitored player had chosen to extract any fish from the communal resource they were subject to a penalty (p). For the weak enforcement treatment a low penalty of 20% of the participant's earnings for that round was used and for the strong enforcement treatment a high penalty of 80% was used such that the expected payoff for each individual was given by ***Equation 2***.

$$\pi_j = \begin{cases} 80a_j + 12\left(100 - \sum_{i=1}^{n} a_i\right) & \text{if } a_j = 0 \\ 80a_j + 12\left(100 - \sum_{i=1}^{n} a_i\right) - 0.1p & \text{otherwise} \end{cases}$$

In the individual incentive treatments participants had the possibility of receiving an incentive of 200 KHR. For the external treatment the allocation process was designed to mimic imperfect awarding of payments for environmental services. Each round, the 5 participants who had taken the least fish from the pond were identified. If there was a tie for the fewest number of fish the cut-off was increased to accommodate this. A die was then rolled to decide which two participants would receive the incentive for that round. For the internal treatment incentives were allocated by the group with each participant given one vote per round. The two participants with the most votes received the incentive. Payoffs were given by ***Equation 3***.

$$\pi_j = \begin{cases} 80a_j + 12\left(100 - \sum_{i=1}^{n} a_i\right) + 200 & \text{if payment received} \\ 80a_j + 12\left(100 - \sum_{i=1}^{n} a_i\right) & \text{otherwise} \end{cases}$$

In the communal incentive treatments, a threshold was placed on the number of fish harvested from the pond. If the group harvested less than the threshold each individual participant would receive an incentive (Table 3.2). This was designed to mimic collective benefits from conservation programs such as ecotourism with varying levels of conditionality and incentives. The payoffs used were given by ***Equation 4***.

$$\pi_j = \begin{cases} 80a_j + 12\left(100 - \sum_{i=1}^{n} a_i\right) + \frac{\varepsilon}{n} & \text{if } \bar{a}_i < \psi \\ 80a_j + 12\left(100 - \sum_{i=1}^{n} a_i\right) & \text{otherwise} \end{cases}$$

3.2 Statistical Analysis

Statistical models were constructed with the number of fish taken by an individual in each round as the response variable. All statistical analysis was carried out using the software package R version 2.9.0 (R Core Development Team 2009). Mixed effects models were used to account for pseudo-replication due to the clustered nature of the data in which observations were crossed within a hierarchical structure

Table 3.2: Communal incentive treatment summary.

Treatment	Extraction Threshold (ψ)	Incentive (ε)
weak communal incentive	50 fish	200 KHR
low/strong communal incentive	20 fish	200 KHR
high/strong communal incentive	20 fish	400 KHR

(Hedeker 2005). Due to the non-normality of the data it was necessary to use generalized linear mixed effects models (GLMMs; Bolker et al. 2009). A logit link function was used to account for the binomial error structures of the response variables. Laplace approximation was used to estimate model parameters (Raudenbusch et al. 2000). Analysis of GLMMs was undertaken using the lme4 package version 0.999375-31 (Bates & Maechler 2009) within R.

GLMMs were fitted using backwards stepwise selection of fixed effect variables. The fixed effects structures were simplified using the Akaike information criterion (Akaike 1974). If AIC values differed by >2 models with the lowest AIC were selected. For models with a difference in AIC of <2, models with lower degrees of freedom were selected (Burnham & Anderson 2002). Random effects were fitted using likelihood ratio (LR) tests.

For GLMMs, the parameter estimate for each fixed effect is found keeping all other effects at their baseline level. The baseline value depends on the data type for each variable so that for categorical variables it is a specific level and for continuous and binary variables it is the lowest value recorded. Setting all variables to their baseline gives the model intercept. For multi-level categorical variables the parameter estimate is interpreted as the effect size in comparison to the baseline level. For continuous variables the parameter estimate is interpreted as the effect of a unit increase in the explanatory variable.

The output of the binomial logit function was converted using ***Equation 5***. For each predictor variable this gives an estimate of the difference in the mean number of fish (DF) taken between the intercept and the variable or level being analyzed.

$$DF = 10\left(\frac{1}{1+e^{-(x_1+x_{ji})}} - \frac{1}{1+e^{-x_1}}\right)$$

where x_1 is the logit parameter estimate for the model intercept and x_{ji} is the logit parameter estimate for variable j, level i.

4 Results

4.1 Control

Figure 4.1 shows the average number of fish taken in each round for the control treatment. The average number of fish taken in the initial round was 5.44 (sd = 3.11), corresponding to a percentage of 54.4%. This is within the range of the 40-60% most commonly reported from dilemma game experiments (Ostrom 2000). With respect to the evolution of extraction over time, Figure 4.1 shows a continuous increase in the average number of fish taken, which is again consistent with common findings from iterated experiments (Ostrom 2000).

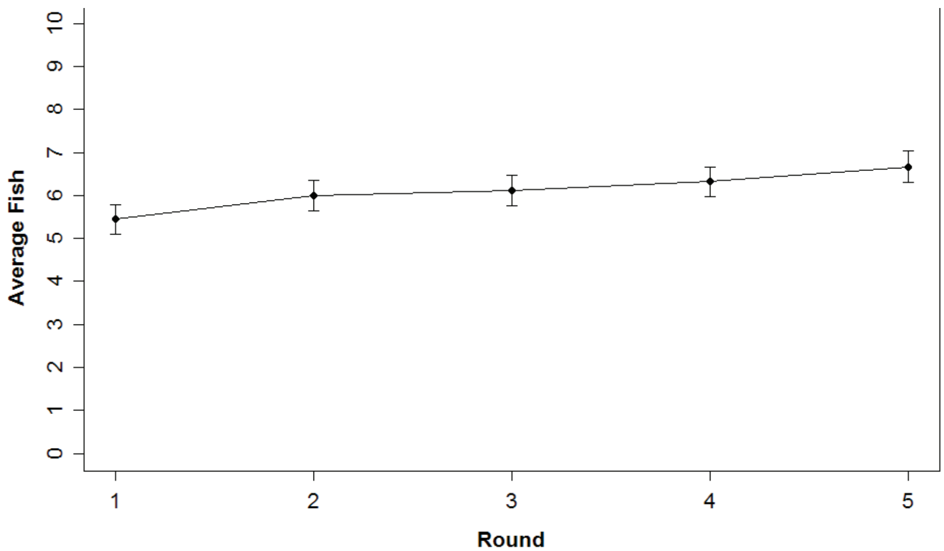

Figure 4.1: Average number of fish taken each round for the control treatment. Error bars show the 95% confidence interval.

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Box 4.1: Summary Findings for the Control Treatment

Initial extraction: initial extraction from the CPR was 54.4%.

Continued decline in cooperation: extraction from the CPR increased continuously between rounds.

The parameter estimates for the fixed effect predictors of the control model (Table A.1) suggest that some treatments produce a learning effect which influenced behavior in the subsequent treatment despite a change in institutional conditions. The weak conditionality communal incentive treatment increased the number of fish taken in the control by 1.50 fish per person compared with cases when no treatments had been played previously (p = 0.025). The internally allocated individual incentive treatment was the only treatment which reduced the number of fish taken (difference in fish = -1.62, p = 0.009). The day had a significant effect on the number of fish taken. This suggests that there was contamination between subjects, with participants discussing the experiment with those who played on later days.

4.2 Description of Treatments

Summary statistics for the number of fish taken in each treatment are presented in Table 4.1. Given the large number of confounding variables it is difficult to draw many conclusions from this data without statistical modeling. In general all treatments, bar the weak enforcement treatment, had averages lower than the control.

Table 4.2 gives the mean and variance for the total number of fish taken per group for the individual and communal incentive treatments. From this table it is clear that there is considerably greater variation for the communal incentive treatments than for the individual incentive

Table 4.1: Summary statistics for the number of fish taken during each treatment.

	No. of	No. of fish taken	
Treatment	participants	mean	std. dev.
control	319	6.1	3.21
peer pressure	80	5.35	3.38
weak enforcement	79	6.47	3.1
strong enforcement	79	4.65	3.39
external individual incentives	80	5.1	3.42
internal individual incentives	80	3.1	3.23
weak communal incentives	79	4.88	2.53
low/strong communal incentives	79	3.76	3.37
high/strong communal incentives	80	3.82	3.44

treatments despite comparable means. This suggests that communal incentives increase the volatility of behavior by making payoffs more clearly dependent on the behavior of other group members.

The success rate of the two individual incentive treatments in rewarding those individuals who took the least fish differed markedly. Only 12.5% of the externally allocated incentives were actually awarded to the two group members who took the lowest number of fish, as opposed to 65% for the internally allocated incentives. This is despite uncertainty with respect to how the incentives were to be awarded. When questioned during the post-game interviews, 13 of 26 respondents said that they voted for their friends or for people who had voted for them.

Of the communal incentive treatments, those with strong conditionality had averages well above the threshold of 2 fish per person. The weak communal incentive treatment had an average just below that of the threshold of 5 fish per person. This difference in the effect of conditionality can also be seen by comparing the number of times in which individual groups were successful at achieving the group incentive. For the weak communal incentive treatment, groups achieved the incentive 57.5% of the time, whereas only 32.5% and 27.5% of attempts were successful in achieving the incentive for low and high strong treatments respectively. Across the three communal treatments nearly 20% of all attempts to achieve the incentive failed by 5 or fewer fish per group.

Table 4.2: Group extraction summary for the individual and communal incentive treatments.

	Group total no. of fish taken	
Treatment	**mean**	**variance**
external individual incentive	40.8	98.8
internal individual incentive	24.78	174.9
weak communal incentive	39.01	327.4
low/strong communal incentive	30.08	367.8
high/strong communal incentive	30.56	370.9

Box 4.2: Summary Descriptive Findings

Response volatility: response to financial incentives was more volatile for collective rather than individual payments

Incentive success: internally awarding incentives was more successful at rewarding group members who took the fewest fish than the external mechanism

Thresholds: groups during the weak collective incentive treatment were more successful (57.5%) at achieving the incentive than groups playing the strong treatments (30%)

4.3 Statistical Analysis of Treatment Results

The factors affecting the number of fish taken during all the treatments were investigated with a GLMM. The selected GLMM included 7 explanatory variables (Table A.2). The confounding effects of increasing round number and day were controlled for through inclusion in the model. Of the demographic variables considered in the analysis only gender and years in education were included as explanatory variables in the final selected model (difference in fish = -0.47 and 0.08 respectively).

Figure 4.2 shows the relative effects of the different treatments considered in the GLMM. No significant effect was found on the number of fish taken in comparison with the control for the peer-pressure treatment ($p = 0.482$). Consequently, there is no evidence to suggest that social approval or disapproval alone are sufficient to decrease extraction in a CPR context. The parameter estimate for the weak enforcement treatment suggests that weak enforcement penalties did not reduce extraction ($p = 0.193$). On the other hand, the parameter estimates for the strong enforcement treatment suggests that high enforcement penalties did reduce extraction from the CPR (difference in fish = -1.45, $p = 0.010$). This implies that increasing enforcement penalties can decrease extraction.

Rearranging the treatment levels to use the weak enforcement treatment as the baseline for the analysis allows a direct comparison of the effects of weak enforcement and other treatments (Table A.3). This shows that all reduced the number of fish taken in comparison with the weak enforcement treatment bar the control, peer pressure and weak communal incentive treatments (Figure 4.3). Consequently, while there is no evidence to show that intrinsic motivation is crowded out by

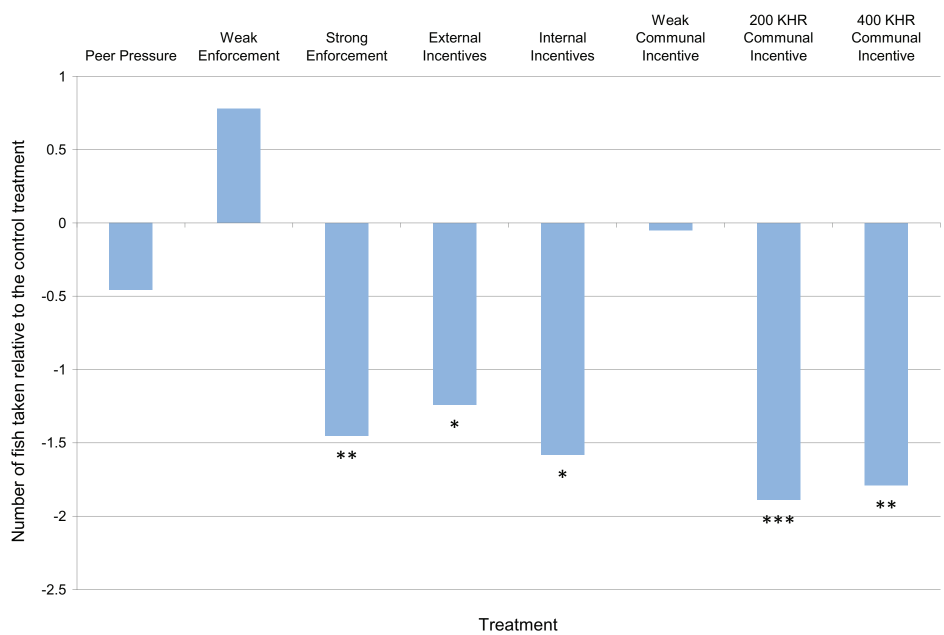

Figure 4.2: Effect estimates for treatment variable of the simplified model in comparison to the baseline control treatment. Difference in fish given by Equation 5. For full parameter results refer to Table A.2 in the Annex.

weak enforcement, the parameter estimates (Figure 4.3) do suggest that weak enforcement performed poorly in comparison to the other treatment conditions.

The parameter estimates for the GLMM analysis of the number of fish taken (Figure 4.2) suggest that the two individual incentive treatments had a similar effect in reducing extraction from the CPR, although internally allocating the incentives had the stronger effect (difference in fish = -1.24 and -1.58 for the externally and internally allocated incentives respectively). Hence, there is some evidence to suggest that internally allocated incentives result in a greater reduction in extraction than externally allocated incentives.

The GLMM analysis (Figure 4.2) found no significant effect on the number of fish taken for the weak communal incentive treatment ($p = 0.938$) but a large effect for both the strong treatments. This indicates that the strong communal treatments were more effective at lowering extraction than the weak treatment. Increasing the size of the payoff from 200 KHR to 400 KHR had no discernable direct effect on extraction behavior for the strong conditionality treatments.

Overall, the effect size in the reduction in fish taken from the CPR compared to the control was roughly equivalent for all treatments bar the peer pressure, weak enforcement and weak communal incentive treatments, ranging from a reduction of 1.24 fish for the externally allocated individual incentive treatment, to 1.89 for the communal incentive treatment with strong conditionality and 200 KHR incentive. The three strongest effects were seen for the three treatments in which the level of self-organization required by participants was

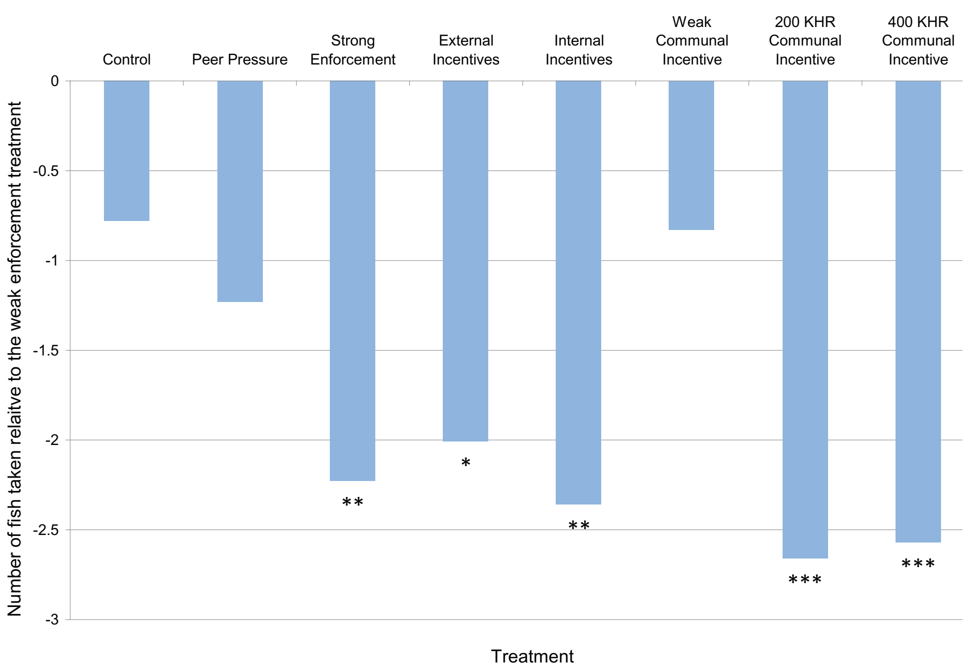

Figure 4.3: Effect estimates using the weak enforcement treatment as the model baseline. Difference in fish given by Equation 5. For full parameter results refer to Table A.3 in the Annex.

greatest: the internal individual incentives and strong communal incentive treatments. For the internally allocated individual incentive, subjects were dependent on the votes of other group members if they wanted to receive the bonus payment, increasing the motivation to be seen to be cooperative. For both the strong communal incentive treatments, receipt of the incentive was dependent on coordination of all extraction within the group. Although the weak communal incentive treatment also required coordination of extraction efforts, the incentive to do so was weaker than the strong treatments as the threshold was much closer to the mean extraction observed in the peer pressure treatment, the baseline group treatment. This suggests that the incentive structures which more obviously require self-organization are more effective at reducing extraction than the other treatments considered.

A learning effect was found when both the internally allocated individual incentive and the 400 KHR strong conditionality communal incentive treatments preceded another treatment. In both cases this resulted in a reduction in extraction in the subsequent treatment in comparison with no treatments being played previously (Table A.2). There was also a marginal result for the 200 KHR strong conditionality communal incentive treatment (p = 0.056) suggesting that with greater power an

Box 4.3: Summary Findings for Statistical Modeling

Peer pressure: social approval/disapproval had no significant effect on reducing extraction from the CPR.

Enforcement penalties: increasing enforcement penalties significantly reduced extraction from the CPR.

Enforcement crowding out: weak enforcement performed poorly relative to other institutional conditions but was not found to crowd out intrinsic motivation.

Individual incentive allocation: internally allocated individual incentives had a greater effect in reducing extraction from the CPR.

Communal incentive conditionality: increasing the conditionality applied to the communal incentives reduced the extraction from the CPR.

Communal incentive magnitude: increasing the payment size for the strong communal incentive treatments had no effect on extraction from the CPR.

Self-organization: treatments allowing higher levels of self-organization had the greatest effect in reducing extraction for the CPR.

Learning effect: treatments requiring self-organization induced a level of cooperation which was robust to institutional change.

effect might be detected. Overall this implies that conditions promoting a greater degree of self-organization support a level of cooperation which is retained in the subsequent treatment, even after a change in institutional structure.

4.4 Effect of Group Decision-Making

One of the strongest effects in reducing the number of fish taken was seen when a group decision was recorded (difference in fish = -1.48, p <<0.001), emphasizing the importance of user self-organization in determining extraction. It was not possible to fit a model containing interaction terms between the treatment played and whether or not a decision was made due to the strong co-linearity between the product and constituent terms. Consequently, the data was split into 2 separate sub-groups: one in which decisions were made and one in which they were not. These sub-groups were then analyzed with the random and fixed effect structures originally selected using the whole data set. Since it was not possible to make a decision during the control, the peer pressure treatment was used as the baseline treatment for the analysis (Table A.4). Figure 4.4 shows the parameter estimates of these two models for the different treatments.

This suggests that when a decision was made there was a strong reduction in extraction in comparison with the peer pressure treatment for the three treatments requiring higher levels of self-organization. This effect was only seen when a decision was made, indicating that an interaction between the two variables was present. This suggests that when a decision is made by the group as to how many fish to extract, the presence of incentive structures requiring group self-organization has a strong effect in reducing extraction from the CPR.

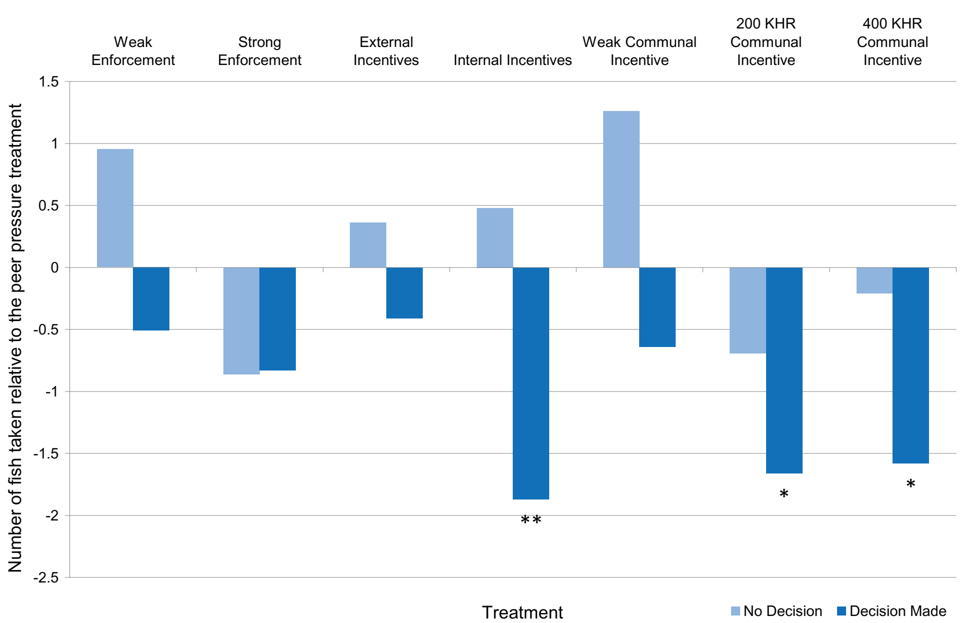

Figure 4.4: Effect estimates for the two split dataset models with peer pressure as the model baseline. Difference in fish given by Equation 5. For full parameter results refer to Table A4 in the Annex.

Box 4.4: Summary Findings for Cost Efficiency and Effectiveness

Efficiency: groups were most efficient at achieving the Pareto optimum for the internally allocated individual incentive treatment.

Cost effectiveness: internally allocated individual incentives were found to be the most cost effective means of achieving reductions in extraction from the CPR.

4.5 Cost-Efficiency and Cost-Effectiveness

The payoffs for each treatment give a measure of how well participants were able to negotiate the different institutional conditions. Each treatment has a specific Pareto optimum (PO), the point at which any deviation in behavior which would result in an improvement in the payoff of one individual would also result in the reduction of the payoff for at least one other individual (Binmore 2007). Comparison of the average payoffs achieved for each treatment against the average earnings at the Pareto optimum therefore provide a measure of efficiency in negotiating the institutional conditions of each treatment. This is preferred to comparison with Nash equilibria since there are multiple equilibria for treatments where incentives are dependent on the behavior of others (Fehr & Falk 2002). This comparison is shown in Table 4.3.

The two individual incentive treatments attain the highest efficiencies, achieving 85.5% and 90.0% of the PO respectively. The communal incentive treatment with strong conditionality and 400 KHR incentive has the lowest efficiency despite having the highest average payoff of all treatments. This is because many groups failed to achieve the target threshold.

Table 4.3: Comparison of mean payoffs against mean Pareto optimal payoffs. Efficiency is given as a percentage.

	Pareto comparison		
Treatment	mean payoff [KHR]	PO [KHR]	efficiency
control	955	1200	79.6
peer pressure	986	1200	82.2
weak enforcement	910	1200	75.9
strong enforcement	943	1200	78.6
external individual incentives	1036	1240	83.5
internal individual incentives	1116	1240	90
weak communal incentives	1113	1400	79.5
low/strong communal incentives	1132	1400	80.9
weak/strong communal incentives	1167	1600	73

The cost effectiveness of the different incentive structures was considered. Table 4.4 compares the total value of the incentives given for each of the incentive treatments with the reduction in individual extraction from the CPR for each treatment. This gives a measure of the cost effectiveness of each incentive structure considered, neglecting the costs of associated monitoring. This suggests that internal allocation of individual incentives is the most cost effective of all the incentive structures considered, with external allocation of individual incentives and 200 KHR strong communal incentives also performing well.

Table 4.4: Comparison of effect against cost for each of the incentive treatments.

	Cost effectiveness		
Treatment	incentives paid [KHR]	diff. fish	effectiveness [fish / 103 KHR]
external individual incentives	16000	-1.24	7.75
internal individual incentives	16000	-1.58	9.88
weak communal incentive	38000	-0.05	0.13
low/strong communal incentive	26000	-1.89	7.27
high/strong communal incentive	48000	-1.79	3.73

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5 Discussion

5.1 Internal and Third Party Sanctions

Many studies have shown that social approval and disapproval can result in increased cooperation in different contexts (Gächter & Fehr 1999, Andreoni & Petrie 2004, Rege & Telle 2004). In this study, however, no significant decrease in extraction was seen during the peer pressure treatment in which social approval and disapproval were the only controls on behavior. The most likely explanation for this is that peer pressure was not strong enough to overcome individuals' extraction preferences. The strength of social (dis)approval incentives depends on the average behavior of the group (Fehr & Falk 2002) and in this treatment the average number of fish agreed on by the group differed only slightly from the mean behavior observed in the control. This suggests that the disapproval of subjects who took a similar number of fish to the control was unlikely to be strong enough to elicit a change in behavior.

The weak third party enforcement treatment mimicked the conditions commonly replicated throughout conservation in which behavior is controlled through weak external sanctioning only. A common sentiment expressed during the group discussions for this treatment was that "it's up to the individual to decide since it is their risk." This is consistent with studies which have shown that social norms governing behavior can be explicitly undermined in the presence of sanctions so that subjects are free to behave without recrimination (Cardenas et al. 2000). This crowding out of social norms may explain why the threat of penalties failed to result in a reduction in extraction.

The results for the strong third party enforcement treatment were more promising from a conservation perspective. High penalties were shown to reduce the number of fish taken despite a relatively low probability of detection. On the surface this is consistent with predictions from economic models that non-compliance of rules decreases with severity of punishment (Keane et al. 2008). On closer inspection, however, it is clear the treatment failed in the enforcement of the no-take rule since the proportion of subjects who complied with the rule was actually lower than in the control. In other words while, on average, subjects reduced their extraction, they did not increase compliance. It is possible that this is indicative of the participants' response to enforcement penalties within the protected areas in which they live. Despite the risk of heavy fines or imprisonment, illegal activity is common in these areas since such penalties are rarely enforced except for severe infractions (WCS, unpublished data).

5.2 Direct Incentives

While a number of other studies have found evidence that financial incentives can crowd out cooperative behavior (Deci et al. 1999, Fehr & Gächter 2000) all of the incentive treatments investigated, except the weak communal incentive treatment, resulted in reductions in the number of fish taken. The reduction in the number of fish taken was on average 0.43 fish less for the two individual incentive treatments than for the two strong communal incentive treatments, suggesting that individual incentives may be less effective at reducing extraction. Internally allocated individual incentives were, however, the most cost effective way of reducing extraction.

The incentive structures which resulted in the greatest reductions in extraction, lasting changes in behavior and the strongest interactions between extraction and group decision making were those which encouraged the greatest levels of self-organization. This mirrors the findings of field studies investigating the institutional conditions required for resource users to be able to effectively control extraction from a common pool resource, and therefore manage the resource sustainably. Such conditions have been the subject of significant research and are well documented (Agrawal 2001). A common finding of such research has been to emphasize the importance of self-organization, the ability of user groups to be able to devise, monitor and enforce extraction rules without interference from external agents, in determining whether or not a resource is managed effectively (Wade 1988, Ostrom 1990, Baland & Platteau 1996).

Within the game, opportunities for self-organization were well defined. Participants were given a forum in which to discuss with other group members the level of extraction they thought would be most beneficial. In addition, all of the group games had perfect monitoring in which every participant knew the individual extraction of the other group members in previous rounds. While participants were not able to exact pecuniary sanctions on each other, they were able to verbally reproach other group members who they had felt had acted selfishly. Hence, participants had the ability to devise, monitor and enforce their own rules. In the context of many developing countries the institutions necessary to self-organize are weak or lacking, suggesting that incentive programs alone may be insufficient to support the establishment of collective resource regulation. Conversely, investment in local institutions capable of self-organization may provide a double benefit through both supporting the implementation of incentive programs and providing the conditions necessary for long-term sustainable management of resources.

6 Conclusion

Understanding and anticipating the response to different policy interventions is crucial for the effective design of such policies in creating the necessary conditions for sustainable management of resources. The results of this study indicate that those policies which are most effective at providing the incentives for resource users to reduce extraction are those which best promote self-organization. This demonstrates the need for parties implementing PES/REDD schemes, in particular, to consider supporting the development of local institutions capable of facilitating self-organization of the targets of incentive programs. Given the investment necessary to support such development it is tempting to assume that simple delivery of financial payments is sufficient to change behavior. On the evidence of this study, however, such an assumption risks being an inefficient use of conservation funds or, worse, risks crowding out existing informal resource controls.

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TRANSLINKS

Case Study

Leveling the Playing Field: The Effects of Institutional Controls on Common Pool Resource Extraction

Appendix 1: Explanation Script

Appendix 2: Result Sheet

Appendix 3: Annex Tables

Appendix 1: Explanation Script

[*Introductions*]

Before I begin to explain the games I would like to make some general comments about what we are going to do today. I will then explain the basic principles of the games that we are going to play. After I have finished the explanation we will play a short practice game to help you to understand the process and then I will take you through four simple examples.

We will be playing games for cash. Any money that you receive in the games is yours to keep and take home. This will be given to you at the end of the day. How much money you receive is dependent on your behaviour within the games. The money for these games has been supplied to undertake scientific research. If at any time you find that this is something that you do not wish to participate in for any reason, you are of course free to leave whether we have started the game or not.

You will all be given 4000 KHR as a thank you for coming today and to pay for your lunch. This is separate from the money that you will receive from playing the games. You will be given this at the end of the day.

It is important that when you are sitting in the group like this you do not discuss the game or how you think you should play the game. Please feel free to talk amongst yourselves but do not discuss the games themselves. This can spoil the game for everyone. If it happens we may not be able to play the game with you today.

[*If this is the second, third or fourth day of the games within the village add the following*:

"You are going to play a very different game than the games played before. If you have heard comments about other games from people who have played games on previous days, whatever they have mentioned might not apply today. If you follow their advice you may end up earning less money than you could do so please just listen to my explanation and play the game how you think best."]

As I said, we will be playing three games today. We will then ask you a couple of questions individually about your thoughts on the day. We should be finished by about 5pm. If you think you will not be able to stay that long please let us know now.

Each game follows the same basic principles which I will explain now. It is important that you listen as closely as possible as you will need to understand how the games work if you are to receive any money. We will run through a number of different examples for you to help you understand how the games are played. If you have any questions about how to play the games once they have been explained please put your hand up and we will try to answer them.

I am now going to explain the game.

Explanation

In all the games we are going to play you will be in groups of 10 other people from this village. In some games you will know who is in your group and in other games you won't. In each game there is a communal fish pond containing 100 fish from which all your group will be able to harvest. You will be asked to individually decide on the number of days that you wish to fish in a season. You can decide to harvest for a maximum of 10 days and a minimum of 0 days. For each day that you decide to fish you will harvest 1 fish for which you will receive 80 KHR. However, harvesting from the pond reduces the number of fish in the pond. The number of fish left in the pond at the end of the season is an indication of the future value of the pond to your group. At the end of each season the number of fish left in the pond will be counted. Everyone in your group will receive 12 KHR for every fish remaining. So, to summarise, if a fish is left in the pond everyone in your group benefits but if a fish is harvested only the person who harvested it receives any benefit.

[*Use whiteboard to show value of fish to individual and fish in the pond.*]

We will play each game for 5 seasons. The number of fish in the pond will be the same for every season that we play no matter how the group behaved in previous seasons.

You will be asked to signal your choice by circling the number of days that you want to harvest on the sheet of paper that you have in front of you. Please have a look at this sheet of paper now. As you can see there is a row for each season. Each season has an option for you to select from 0 days harvesting to 10 days. Each fish represents a day spent fishing. So if you want to spend 4 days fishing, circle four fish. If you decide to spend 8 days fishing, circle 8 fish. If you decide to spend no days fishing, circle the zero. [*Holds up A3 example row*.] The top row has been filled out for you as an example to show how to select your choice. In this case you can see that 4 days harvesting has been selected. Once you have made your choice for the season we will collect your paper so that we can calculate the total harvest for the group. We will then tell you the total harvest for that season and tell you your individual winnings for that season.

After we have played 5 seasons the game will end.

[*Play practice round as per the control*]

You should all now have a completed practice round sheet. As you can see we have filled out the two boxes at the end of the row. The number in the first box is the total number of fish taken out of the pond by your group. So this is the number of fish circled by each member of your group all added up together. The second number is the money that you receive from the round. Now remember that this is a practice round so the money in that box won't go towards your earnings at the end of the day. We calculate this number by giving you 80 KHR for each of the fish you have circled. We then give you 12 KHR for each of the fish left in the pond after every member of the group has taken fish out.

I will now take you through four simple examples to show you the range of behavior possible:

- Example 1: All members take 0 fish payoff = 1200 KHR
- Example 2: All members take 10 fish payoff = 800 KHR
- Example 3: 9 take 10 fish/1 takes 0 fish payoff = 920/120 KHR
- Example 4: 1 takes 10 fish/9 take 0 fish payoff = 1880/1080 KHR

Appendix 2: Result Sheet

0 1 2 3 4 5 6 7 8 9 10

0 1 2 3 4 5 6 7 8 9 10

0 1 2 3 4 5 6 7 8 9 10

0 1 2 3 4 5 6 7 8 9 10

0 1 2 3 4 5 6 7 8 9 10

0 1 2 3 4 5 6 7 8 9 10

0 1 2 3 4 5 6 7 8 9 10

Appendix 3: Annex Tables (A.1-A.4)

Table A.1: Logit parameter estimates for the selected control treatment model. Baseline levels for categorical variables are shown in parentheses. DF refers to the difference in the mean number of fish taken given by Equation 5. No parameter estimates are given for the externally allocated individual incentive or high, strong communal incentive treatments as these did not immediately precede the control.

	No. of fish taken				
Variable	**estimate**	**std. error**	**DF**	**p value**	
intercept	-0.47	0.43	0	0.28	
previous treatment: (none)					
peer pressure	0.42	0.43	1.02	0.34	
weak enforcement	0.46	0.24	1.13	0.06	
strong enforcement	-0.44	0.40	-0.97	0.28	
internally allocated individual incentives	-0.78	0.3	-1.62	0.01	*
weak communal incentives	0.61	0.27	1.5	0.03	*
low, strong communal incentives	-0.66	0.41	-1.41	0.10	
round number: (1)					
2	0.33	0.06	0.8	<< 0.001	***
3	0.41	0.06	1.01	<< 0.001	***
4	0.54	0.06	1.32	<< 0.001	***
5	0.76	0.06	1.87	<< 0.001	***
day: (1)					
2	1.03	0.28	2.52	< 0.001	***
3	0.65	0.24	1.61	0.01	**
4	1.01	0.30	2.48	0.00	***

Table A.2: Effect estimates for the simplified model. Baseline levels for categorical variables are shown in parentheses. DF given by Equation 5.

	no. of fish taken				
Variable	estimate	std. error	DF	p value	
intercept	-0.37	0.36	0	0.31	
treatment: (control)					
peer pressure	-0.19	0.27	-0.46	0.48	
weak third party enforcement	0.32	0.24	0.78	0.19	
strong third party enforcement	-0.66	0.26	-1.45	0.01	**
external individual incentives	-0.55	0.28	-1.24	0.05	*
internal individual incentives	-0.73	0.35	-1.58	0.04	*
weak communal incentive	-0.02	0.27	-0.05	0.94	
low/strong communal incentive	-0.90	0.25	-1.89	< 0.001	***
high/strong communal incentive	-0.84	0.26	-1.79	0.00	**
previous treatment: (none)					
control	0.31	0.19	0.76	0.10	
peer pressure	-0.11	0.28	-0.25	0.70	
weak third party enforcement	0.23	0.28	0.57	0.40	
strong third party enforcement	-0.24	0.29	-0.57	0.40	
external individual incentives	-0.41	0.36	-0.95	0.25	
internal individual incentives	-0.94	0.27	-1.95	0.00	***
weak communal incentive	-0.01	0.27	-0.02	0.98	
low/strong communal incentive	-0.64	0.34	-1.42	0.06	
high/strong communal incentive	-1.46	0.46	-2.7	0.00	**
years in education	0.03	0.02	0.08	0.04	*
gender: (male)					
female	-0.20	0.09	-0.47	0.02	
group decision recorded	-0.67	0.04	-1.48	<< 0.001	***
round number: (1)					
2	0.30	0.03	0.73	<< 0.001	***
3	0.38	0.04	0.94	<< 0.001	***
4	0.47	0.04	1.17	<< 0.001	***
5	0.57	0.04	1.42	<< 0.001	***
day: (1)					
2	0.89	0.20	2.19	< 0.001	***
3	0.88	0.20	2.15	< 0.001	***
4	1.10	0.20	2.66	<< 0.001	***

Table A.3: Effect estimates using the weak enforcement treatment as the baseline treatment.

Variable	estimate	std. error	DF	p value	
	no. of fish taken				
Intercept	-0.05	0.41	0	0.90	
treatment: (weak enforcement)					
Control	-0.32	0.24	-0.78	0.19	
peer pressure	-0.51	0.34	-1.23	0.13	
strong third party enforcement	-0.97	0.32	-2.23	0.00	**
external individual incentives	-0.87	0.35	-2.01	0.01	*
internal individual incentives	-1.04	0.40	-2.36	0.01	**
weak communal incentive	-0.34	0.33	-0.83	0.30	
low/strong communal incentive	-1.21	0.31	-2.66	< 0.001	***
high/strong communal incentive	-1.16	0.33	-2.57	< 0.001	***

Table A.4: Effect estimates for the two split dataset models.

Variable	estimate	std. error	DF	p value	
	No. of fish taken				
No decision made:					
intercept	-0.26	0.61	0	0.68	
treatment: (peer pressure)					
weak third party enforcement	0.38	0.38	0.95	0.32	
strong third party enforcement	-0.36	0.39	-0.86	0.35	
external individual incentives	0.15	0.36	0.36	0.69	
internal individual incentives	0.19	0.42	0.48	0.65	
weak communal incentive	0.51	0.41	1.26	0.21	
low/strong communal incentive	-0.29	0.38	-0.69	0.45	
high/strong communal incentive	-0.08	0.39	-0.21	0.83	
Decision made:					
intercept	-1.00	0.52	0	0.05	
treatment: (peer pressure)					
weak third party enforcement	-0.28	0.58	-0.51	0.63	
strong third party enforcement	-0.48	0.51	-0.83	0.35	
external individual incentives	-0.22	0.50	-0.41	0.66	
internal individual incentives	-1.41	0.5	-1.87	0.01	**
weak communal incentive	-0.35	0.50	-0.64	0.48	
low/strong communal incentive	-1.16	0.50	-1.66	0.02	*
high/strong communal incentive	-1.09	0.50	-1.58	0.03	*

TRANSLINKS

TransLinks is a 5-year Leader with Associates cooperative agreement that has been funded by the United States Agency for International Development (USAID) to further the objective of increasing social, economic and environmental benefits through sustainable natural resource management. This new partnership of the Wildlife Conservation Society (lead organization), the Earth Institute of Columbia University, Enterprise Works/VITA, Forest Trends, the Land Tenure Center of the University of Wisconsin, and USAID is designed to support income growth of the rural poor through conservation and sustainable use of the natural resource base upon which their livelihoods depend.

The program is organized around four core activities that will be implemented in overlapping phases over the life of the program. These are:

1. Knowledge building including an initial review, synthesis and dissemination of current knowledge, and applied comparative research in a number of different field locations to help fill gaps in our knowledge;
2. Identification and development of diagnostic and decision support tools that will help us better understand the positive, negative or neutral relationships among natural resource conservation, natural resource governance and alleviation of rural poverty;
3. Cross-partner skill exchange to better enable planning, implementing and adaptively managing projects and programs in ways that maximize synergies among good governance, conservation and wealth creation; and
4. Global dissemination of knowledge, tools and best practices for promoting wealth creation of the rural poor, environmental governance and resource conservation.

Over the 5-year life of the program, TransLinks aims to develop a coherent, compelling and, most importantly, useful corpus of information about the value of, and approaches to, integrating Nature, Wealth and Power. To do this, TransLinks is structuring the work around two core issues – 1) payments for ecosystem services and 2) property rights and resource tenure.

TRANSLINKS

A partnership of NGOs, Universities and USAID led by The Wildlife Conservation Society, dedicated to finding and sharing practical ways to generate benefits from conserving natural resources that are of global importance, and that serve as the supermarkets, bank accounts and insurance for many of the poorest people on earth.

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For more information please visit our website at www.translinks.org or contact Dr. David Wilkie, the program director, at dwilkie@wcs.org.

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