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Analysis

Environmental Uncertainty and Self-monitoring in the Commons: A Common-pool Resource Experiment Framed Around Bushmeat Hunting in the Republic of Congo

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ABSTRACT

Bushmeat is often a common pool resource issue and is a major threat to wildlife in west and central Africa. Participatory monitoring systems have been proposed to both better monitor natural resources and to engage resource users in Community Based Natural Resource Management systems, in a variety of social-ecological systems. However, studies of self-monitoring schemes in bushmeat hunting systems are scarce, and there are no empirical studies of the impact of self-monitoring on bushmeat hunting. We used a lab-in-the-field common pool resource experiment framed around a bushmeat hunting system, in which participants made individual decisions on time allocation between hunting and farming under three different conditions: without communication between group members, with communication, and with communication and a self-monitoring system. We found that self-monitoring was associated with a lower level of hunting and lower rate of resource decline. However, contrary to expectations, communication alone was not enough to lower hunting levels. We draw on behavioural economic and psychological research on environmental and social uncertainty and self-perception to explore how the act of self-monitoring could have changed behaviour by changing how participants perceived the resource, each other, and themselves. Our results support the notion that hunter self-monitoring could be a useful tool to initiate behaviour change, as well as providing estimates of resource trends.

1. Introduction

The hunting of wildlife for meat, or "bushmeat", is one of the most urgent threats to wildlife in the tropics, driving many species towards extinction (Ripple et al., 2016). Bushmeat hunting is a Common Pool Resource (CPR) dilemma, although rarely explicitly treated as such (but see Mavah, 2011 and Rickenbach, 2015). CPRs are natural or man-made resources in which yield is subtractable (i.e. the resource can be depleted through overexploitation) and exclusion is difficult but non-trivial (i.e. restricting people's access to it is difficult, but not impossible. Ostrom et al., 1992). Tropical forest lands are often the property of the state, which almost always lacks the means to enforce the law (Wilkie and Carpenter, 1999) while traditional means of management have been undermined by loss of customary land rights (Mavah, 2011; Walters et al., 2015), or overwhelmed by economic, demographic, and technological changes, in many cases leaving bushmeat a de facto open access resource with limited enforcement of restrictions on hunting (Bennett et al., 2007).

Community Based Natural Resource Management (CBNRM) has been proposed as a means to meet these governance challenges (FAO, 2011). According to Nelson et al. (2008), interest in CBNRM "is rooted in the empirical failures of strictly centralized natural resource management policies and practices, broader trends in favour of decentralization in rural development and economic policy, and the desire to create stronger synergies between local economic interests and global conservation objectives". Self-monitoring is a form of locally based monitoring (Danielsen et al., 2009), in which estimates of resource use and/or trends are produced using records of resource harvesting as data. Self-monitoring is one possible component of CBNRM that has received significant attention in the bushmeat literature, with a number

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of documented implementations (e.g. Sirén et al., 2004; Noss et al., 2005; Rist et al., 2010). Monitoring, specifically involving monitors who are, or are accountable to, resource-users, appears to be critical to successful CBNRM and is included in Ostrom's (1990:94) design principles for successful management of commons, derived primarily from the extensive literature on the governance of fisheries, community forestry, and irrigation systems.

Evidence from resource systems other than bushmeat suggest that participatory monitoring can be both a cost-effective method for producing information on resources, and a platform for strengthening governance systems through the processes of empowerment and integration of resource users into decision making (Danielsen et al., 2005a, 2005b). A recent review of 35 studies of volunteer environmental monitoring (Stepenuck and Green, 2015) found an array of positive effects, including increased social capital (i.e. economic and social benefits), influence on natural resource management policies and practices, and increased community awareness. However, changes in attitudes and behaviour were only observed in five of these studies. Changes resulting from participatory monitoring schemes have included an increase in the number of locally initiated interventions aimed at conserving natural resources (Topp-Jørgensen et al., 2005), an increase in compliance with rules relating to resource use, and increased trust between stakeholders (Rijsoort and Jinfeng, 2005). Noss et al. (2005) note the usefulness of self-monitoring schemes in wildlife management, and propose that participatory methods can provide the "inputs and framework" for community level discussions about wildlife management, even when they do not provide highly accurate assessments of short-term changes in wildlife resources.

Despite this interest there are no empirical studies of the impact of self-monitoring on wildlife management performance. Economic experiments can provide a means of investigation (Ostrom, 2006), and framed field experiments, in which resource users participate in a representation of their own real-world resource system, have been used to explore human behaviour in a number of CPR systems (Cardenas and Carpenter, 2008). Because they include the resource users themselves as subjects, they have the potential to reveal behaviour in response to a broad range of factors specific to the case in question (van Vugt, 2009), which may diverge from those predicted (Ostrom, 2006).

Uncertainty is inherent to many CPR systems (Hine and Gifford, 1996) and social and environmental uncertainty are the major sources, including in bushmeat hunting systems. Each raises different problems. Environmental uncertainty is mainly a problem of optimality or efficiency, whereas social uncertainty is mainly a coordination problem (Messick et al., 1988). People must not only try to understand what is the best way to harvest a resource (i.e. find extraction rates that are profitable but do not destroy the resource), but also whether or not other people will cooperate in this strategy, and if not, how this in turn changes the optimal harvesting solution.

Most research on CPR dilemmas has been conducted under some social uncertainty, in which the intentions and actions of others are imperfectly known, usually by concealing the harvesting behaviour of individuals and only reporting aggregate group harvest. In general, reducing social uncertainty seems to increase cooperation, i.e. Sell and Wilson (1991), while a common social identity, reduction in group size, commitment, and feed-back on others behaviour can also increase cooperation (Van Dijk et al., 2004). The majority of CPR experiments provide a context of very low environmental uncertainty i.e. the size and rate of replenishment of the resource is known at all times, and group harvest level is reported (Cardenas, 2004; Janssen, 2013). Experimental research into the effect of uncertainty has found that when faced with uncertainty in CPR experiments, people tend to increase harvest rates (Hine and Gifford, 1996). Several reasons for this effect have been posited (Van Lange et al., 2013), including over-optimism or over-estimation of resource size (Gustafsson, 1999; Rapoport et al., 1992), the undermining of efficient cooperation (De Kwaadsteniet et al., 2006), and providing an excuse for non-cooperative behaviour (Van Dijk et al., 2004).

A number of studies have also tested social and environmental uncertainty simultaneously. Messick et al. (1988) found that allowing communication between players made decision making more optimal in a task with both social and environmental uncertainty. In a game setup somewhat close to a real natural resource situation, Janssen (2013) found that when players in a spatially explicit CPR experiment had complete information about resource size and players' harvest rates, their own harvest rates were higher than when they had only incomplete information. In this case it appears that being aware that others are harvesting at a high rate spurs people to do the same, and so the effect of combined social and environmental uncertainty may be unpredictable.

This paper aims to investigate the effect of self-monitoring on wildlife hunting, one of the most commonly proposed CBNRM approaches for wildlife management, using an experimental behavioural economics approach. Specifically, we tested how resource extraction rate in a CPR experiment (henceforth "game") differed under three conditions: (i) without communication, (ii) with communication between rounds, and (iii) with communication between rounds and a Self-Monitoring system (henceforth SM, and 'SM with communication'), in which participants (henceforth 'players') could voluntarily produce a public visual record of their hunting effort, success and failure at the end of each round. To do this, we modified an existing CPR game to more closely approximate a wildlife harvest system. We did this through the addition of environmental uncertainty, about resource size and regeneration rate, and by making the probability of harvesting success dependent on the size of the resource. In this manner, players could only learn about the resource through the process of harvesting, a situation analogous to most bushmeat harvest systems. We are not aware of any other study that has tested the effect of SM experimentally, or that has carried out a common pool resource experiment with bushmeat hunting communities.

2. Hypotheses

We considered hunting at a low level to reflect cooperative behaviour, because it supports the group-level objective of maintaining a productive resource, which is ultimately most profitable to the group. Conversely, hunting at a high level was considered to reflect uncooperative behaviour, because it risks resource collapse in an attempt to maximise personal profit at the expense of the group. The experiment was guided by the following hypotheses, H1: Communication would increase cooperation, and H2: SM would further increase cooperation. We expected players to hunt the least in this condition. We hypothesised that hunting would occur at a lower rate in the two conditions where communication was permitted as there is substantial evidence finding communication reduces harvesting in CPR games (Ostrom, 2006). Increased cooperation was expected to result in higher group earnings. However, due to a number of factors, including empirical findings elsewhere (i.e. Janssen, 2013), and the fact that SM was voluntary and open to abuse as players could intentionally use it to try to manipulate competitors, the alternative was also feasible, i.e. H3: SM would not improve cooperation. In addition to our central question, we further hypothesised that socioeconomic characteristics of players and psychological factors would influence behaviour.

3. Methods

3.1. Study Location and Socio-economic Context

The game was played in 10 villages within Forest Management Unit (FMU) Ngombé in the Northern Republic of Congo. The rural population is mostly made up of several Bantu and Bayaka ethnic groups, living in settlements on roads or major rivers. Bayaka includes a number of ethnic groups often referred to as Pygmies (Lewis, 2002),