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Abstract

This study used a sample of 336 households and community-level data from 30 communities around Gonarezhou National Park in Zimbabwe to analyse the association between institutions and cooperation (defined as the ability to self-organise) and the relationship between cooperation and success of biodiversity outcomes. Using both ordinary least squares and instrumental variables estimation with heteroskedasticity-based instruments, our results confirmed that sound institutions are indeed an important ingredient for cooperation in the respective communities and that cooperation positively and significantly affects biodiversity outcomes. Community-level trust, the number of stakeholders, punishment and group size were found to be important variables explaining cooperation. From a policy perspective, our results show that external enforcement of rules and regulations does not necessarily translate into sound ecological outcomes; rather, better outcomes are attainable when punishment is endogenized by local communities. This seems to suggest that communities should be supported in a way that promotes the emergence of robust institutions that are tailor-made to suit their local needs; this will, in turn, facilitate good environmental husbandry. Cooperation, training, benefits, distance from the nearest urban centre, distance from the fence of protected areas, social capital, average age of household head, new electric fencing and information sharing were found to be very important variables explaining the success of biodiversity outcomes. Government programmes should target capacity building in terms of institutional capacity and skills development in order to have a positive impact on biodiversity. Both stakeholders (e.g., non-governmental organisations and government) should have a role in capacity building; these roles should complement each other to ensure that the necessary resources are mobilized and all communities receive the necessary training.

Key Words: institutions, self-organise, common pool resources, wildlife, conservation

JEL Classification: DO2, DO4, Q20, Q28, Q58

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Herbert Ntuli and Edwin Muchapondwa*

1. Introduction

Wildlife conservation has become popular with policymakers and development practitioners alike as a vehicle for rural development because of abundant tourism opportunities in Southern Africa. A significant proportion of wildlife is managed as a common pool resource (CPR) under various forms of community-based natural resource management (CBNRM) arrangements involving both local communities and private game farms.[1] Wildlife shares some characteristics with other CPRs, such as water, forests, rangelands and fisheries, thus making its management and utilization under joint-use arrangements a daunting task. For instance, conservation efforts are affected by global market trends and by past and prevailing governance and institutional arrangements (Gibson and Marks 1995). The situation is made even worse by the fugitive character of the resource, which makes it difficult to assign property rights to wildlife (Muir-Leresche and Nelson 2000).

The challenges associated with the management and utilization of CPRs in most developing countries have resulted in a search for policy options in an effort to make social-ecological systems (SESs) sustainable[2] over time. Following the publication of Hardin (1968), both state control and private ownership were embraced by colonial governments in the region as panaceas for all environmental problems. While both policy instruments have benefited minority groups and persisted even after independence, the colonial legacy created tension between wildlife authorities and local communities living adjacent to national parks (Songorwa 1999). At the rate at which wildlife is being decimated by local communities, the region could lose some of its prime wildlife species sooner than 2050 (Thuiller et al. 2006). This realization has led

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[1] Private game farms are normally organised into conservancies, which have dissolved their internal boundaries in order to manage wildlife as a common pool resource. Private game farms are referred to as landowner communities because each one usually comprises multiple private landholdings (Kreuter et al. 2010).

[2] Sustainability is defined as the ability of an ecosystem to provide goods and services today without compromising its ability to provide the same goods and services in the future (Brundtland et al. 1987).

policymakers to shift attention to people-oriented approaches rather than the conventional top-down governance systems.

This paper argues that the ability of a community to manage resources sustainably depends on the capacity of local communities to self-organise and that self-organisation depends on the nature of the institutions[3] that are in place. Existing institutions have failed to protect wildlife and biodiversity, and hence there is a need for more ideas to feed into future policy or institutional reforms. The study was conducted in local communities around Gonarezhou National Park in Zimbabwe that are participating in community wildlife conservation. The global objective of this study is therefore to enhance our understanding of the role of local institutions in promoting sustainable management of CPRs, using Zimbabwe's CAMPFIRE nature conservation programme[4] as a case study. Following the discussion above, three important questions arise. Are there any practical differences in terms of resource units, resource users, and quality of institutions in common pool wildlife systems within and across communities? Under what conditions will the users of common pool wildlife self-organise? What attributes of resource units, resource users and local institutions are consistent with sound biodiversity outcomes?

This paper contributes to the literature on common pool resources by applying Ostrom's framework and collecting primary data on a little-studied topic. The framework has been used extensively in areas such as forestry, fisheries, rangelands and water resources management, while little has been done in the wildlife sector, particularly in Southern Africa. From a policy perspective, this paper sheds light on the processes governing human-environment systems and provides results comparable to other studies and ongoing projects. Furthermore, our research findings allow both policymakers and development practitioners to question their wildlife management strategies and policies while at the same time identifying areas that need to be improved.

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[3] North (1991) defined institutions broadly as humanly-devised constraints that structure political, economic and social interactions. In this paper, we define institutions as systems of established and prevalent social rules that structure social interactions (Hodgson 2006), including community-level organisations.

[4] The Communal Areas Management Programme for Indigenous Resources (CAMPFIRE) is a benefit-sharing scheme that involves local communities that live in the vicinity of national game parks and suffer wildlife intrusions. The programme was instituted by the government of Zimbabwe during the mid-1980s in order to create incentives to conserve wildlife by directly transferring benefits from conservation to the local communities.

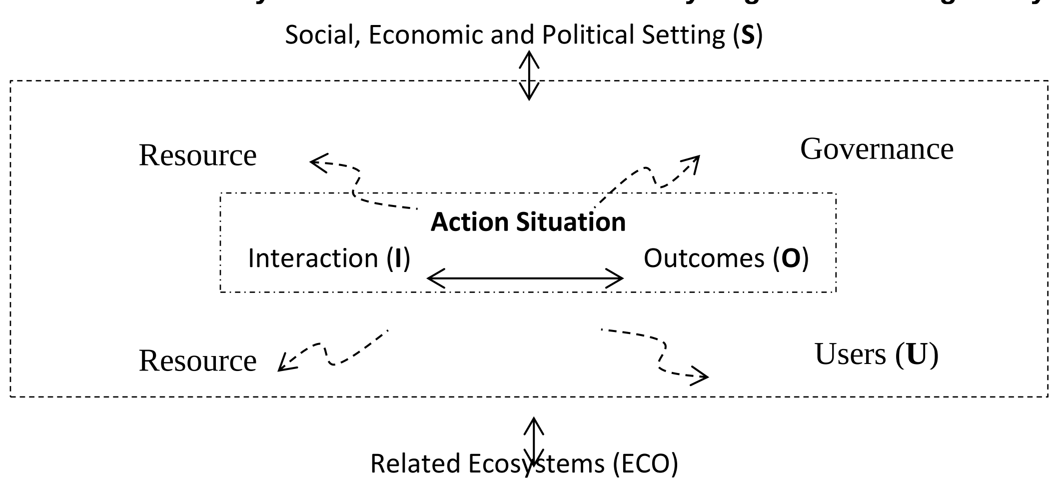
This paper is organised into five sections. Section 1 presented the background, objective of the study and research questions, while Section 2 presents a review of the theory of collective action and the conceptual framework. Section 3 gives an outline of the research methods, i.e., the analytical framework, empirical model specifications and data issues. We then proceed to present and discuss the results in Section 4 and wind up with conclusions and policy implications in Section 5.

2. Review of Theory

2.1 Conceptual Framework

This study employs the general framework for analysing complex social-ecological systems (SESs), as developed by Ostrom (2007). Figure 1 shows eight core subsystems that have been observed to affect both the ability of a community to self-organise and the sustainability of a resource system. In empirical work, many variables have been observed to affect the patterns of interaction and outcomes. In an earlier study, Agrawal (2001) identified more than 30 variables that had been posited in major theoretical work to affect incentives, actors, and outcomes related to sustainable governance of a resource system. By unpacking the eight core subsystems and expanding on Agrawal's work, Ostrom et al. (2007) went further to provide an even longer list of variables under each subsystem (see Table A.1 in the annexes). This framework helped to identify the variables that are relevant in studying community wildlife conservation, designing the research instrument and analysing findings about the sustainability of a SES.

Figure 1. The core subsystems in a framework for analysing social-ecological systems



Source: Extracted from Ostrom (2007: 15182)

By applying Ostrom's framework, it is possible to analyse different environmental problems under different scenarios and predict the associated outcomes. Table 1 below shows how we can adapt this framework in the context of the wildlife sector in Southern Africa. For example, this study deals with a fugitive and finite renewable resource which is either harvested legally through trophy hunting activities by engaging a safari operator (in which case the community gets wildlife income, thereby maximizing societal welfare) or illegally by poachers, who maximize their individual short-term gains. Local communities are not allowed to hunt wildlife for their own purposes either inside or outside the national game park (i.e., in their own conservation area). The community does not benefit from tourism, research, wildlife photography or filming activities, implying that trophy hunting is their only means of generating revenue from conservation. The community applies for a hunting quota from the Zimbabwe National Parks and Wildlife Authority and generates income by selling the quota to safari operators, who will in turn obtain clients through organized international events and sell the quota at a premium. The client or trophy hunter utilizes the quota. The most important institutions involved in community wildlife conservation are the wildlife management committee, park authorities, Rural District Councils (RDCs, the main administrative organ and entry point into the community) and non-governmental organisations (NGOs).

Table 1. Second tier variables used in this paper

Resource System	Governance System
RS1: Sector – wildlife sector RS2: Resource size – finite RS3: Renewable Resource	GS1: Wildlife Management Committee *- Expected to continue with conservation outside park* GS2: Rural District Council *- enact bylaws and sometimes monitoring & enforcement* *- has the appropriation rights* *- collect and distribute revenues* GS3: National Parks *- custodian of wildlife* *- set hunting quotas* *- monitoring & enforcement inside protected area*
Resource Units	**Users**
RU1: Fugitive Resource *- Wildlife destroy crops and livestock* RU2: Legal harvesting by the PH *- generate income to the community* RU3: Illegal harvesting by poachers	U1: Large number of users U2: Conflict of Interest *- Maximize community welfare (altruistic motive)* *- Maximize short-term gain (self-interest)* *- Nuisance motive for harvesting wildlife*
Interaction	**Outcome**
I1: Maximum harvesting levels by poachers I2: PH guided by quota	O1: Resource overexploitation O2: Destruction of the ecological system

Source: adapted from Ostrom (2007)

The interaction between the community and the resource system produces undesirable outcomes. For instance, harvesting levels by poachers exceed the maximum sustainable yield because they maximize personal gain. Therefore, if the communities in question are without the means of controlling extraction, then the end result is resource overexploitation and eventually total collapse of the social-ecological system. The prediction of resource collapse usually comes true in a very large and highly valuable resource system under open access conditions when users are diverse, do not communicate and have failed to develop institutions for managing resources (Berkes et al. 2006).

2.2 The Collective Action Problem

The theory of collective action[5] has matured tremendously since the publication of Olson (1965), entitled 'The Logic of Collective Action.' It relates to the group or individual's lack of capacity (except under certain conditions) to solve what is referred to as the

[5] Collective action is defined as any action taken together by a group of people whose goal is to enhance or achieve a common objective (Olson 1965).

‘*collective action problem.*’ Resource economists and theorists ask questions about the conditions under which those who face the ‘tragedy of the commons’ are able to organise a system of rules, monitoring and enforcement by which the tragedy is averted (Wade 1987). The analytical framework in contemporary analysis is that of a rational, self-interested individual who maximizes short-term gain while the society maximizes community welfare (Ostrom 2003). Conflict of interest exists between the community’s objective function and that of an individual. Of particular interest to this study is the literature that focuses on creating incentives for collective action through designing sound CPR institutions. What causes communities to develop institutions is the scarcity of natural resources and the need to avoid tragedy in the commons.

There is a great deal of literature focusing on the role of punishment and social sanctioning or ostracism in promoting cooperation among resource users; much of this literature comes from the field of experimental economics (Fehr and Gachter 2000; Cardenas et al. 2000; Murphy and Cardenas 2004; and Akpalu and Martinsson 2011). Agrawal (2001) emphasizes the differences between a self-organised community and externally imposed collective action in terms of rule enforcement and sanctioning. Studies reveal that communities benefit when institutions are endogenized by the community, compared to the case when rules and regulations are externally enforced by the government (Murphy and Cardenas 2004; and Akpalu and Martinsson 2011). Community-based wildlife conservation in Zimbabwe, for example, relies to a great extent on state authorities to monitor and enforce rules and regulations, but the capacity to do so is limited by the budget. The knowledge of local collective action and informal institutions in natural resource management provides crucial information for designing policy instruments or interventions aimed at simultaneously addressing conservation and poverty issues.

3. Research Methods

3.1 Analytical Framework

The paper utilizes both household survey data and key informant interviews. We provide a detailed characterization (mapping) of local CPR institutions of 25 CAMPFIRE projects and 5 communities from three resettlement schemes[6]. From a qualitative perspective,

[6] Peasant farmers around Gonarezhou National Park are found under two different types of land tenure systems, namely, communal areas and resettlement schemes. The resettlement scheme is a product of the government of Zimbabwe’s land reform program created after independence in 1980, when the country embarked on a land redistribution exercise in which some of the land that belonged to large-scale commercial farmers was transferred to poor households from the overcrowded communal areas (Mushunje et al. 2003).

the analysis will articulate how institutions in different communities differ and why they differ given similar ecological conditions. This is followed by empirical model estimations to investigate the link between institutions and cooperation and the relationship between cooperation and success of biodiversity outcomes.

3.2 Empirical Methods

This study makes use of econometric modelling to establish the relationship between (a) cooperation and other institutional variables identified by Ostrom (2007) as affecting the likelihood of cooperation, and (b) cooperation (as well as other variables identified by Ostrom as affecting the sustainability of SESs) and ecological outcomes.

3.2.1 Model 1: Participation in Community-Based Wildlife Management Programs

A variable measuring ability to self-organise or a signal of cooperation is used as a dependent variable in our first model. This could be participation of individuals in community wildlife projects or activities at a community level. Following McCarthy et al. (2002) and Pennings and Leuthold (2000), ability to self-organise (cooperation) is assumed to be an unobservable latent variable. Factor analysis of variables thought to be associated with cooperative capacity is employed in order to recover the latent variable. Indicators of cooperation are drawn from two main categories, namely, networks and organisational performance variables. Network indicators include the density of organisations and density of household participation, while organisational performance indicators include the number of rules, regulations, activities and meetings. Mathematically, we write Model 1:

$$C_i = \beta_0 + \beta_1 Institutions + \beta_2 Groupsize + \beta_3 Trust + \beta_4 Ethinicity + \beta_5 Wealth + \beta_7 \Pr ojectyear + \beta_8 Punishment + \beta_9 \operatorname{Re} sourcesize + \beta_{10} Stakeholders...... + \varepsilon_i$$

To measure the quality of institutions in a community, we made use of the extended version of Ostrom’s (2010) design principles for stable local common pool resource institutions (refer to Table 2 below). A complete enumeration of CPR institutions in each community provided vital information for calculating an index of the quality of institutions. We then used this index plus other explanatory variables to explain cooperation, as described in Model 1 above.

Table 2. Design principles for CPR institutions

Variable	Description
P1:	Clearly defined boundaries (effective exclusion of external non-entitled parties)
P2	Rules regarding the appropriation and provision of common resources that are adapted to local conditions
P3	Collective choice arrangements that allow most resource appropriators to participate in the decision-making process
P4	Effective monitoring by monitors who are part of or accountable to the appropriators
P5	A scale of graduated sanctions for resource appropriators who violate community rules
P6	Mechanisms of conflict resolution that are cheap and easy to access
P7	Self-determination of the community recognised by higher-level authorities
P8	In the case of larger common-pool resources, organisations in the form of multiple layers of nested enterprises, with small local CPRs at the base level

Source: Ostrom (2010) - Analysing Collective Action

3.2.2 Model 2: Success of Biodiversity Outcomes

To measure the success of biodiversity outcomes across communities, a measure of relative abundance or diversity was used. The relative abundance of a species in a community is defined as the proportion of individual organisms in the community that belong to that species. Let P_j for $j = 1,2,.....,N$ be the relative abundance of species j and N the number of species. We can define the Shannon index as:

$$S_j = \sum_{j=1}^{N} P_j \left|\log P_j\right|$$

The Shannon index (S) provides important information about rarity and commonness of species in a community. Mouillot and Lepretre (1999) and Nagendra (2002) suggest that a good measure of species diversity should be able to capture two important dimensions of biodiversity, namely, species richness and species evenness. Thus, the Shannon index is a quantitative measure that reflects how many different groups, types or species there are in a data set. The value of *S* rarely exceeds 4 in most ecological studies and increases when the number of types (species richness) and the evenness increase. Although the index does not tell us anything about the endangeredness of a species, it is sufficient for the purposes of this analysis because it incorporates both components of biodiversity. Moreover, endangered species such as rhinos are not found in the communities in question.

To calculate the Shannon index, we used information about animal counts (commercial species only) done by the RDC and the respective communities. Each year, communities keep information by type and species about the number of wild animals traversing their conservation area[7]. The records are kept at the RDC offices and this information is then used by the community as justification when applying for a quota. Wild animal counting is done at the community level by a team of people that includes members from local communities, the RDC and sometimes park authorities. So, algebraically, we have the following equation linking biodiversity and cooperation, Model 2:

$$S_j = \beta_0 + \beta_1 Cooperation + \beta_2 Benefits + \beta_3 Market + \beta_4 Distfence + \beta_5 Socialcapital + \beta_6 Fence$$
$$\beta_7 Age + \beta_8 School + \beta_9 \mathrm{Re}sidence + \beta_{10} Yearsliving .... + \varepsilon_i$$

Table 3 describes the explanatory variables that are used in the two models. The last column shows the expected signs of the variables. However, the expected signs of some variables could not be determined from the literature review.

[7] The community's conservation area (CA) is an area set aside by the community for the purpose of conservation. This is a requirement by the state for the community to participate in the CAMPFIRE programme. In addition, local communities are tasked to continue with conservation work in order to keep their land bordering the national park. Failure to comply with this requirement means that the community could risk losing part of its land.

Table 3. Nature of variables and expected signs

Variable	Nature of variable	Expected sign
Variables for the first model		
Cooperation index	Dependent variable measuring ability to self-organise or cooperation	
Institutions	Institutional index (continuous)	+
Groupsize	Group size (continuous)	±
Trust	Measured on a scale from 0 – 10 (continuous)	+
Ethnicity	Number of ethnic groups (continuous)	-
Wealth	Wealth index (continuous)	±
Projectyear	Year project was established (continuous)	+
Punishment	Punishment [0=punishment exogenous 1=endogenized]	+
Resource size	Resource size in ha (continuous)	±
Stakeholders	Number of stakeholders (continuous)	undetermined
Variables for the second model		
Biodiversity index	Dependent variable measuring success of biodiversity outcomes	
Benefits	Benefits from wildlife conservation (continuous)	+
Market	Distance to the nearest urban centre in km (continuous)	+
Distfence	Distance to the fence (continuous)	undetermined
Social capital	Social capital index (continuous)	±
Fence	New electric fence	undetermined
Age	Average age of household head (continuous)	±
School	Average number of years in school (continuous)	±
Training	Received training (number of training courses)	+
Yearsliving	Average number of years living in the area (continuous)	+
Information	Information sharing index	+

We suspect the problem of endogeneity, particularly in the relationship between cooperation and biodiversity. This is because the theory posits that there is reverse causality between biodiversity outcomes and cooperation, i.e., less biodiversity (scarcity) translates into more cooperation in order to avoid the tragedy of the commons, and vice versa. As a result, some scholars argue that the incentive to self-organise does not always hold, especially when resources occur in abundance (Ostrom 1990). However, this is not the case in Zimbabwe because wildlife resources have declined tremendously since the turn of the 21st century. To put this into perspective, the wildlife management policy in the country speaks to the scarcity of resources. This is also the reason that the government institutionalized the CAMPFIRE programme in order to enhance the stock of wildlife.

In the absence of institutions (rules, values, norms, etc.), it is difficult to measure cooperation because there is no reference point (or standard) against which we can compare people's behaviour. Ostrom et al. (1994) distinguished between triggering institutions, which trigger cooperation among community members, and sustaining institutions, which are responsible for sustaining cooperation over time, thereby leading to sustainability of a SES. The authors suggested that triggering institutions should come first and cooperation later, because people need to conform to some form of rules, norms or values. Based on this idea, the relationship between institutions and cooperation might be unidirectional, particularly for communities in which relevant institutions are not yet capable of addressing their current needs for resource management. Therefore, the endogeneity problem comes into play when we consider the effect of cooperation on institutions in a later phase of development, when community members demand better institutions in order to sustain cooperation after realizing the benefits accruing to the group as a whole.

Furthermore, considering the literature on conditional cooperation, it can also be argued that the relationship between punishment and cooperation is unidirectional. This literature seems to suggest that cooperation by users of a common pool resource is conditional on punishment (e.g., Fehr and Gachter 2000; Masclet et al. 2003; Nikiforakis et al. 2007; and Herrmann et al. 2008) and on cooperation of others (Rustagi et al. 2011; Fischbacher and Gachter 2010; and Fischbacher et al. 2001). Punishment is part of the community's institutions; it is administered to offenders so that people will cooperate with the rules, values or norms of the group. In this sense, we can view institutions as treatments and cooperation as an outcome.

Because of the endogeneity issues discussed above, we first estimate the models using ordinary least squares (OLS), ignoring any issues of endogeneity. We then employ instrumental variables estimation with heteroskedasticity-based instruments, which methodologically deal with the problem of endogeneity, and compare the results. Following Lewbel (2012), this method estimates an instrumental variables regression model providing the option to generate instruments and allows the identification of structural parameters in regression models with endogeneity or mismeasured regressors in the absence of traditional identification information such as external instruments.

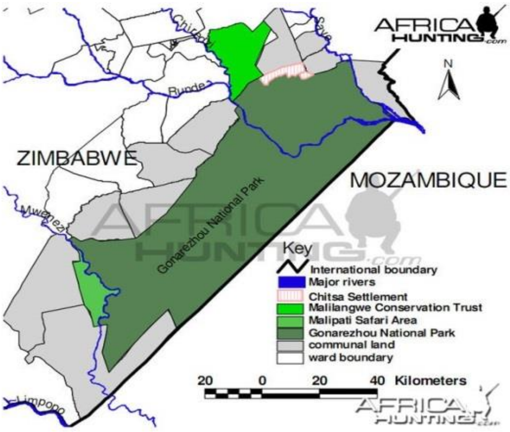
Identification is achieved in this context by having explanatory variables that are uncorrelated with the product of heteroskedastic errors.[8] Correlation in the error terms due to an unobserved common factor is a key feature in many models (Baum et al. 2013). According to Lewbel (2012), instruments may be constructed as simple functions of the model's data. As a result, the approach may be applied in cases where no external instruments are available or used to supplement weak external instruments in order to improve the efficiency of the instrumental variables estimator.

[8] The greater the degree of scale heteroskedasticity in the error process, the higher will be the correlation of the generated instruments with included endogenous variables, which are the regressands in the auxiliary (first stage) regression (Lewbel 2012).

3.3 Data Sources and Sample Size

This study collected primary data from 30 local communities in 13 wards around Gonarezhou National Park (GNP) in Zimbabwe that are participating in wildlife conservation. GNP is the second-largest game reserve in the country after Hwange National Park. It is located in south-eastern Zimbabwe (coordinates 21^0 40′ S 31^0 40′ E) and covers about 5 053 km^2. It forms part of the Great Limpopo Trans-frontier Park that links Gonarezhou with Kruger National Park in South Africa and Limpopo National Park in Mozambique. Owing to its vast size, rugged terrain and location away from the main tourist routes, large tracks of Gonarezhou still remain pristine wilderness. Figure 2 below shows the map of GNP (in dark green) and the communal areas (in grey) bordering the national park.

Figure 2. Map of Gonarezhou National Park



Source: www.africahunting.com

Through household surveys and key informant interviews, the study collected data from a sample of 336 households and 30 key informants. Out of the 30 communities visited, 25 are CAMPFIRE projects while the remainder, namely, Nyangambe, Chizvirizvi and Gonakudzingwa, are resettlement schemes (see Table 4 below). Although Gonakudzingwa has the least number of households (about 43), it had about three CPR groups, each with its own wildlife management committee, thereby bringing the total number of communities under resettlement schemes to five. Resettlement schemes differ from communal areas in that the former are located on private land that is subject to the laws governing the private tenure system in the country, while the latter have communal tenure.

Table 4. Number of communities involved in wildlife conservation by tenure

Type of tenure	Freq.	Percent	Cum.
Communal	25	83.33	83.33
Resettlement	5	16.67	100.00
Total	30	100.0	

Source: survey data Aug 2013

By design, all CAMPFIRE projects were supposed to operate at ward level. However, due to conflict and unequal distribution of resources within communities, they had to split up in order to spread the benefits to every community member. About three communities were operating at ward level, i.e., Mahenye, Mutandahwe and Nyangambe. The rest of the wards are divided into several community groups ranging from two to six different sub-groups in a single ward. In the case of communal areas, these different community groups are referred to as CAMPFIRE villages.[9]

The household questionnaire collected information about the household’s socio-economic characteristics, such as demographics, agricultural activities, assets, income, expenditure and involvement in community wildlife activities, while the key informant questionnaire collected information at the community level about the community’s involvement in wildlife activities. Secondary data was also collected from the respective RDCs to complement the survey data.

The household survey employed a simple random sampling procedure using the list of beneficiaries from each community as the sampling frame. Initially, sampling was done using information gathered at district level from the RDC. There was a huge disparity between the information supplied at the district level and what was on the ground in terms of the number of community groups (projects) and number of households participating in community wildlife conservation, as the RDC did not update its records regularly. As a result, information gathered from the chairperson of the respective community groups was used to update the initial calculation of the sample size. This complicated the exercise because the information needed to keep the same sample size among the areas was not readily available.

Table 5 below shows the number of households interviewed, by ward, against the total number of households participating in wildlife conservation in each ward, and ward population expressed in terms of households. The sample size was compromised by the fact that some enumerators did not meet their targets, particularly in areas that were sparsely populated, while some questionnaires were not usable due to non-response or lack of critical

[9] By definition, a CAMPFIRE village comprises several political administrative villages, each with its own headman. Its primary objective is conservation.

information. Table 5 seems to suggest that Ward 8 and Ward 15 were over-sampled. The reason is that these two wards had the highest number of CAMPFIRE villages (groups) than any other ward, i.e., six and five groups respectively (refer to Table A.2 in the annexes).

Table 5. Number of households by ward

Ward	Interviews		Household involved in CWM		Ward Population	
	Number	Percent	Number	Percent	Number	Percent
Ward 10	20	5.95	820	7,82	1300	7,46
Ward 12	7	2.08	43	0,41	43	0,25
Ward 13	15	4.46	861	8,21	1000	5,74
Ward 14	9	2.68	492	4,69	1750	10,04
Ward 15	64	19.05	955	9,11	2000	11,47
Ward 22	10	2.98	81	0,77	81	0,46
Ward 23	13	3.87	181	1,73	181	1,04
Ward 29	19	5.65	2000	19,08	2000	11,47
Ward 30	29	8.63	960	9,16	1700	9,75
Ward 4	10	2.98	350	3,34	1850	10,61
Ward 5	32	9.52	1589	15,16	2100	12,04
Ward 8	84	25.00	1235	11,78	1470	8,43
Ward 9	24	7.14	917	8,79	1960	11,24
Total	336	100.00	10484	100.0	17435	100,00

Source: Survey data Aug 2013

4. Results and Discussion

4.1 Characterization of the Community and its Institutions

The data shows great variability in terms of household, community and institutional characteristics. Table 6 shows that the average group size is about 451.6 and ranges from 6 to about 2000 households, depending on whether the community is operating at ward level and whether we are talking about CAMPFIRE projects or resettlement schemes[10]. The average number of ethnic groups for the communities in question is 2.6. The data shows that the average age of the head of the household is 48.9 and ranges from about 22 to 89 years. About 50.0% of the communities have managed to endogenize punishment; they have systems in place for monitoring and enforcing rules and regulations, but the degree to which punishment is internalised varies as we move from one community to another. Whether monitoring and enforcement are externally done by a third party or internalized by local communities has implications for cooperation, which in turn affects the success of biodiversity outcomes.

[10] As part of the land reform programme during the 1990s, peasant farmers were allocated plots around Gonarezhou National Park that were previously reserved for white commercial farmers.

The benefits from wildlife conservation range from 0 to US$68 880.00 during the survey period, with a mean of US$20 047.00, while the average size of the conservation area is 14 186 hectares (ha), ranging from about 7 614 ha to 26 000 ha. In some communities, the conservation area has been greatly reduced because the fence of the national park has recently expanded its boundaries, partly due to pressure from the state to increase land under conservation and the availability of donor funding. This affected the benefits flow because some communities are no longer entitled to benefits. About 62.5% of the committee members in the respective communities have received some form of training, some of which was related to wildlife management. A number of stakeholders were involved in administering the training, including the RDC, Zimbabwe National Parks and Wildlife Authority and several local NGOs.[11] The average number of stakeholders was 4.2 per community, which is quite substantial given the size of the area under consideration (refer to Table A.3 in the annexes).

Table 6. Descriptive statistics of the variables used in the econometric model

Variable	Obs	Mean	Std. Dev.	Min	Max
Group size	336	451.6	461.4	6	2000
Trust [scale from 0 - 10]	336	4.896	2.192	1	10
Number of ethnic groups	336	2.631	0.901	1	5
Year project was established	336	12.99	7.157	4	31
Nature of punishment [0=Endo, 1=Exo]	336	0.506	0.501	0	1
Resource size (ha)	336	14186	7614	0	26000
Training (0=no 1=yes)	336	0.628	0.484	0	1
Benefits	336	20047	17290	0	68880
Distance to the market (km)	336	65.45	25.88	33	133
Distance to the fence (km)	336	9.843	16.77	0.100	80
Number of poaching incidents	336	7.955	6.192	0	22
Average age of household head	336	48.88	13.62	22	89
Average number of years in school	336	5.524	4.257	0	15
Residence status for the head	336	0.848	0.359	0	1
Head born in this area	336	0.708	0.455	0	1
Average number of years living in the area	336	36.64	13.57	6	73

Source: survey data Aug 2013

Table 7 below shows that the performance of most communities in the study area is well below the desirable level in terms of many characteristics that matter for conservation. On a scale from 0 to 100, where 0 signifies the complete absence and 100 the complete presence of an attribute, all community attributes in Table 7 fall below half (50.0), except for

[11] Training offered by these organisations ranges from basic courses, such as bookkeeping or record keeping, to specialised courses, such as constitution development, leadership courses, veldt fire management, training for armed game guards (including the use of firearms) and general wildlife management (including animal counting, provision of watering points, trophy quality, live animal cropping, etc.).

information sharing, which has a mean of about 60.56. Most communities share vital information such as financial matters, past actions and knowledge of the SES, mainly through village meetings. The mean level of cooperation is about 39.26, while the mean for the overall institutional index is 34.06. Disaggregating the institutional index into four attributes, namely, clarity of institutions, fairness, governance (including participation and democracy) and monitoring and enforcement (including formal punishment and social sanctioning), we observe that the mean of each attribute is still worrisome, especially for the governance, participation and democracy index. This seems to suggest that, in most communities, the quality of local institutions is very poor. This could have implications for cooperation in a community.

Table 7. Summary of indices

Variable	Obs	Mean	Std. Dev	Min	Max
Cooperation index	336	39.26	28.47	0	100
institutional index	336	34.06	22.05	0	100
clarity index*	336	40.97	23.62	0	100
fairness index*	336	40.81	20.85	0	100
governance index*	336	34.96	20.82	0	100
monitoring index*	336	37.67	24.40	0	100
wealth index	336	31.84	24.18	0	100
social capital index	336	18.18	14.49	0	100
information index	336	60.56	22.95	0	100
biodiversity index**	336	1.520	0.950	0.06	3.14

Source: Survey data Aug 2013

* Indices for institutional characteristics ** The Shannon index for biodiversity

In general, qualitative interviews revealed that communities that joined the CAMPFIRE programme earlier had better institutions in place compared to communities that either joined later or are operating outside the programme, except for Nyangambe.[12] The discrepancies in institutional characteristics across communities can be attributed to the fact that communities that started earlier, such as the Mahenye CAMPFIRE project, enjoyed a lot of donor funding and privileges from the state, which led to their success. This also meant that the relationship between earlier communities and state authorities improved over time because of the attention they got from the international community. Furthermore, these communities had ample time to learn from their own mistakes, experiences and past achievements and hence adapted accordingly. In addition to this, such communities also

[12] Its success came from the fact that the community was part of the Savé Valley Conservancy from its establishment and was involved in wildlife conservation from 1990 until 2004, when Nyangambe temporarily pulled out due to political interference in the conservancy.

received adequate training to build their own institutional capacity from the CAMPFIRE programme itself, state apparatus and various other local and international non-governmental organisations that were involved in wildlife conservation at that time.

Table A.4 in the annexes shows that community involvement in wildlife conservation in the study area varied significantly across communities. Most respondents (96.7%) indicated that the community uses awareness campaigns as a vehicle to fight illegal harvesting of wildlife, to educate the community and to foster cooperation, while 59.5% indicated that they actually carry out anti-poaching activities. About 42.3% indicated that they have a veldt fire management committee in place, while 36.3% use whistle-blowers to alert the authorities to any illegal activities happening in their community. Fewer respondents indicated that the community participates in quota setting (32.4%) or game cropping[13] (12.5%).

About 38.7% of the respondents stated that they enjoyed use rights, while 33.6% indicated decision-making rights (refer to Table A.5 in the annexes). When asked about the extent to which the communities enjoy both use and decision-making rights on a scale from 0 to 10, there is great variation in the observations across projects, with means of 1.97 for use rights and 1.55 for decision making. About 91.3% of the respondents indicated that the option to enter or exit is not available for community members, while 66.4% indicated that the community is not able to exclude external or untitled parties. Many respondents (about 86.0%) were aware of the existence of a constitution for the community, while fewer respondents (25.6%) were aware of the existence of a wildlife management plan. It is essential at this stage to highlight that wildlife management committees exist for all communities (100.0%) since this is a requirement for local communities to be recognised by the state as a conservation group and for them to benefit from wildlife conservation.

Table A.6 in the annexes shows the number of rules, meetings and activities, and the participation rates for each. On average, using a scale from 0 – 10, the extent to which community rules are recognized by community members and higher level authorities is 3.51 and 6.10, respectively. This indicates that a number of communities still have problems in terms of rule compliance. This is also supported by the high number of poaching incidents (about 7.9 per year) in the study area.

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[13] Eltringam (1994) defines game cropping as the taking of a sustainable yield from a completely wild population. This definition implies regular harvest from a wild population. Cropping would have the objective of either wild animal population control or harvesting to provide bushmeat and other wild animal products for local consumption and/or for income generation.

4.2 Results of the Regression Models

This paper argues that institutions directly affect cooperation (defined as the ability to self-organise) and indirectly influence the success of biodiversity outcomes through cooperation. Using regression analysis techniques, we analyse the association between institutions and cooperation and the relationship between cooperation and success of biodiversity outcomes. As stated earlier, we are aware of the endogeneity problem; although we did not expect our data to suffer from it, it has to be corrected. First, we ignore any endogeneity issues and use ordinary least squares regression analysis, and then we use instrumental variables estimation with heteroskedasticity-based instruments to methodologically deal with the problem.

The Durbin-Wu-Hausman tests for endogeneity (refer to Table A.7 in the annexes) seem to suggest that OLS yields better results in the first model (relationship between cooperation and institutions) while the instrumental variables estimation with heteroskedasticity-based instruments yields superior results in the second model (relationship between biodiversity and cooperation). The VIF tests show that multicollinearity is not a severe problem for either model (please refer to Table A.8 in the annexes). The rule of thumb suggests that the VIF should be less than 10; otherwise, we have multicollinearity issues (Menard 1995; Neter et al. 1989; and O’Brien 2007). Furthermore, the correlation results in Table A.16 and Table A.17 in the annexes also support the results of the VIF test above.

Table A.9, Table A.10 and Table A.11 in the annexes show the results of the under-identification, weak identification, over-identification and heteroskedasticity tests obtained from the instrumental variables estimation models. Under the null hypothesis that the equation is under-identified, the Kleibergen-Paap test shows that it is safe to proceed with the instrumental variables estimation with heteroskedasticity-based instruments in both models. Usually, the p-value should be very small in order to reject the null hypothesis in favour of the alternative hypothesis that the equation is not under-identified. The rule of thumb for the weak identification test using the Cragg-Donald Wald F-statistic suggests that we reject the null hypothesis of weak identification if the F-statistic is large. Weak identification arises when the excluded instruments are weakly correlated with the endogenous regressors. Estimators can perform poorly when instruments are weak.

The Hansen J statistic for testing over-identification of all instruments also reveals that it is safe to use instrumental variables estimation with heteroskedasticity-based instruments in both models under the joint null hypothesis that the instruments are valid instruments, i.e., uncorrelated with the error term, and that the excluded instruments are correctly excluded from the estimated equation. A rejection casts doubt on the validity of the instruments. Therefore, the p-value must be very large in order not to reject our null hypothesis.

Because we are considering about 30 observations (30 communities), there is a worry that we might be dealing with too few observations. One way to deal with that is bootstrapping. We applied the bootstrapping procedure to check for robustness of the standard errors and found that the results are consistent with each other. Tables A.13 through A.15 in the annexes show that our results do not vary significantly from the original results. We take this to be a validation of our results and, henceforth, we will interpret them. In the section below, we present both OLS and instrumental variables estimation results for both models.

4.2.1 Regression Model 1: Relationship between Cooperation and Institutions

The results in Table 8 show that both the OLS regression model and the instrumental variables estimation are highly significant and explain over 80.0% of the variation in the dependent variable. We consider two models, a model with the overall institutional index and another with disaggregated institutional indices.[14] Replacing the overall institutional index with disaggregated institutional indices does not affect the signs of the explanatory variables in the model and so the interpretation remains the same. Comparing OLS and the IV results, we observe that most variables are highly significant, except for group size, ethnicity, resource size and wealth. The variable ethnicity measures heterogeneity in a community or group, but the variable is insignificant in both models, suggesting that ethnicity is not an important variable explaining cooperation in the area. However, with disaggregated institutional indices, group size, resource size and wealth become significant under both OLS and IV estimation, implying that cooperation is explained better with the latter model than with the former.

[14] As highlighted earlier, the overall institutional index can be disaggregated into four institutional characteristics: clarity of institutions, fairness, governance and monitoring, and enforcement. The objective of disaggregating the overall institutional index into these four attributes is to establish those characteristics of institutions that matter most for cooperation.

Table 8. Relationship between ability of a community to self-organise and institutions

Cooperation	Model with overall institutional variable		Model with institutional attributes	
	OLS	*IV*	*OLS*	*IV*
Number of obs	336	336	336	336
Prob>F	0.0000	0.0000	0.0000	0.0000
R-squared	0.8542	-	0.8854	-
F (10, 325)	-	223.22	-	320.2
Centered R2	-	0.8191	-	0.844
Uncentered R2	-	0.9378	-	0.946
overall institutional index	0.129***	0.557***		
	(0.0487)	(0.177)		
clarity index			0.117*	0.195
			(0.0696)	(0.137)
fairness index			-0.160***	-0.515**
			(0.0537)	(0.150)
governance index			0.192***	0.603***
			(0.0732)	(0.168)
monitoring and enforcement index			0.360***	0.245***
			(0.0512)	(0.103)
group size	0.00121	0.00472*	0.00309*	0.00205**
	(0.00181)	(0.00197)	(0.00161)	(0.00152)
Trust	3.120***	1.151***	1.800***	1.496***
	(0.574)	(0.893)	(0.554)	(0.756)
Ethnicity	-1.172	0.231	-0.626	-0.594
	(0.767)	(1.135)	(0.714)	(0.960)
wealth index	0.0673**	0.0254	0.0555**	0.0642**
	(0.0268)	(0.0342)	(0.0239)	(0.0278)
year of establishment	1.672***	1.181***	1.255***	1.166***
	(0.202)	(0.328)	(0.187)	(0.267)
punishment [0 = Exo, 1 = Endo]	12.99***	11.23***	7.195***	9.815***
	(1.843)	(2.170)	(1.831)	(2.528)
resource size	-0.000150	-0.000287***	-0.000265**	-0.000366***
	(9.22e-05)	(9.84e-05)	(0.000111)	(0.000157)
number of stakeholders	1.552***	1.741**	0.912*	0.557***
	(0.564)	(0.702)	(0.533)	(0.596)
Tenure	-8.657***	-7.465***	-6.617**	-12.17***
	(2.883)	(2.153)	(3.271)	(4.855)
Cons	-12.04***	-12.62**	-9.085***	-3.016
	(3.635)	(5.121)	(3.360)	(4.072)

Source: survey data Aug 2013

NB: Standard errors shown in brackets

* Significant at 10% ** Significant at 5% *** Significant at 1%

The results above show that the institutional variable is positive and significant at the 1% level of significance. This seems to suggest that an improvement in the quality of institutions increases cooperation in the respective communities. This result is consistent with theory and confirms our hypothesis that institutions matter for self-organisation, i.e., good institutions translate into higher levels of cooperation and vice versa. It is important to note at this point that all communities in the study area have managed to develop some form of institutions, although these institutions differ in terms of their characteristics as we move from one community to another. Hence, we can rule out the possibility of an open access regime where members of the community can access resources at any time without restraint, i.e., a system where there are no rules governing access to and utilization of resources.

When we consider the model with the disaggregated institutional index, we observe that both the governance index and the monitoring and enforcement index are highly significant and positive, suggesting that an improvement in these variables might increase cooperation. Our results suggest that governance and monitoring and enforcement are more important for cooperation than are fairness and clarity of institutions. The results underscore the need for institutional arrangements that allow local communities to fully participate in wildlife conservation, govern their resources in a democratic way, monitor each other, and enforce rules and regulations internally; these measures are more likely to encourage higher levels of cooperation, with possible implications for biodiversity outcomes.

However, to our surprise, the fairness index is highly significant and carries a negative sign. This is a little problematic. Because we collected qualitative data, a possible explanation for this anomaly could be that beneficiaries closer to the park fence frequently suffer from wildlife intrusion and hence they feel that they should be treated differently from those farther away from the fence. This also explains why group size is very unstable at the ward level and why communities frequently divide into smaller groups in order to ensure that communities that suffer more from wildlife intrusion benefit more than those farther away.

Community-level trust, year of establishment, punishment and number of stakeholders have positive and significant impacts on cooperation. This seems to suggest that cooperation is better in communities where members trust each other than in communities where trust is lacking. As suggested in the previous section, cooperation is higher in communities that joined wildlife conservation earlier than in communities that joined later. This makes sense because the longer a community is involved in wildlife conservation, the more likely it is for that community to develop robust institutions that are adapted to local conditions. Cooperation is also higher in communities that have endogenized punishment as opposed to communities that still rely on external force in order to enforce adherence to rules and regulations.

Policymakers and development practitioners should seriously consider institutional reforms that convey greater control of natural resources through devolution and decentralization of managerial functions, decision making and authority into the hands of local communities, while the state maintains regulatory functions. Ostrom et al. (2007) argue that it is cheaper for local communities to engage in monitoring and enforcement activities than it is for the state apparatus to do so, due to budgetary and information constraints. Our results also reveal that cooperation increases with an increase in the number of stakeholders. This is true in the study area because there are a number of NGOs working with local communities in wildlife conservation, particularly in providing training or capacity building.

The tenure variable is negative and highly significant (at 1%) under both models, implying a negative relationship between tenure and cooperation. This suggests that cooperation declines as we move from communal areas into the resettlement schemes. This is true for two main reasons. Firstly, the resettlement schemes are comprised of private land holders operating on individual plots, who are thus maximizing individual objectives at the farm level but not as a community. Given the nature of resettlement schemes, it is difficult for park authorities to monitor and enforce rules on private property unless farm owners come together and act as a community in order to achieve a common objective of conservation. Secondly, unlike in communal areas where institutions bring people together, in resettlement schemes such institutions do not exist; farmers act individually and no one knows what the other farmer is doing on his farm.

Furthermore, with the introduction of disaggregated institutional indices, group size, the size of the resource system and wealth become significant under both models, although the interpretation is a little bit problematic. Our results show that there is a significant and positive relationship between group size and cooperation. In general, theory posits that the effect of group size on self-organisation tends to be negative, given the higher transaction costs associated with getting people together and agreeing on important issues (Ostrom 2009; Wade 1994). However, if the tasks of managing a resource system are very costly (e.g., monitoring an extensive resource system), larger groups are in a better position to mobilize the necessary resources required for such undertakings. Hence, the size of the group is always relevant, but its influence on the ability of a community to self-organise is contingent on other variables of the SES and the type of management activities in question (Ostrom 2009).

The results also show that the level of cooperation in a community declines as the size of a resource system increases. Chhatre and Agrawal (2008) argue that self-organisation is more unlikely in very large and very small resource systems. The reason could be that very large resource systems are associated with high costs of defining boundaries, monitoring and enforcement, and gaining ecological knowledge, while very small resource systems do not generate substantial flows of valuable products. Hence, a moderate-sized resource system is most conducive to self-organisation. We therefore argue that, for most communities considered in the study area, the resource system is big enough to generate tangible benefits, and communities with a smaller conservation area and larger group size are better off in terms of fostering cooperation than communities with a larger conservation area and smaller group size.

Surprisingly, the wealth index becomes significant and still carries a positive sign under both models when the disaggregated institutional attributes are introduced, suggesting more cooperation in wealthier communities than in poor communities. The conventional wisdom from field experiments suggests that, at the group level, both average group wealth and variance in the distribution of wealth decrease the level of cooperation or social efficiency achieved by the group (Ostrom et al. 1994; Cardenas 2003). This could be a result of measurement error.

4.2.2 Regression Model 2: Relationship between Biodiversity and Cooperation

Both OLS and IV estimation models are significant at the 1% level and explain over 72.2% of the variation in our dependent variable (please refer to Table 9 below). Although the Durbin-Wu-Hausman tests suggest that IV estimation with heteroskedasticity-based instruments is superior to its OLS counterpart, all variables in both models are significant and do not vary much in terms of their coefficients, standard errors and the level of significance for the two models.

The results in Table 9 show that cooperation is positive and highly significant. This implies that cooperation is an important variable explaining biodiversity outcomes, as suggested in the CPR literature. Hence, we expect to find more sound ecological outcomes in those communities with high levels of cooperation and strong institutions than in communities with less cooperation and weak institutions. We maintain that institutions affect biodiversity outcomes indirectly, through ability to self-organise, or cooperation. Alternatively, we might think of cooperation as refraining from illegal harvesting of wildlife resources, so that, in areas where the level of cooperation is very low and poaching activities are rife, wildlife is either quickly decimated due to overharvesting or may respond to higher levels of poaching by retreating back into the park, thereby leaving few wild animals in the community’s conservation area. As a result, a community that is less poached has more animals in its vicinity than does a community that is heavily poached.

Table 9. Model 2 - Relationship between biodiversity and cooperation

Biodiversity	OLS	IV
Number of obs	336	336
Prob>F	0.0000	0.0000
R-squared	0.7223	-
F (10, 325)	-	283.38
Centered R2	-	0.807
Uncentered R2	-	0.9224
Cooperation	0.00595***	0.00758***
	(0.00246)	0.00215
training [0=yes, 1=no]	0.215***	0.208***
	0.0745	0.0762
Benefits	1.51e-05***	1.25e-05***
	3.56e-06	3.37e-06
distance to nearest urban centre	0.0122***	0.0126***
	0.00151	0.00130
distance to the fence	0.0148***	0.0131***
	0.00212	0.00205
social capital index	0.00704***	0.00710***
	0.00200	0.00202
average age of household head	-0.357***	-0.381***
	0.123	0.135
average number of years in school	-0.0926***	-0.0892***
	0.0227	0.0234
average number of years living in the area	-0.00538**	-0.00597**
	0.00218	0.00247
Fence	-0.00345***	-0.00490***
	0.00129	0.00182
Information sharing index	0.242***	0.210***
	0.0429	0.0455
Cons	9.631***	10.34***
	3.025	3.347

Source: survey data Aug 2013

NB: Standard errors shown in brackets

* Significant at 10% ** Significant at 5% *** Significant at 1%

As expected, training is positive and highly significant, implying that this variable is an important factor explaining the success of biodiversity outcomes. This implies that communities that received training are better off in terms of managing and conserving wildlife than are communities where training has not been administered. However, not all communities have received training relevant to wildlife management. The number of households and communities involved in wildlife conservation is growing, signalling the need for more training in the study area. Qualitative interviews also revealed that committee membership changes quite frequently and, at times, there is a total overhaul of the entire management committee, which may severely affect operations. There is therefore a need for continuous training so that the institutional memory and entrepreneurial and leadership skills acquired through training are not lost when such a dramatic change occurs. Therefore, government programmes should target capacity building in terms of institutional capacity and skills development in order to have a positive and significant impact on biodiversity.

As expected, the benefits from wildlife conservation significantly and positively affect biodiversity outcomes in a community. If the resource system is very important in the eyes of the users and generates a substantial flow of benefits, then users attach high value to sustainability of the resource (Berkes and Folke 1998; and Chhatre and Agrawal 2008); otherwise, the cost of organising and maintaining a self-organised system may not be worth the effort (National Research Council 2002). Communities from the study area have come to realize that using the proceeds from wildlife conservation to invest in public goods such as schools, clinics, water, grinding mills, and electricity is much more beneficial than getting dividends at the household level. Viewed from this angle, the benefits from wildlife conservation are tangible in the eyes of the community and therefore community wildlife conservation is very successful. This line of reasoning differs from previous studies which considered benefits in terms of income flowing directly into the household.

Market integration and global market trends are viewed worldwide as potential threats to wildlife conservation in developing countries. In this paper, we used distance to the nearest urban centre as a proxy for market integration. The variable distance to the nearest urban centre is positive and highly significant, suggesting that biodiversity outcomes improve as the distance to the market increases. We argue that the incentives for poaching are much higher for those communities that are located closer to urban centres or main routes linking rural communities to urban areas because animals and game fetch higher prices in wider markets. Qualitative interviews with key informants revealed substantial evidence of game meat being sold on the black market in almost all the communities visited during the survey period and, under certain circumstances, poachers transporting game meat to distant markets such as growth points and urban centres.

On the other hand, communities that are located closer to the fences are less likely to conserve biodiversity because they suffer more from wildlife intrusion, interact with wildlife quite frequently and hence have greater access to wildlife than those communities located further away. This is confirmed by our results: the variable measuring distance to the fence is positive and highly significant. In other words, as the distance to the fence increases, biodiversity outcomes improve significantly. Our results seem to suggest that biodiversity outcomes are more successful for those communities that are located far away from urban centres or routes connecting rural communities to urban centres but are not very close to the boundary of the game park.

Social capital is also an important variable explaining the success of biodiversity outcomes. The variable is positive and significant. Social capital may either help to conserve or destroy biodiversity depending on the nature of the relationship. If social capital is high in a community, such that households have links both inside and outside the community, then these households are more likely to get assistance in times of need and hence less likely to depend on illegal harvesting of wildlife resources. This is true for some communities in the study area because they have more children or relatives working in urban areas or abroad in South Africa. If households are connected at the community level (through common understanding, common interests, respect for each other and the need to maintain a long-term relationship that is beneficial to everyone), they are more likely to make decisions as a community. This minimizes the possibility of social deviance while at the same time enhancing society's welfare.

The average age of the household head is significant and negatively related to the success of biodiversity outcomes. This implies that, as the age of the household head increases, biodiversity outcomes worsen. Godoy et al. (1997) reported that the age of household head may be positively related to resource-based income until a point where resource use declines with age, coupled with children moving away to seek new opportunities and start their own households elsewhere. Including a quadratic term for the average age of the household head does not affect our results much. Table A.12 demonstrates that, as the age of the household head increases, biodiversity outcomes deteriorate up to a certain age (51.4 years), when poaching ceases to be an important livelihood activity for the household head due to old age. This suggests a positive relationship between the age of the household head and income based on resource use.

Surprisingly, number of years in school and number of years living in the area for the household head are both significant and negatively related to biodiversity outcomes. Expectations were that, as the number of years in school and the number of years living in the area increases, biodiversity outcomes would improve. This result could be due to the alternative sources of income brought about by an additional year in school, which might make it less financially important to participate in wildlife conservation, and the knowledge about animal movements acquired by the household head over a number of years. If the benefits from wildlife conservation are negligible relative to other sources of income, the incentives to conserve wildlife are eroded and the household finds it rational to poach, as the benefits accruing to the household are much greater.

An interesting development in the study area is the idea of putting an electric fence around Gonarezhou National Park in order to conserve wildlife and reduce human-wildlife conflict. The project has already started with support from donor funding and its completion depends heavily on the availability of these funds. Most communities have lost part of their conservation area to the national park and the number is growing with an increase in the area of the park covered by the electric fence. Beneficiaries of conservation payments view this development as a potential threat to the CAMPFIRE project. Our results show that the fence reduces biodiversity in the community's conservation area. This is true for two main reasons. Firstly, the fence greatly reduces the number of wild animals moving into the community's conservation area from the park. Secondly, the electric fence greatly reduces the benefits from wildlife conservation, thereby eroding the community's incentives to conserve wildlife resources. As a result, the local community might fight back by increasing its poaching effort, leading to resource overexploitation and finally exhaustion of all resident species and those that can make it across the fence.[15]

According to Ostrom (2007), information sharing is one of the most important variables that can affect ecological outcomes. During meetings, communities share vital information about past actions, progress updates, general finance matters, fire outbreaks, watering points, poaching and knowledge of the SES, in addition to their usual community agendas. Our results show that biodiversity improves when the community is able to share information. Sharing information entails both responsibility and accountability of community leadership, which will in turn facilitate the development of a relationship based on trust and honesty. In addition, when users share common knowledge of relevant SES attributes, rules and regulations, and how their actions affect each other, they will perceive lower costs of organising (Ostrom 2009; and Berkes and Folke 1998).

[15] Predators and small plains game that can sneak under the fence in rugged terrain are still able to move inside and outside the park and interact with human beings. Furthermore, elephants can still damage the electric fence if they have mastered the technique of doing so.

5. Conclusions and Policy Recommendations

This study used a sample of 336 households and community-level data from 30 communities to analyse (i) the relationship between ability to self-organise and institutions, among other variables identified as affecting collective action; and (ii) the relationship between success of biodiversity outcomes and cooperation among variables, identified as enhancing the sustainability of a resource system. To achieve this, the study relied heavily on Ostrom's general framework for analysing complex social-ecological systems. We used ordinary least squares regression analysis and instrumental variables estimation with heteroskedasticity-based instruments. This approach methodologically deals with the endogeneity problem associated with the relationships above.

Our results confirmed that sound institutions are indeed an important ingredient for cooperation. Improvements in institutional attributes such as governance (participation and democracy) and monitoring and enforcement might lead to increased cooperation, while fairness and clarity of institutions were found to be less important. Community-level trust, punishment, number of stakeholders and tenure were also found to be important variables explaining cooperation. With the introduction of disaggregated institutional indices, group size, the size of the resource system and wealth become significant, although the interpretation was problematic.

Furthermore, cooperation had a positive and significant impact on biodiversity outcomes, suggesting that higher levels of cooperation might translate into a healthy wildlife population. We therefore argue that institutions directly affect cooperation, and indirectly influence biodiversity outcomes through cooperation. Cooperation, training, benefits, distance from the nearest urban centre, distance from the park fence, social capital, and information sharing were found to have a positive and significant impact on biodiversity outcomes. The average age of the household head, number of years in school, number of years living in the area and proximity to the park fence had a negative and significant impact on biodiversity.

From a policy perspective, our results show that external enforcement of rules and regulations does not necessarily translate into sound ecological outcomes; rather, better outcomes are attainable when punishment is endogenized by local communities. This seems to suggest that communities should be supported in a way that promotes the emergence of robust institutions that are tailor-made to suit local needs; this will, in turn, facilitate good environmental husbandry. Future policy reforms should also consider the possibility of giving full autonomy to local communities so that they can monitor each other and internalize enforcement of rules and regulations.

State authorities should reconsider the way in which they engage with farmers under resettlement schemes, because biodiversity suffers more under this type of arrangement than in communal areas. There is a need for appropriate institutional reforms that allow park authorities to work closely with resettlement schemes, while at the same time giving incentives for plot holders to work together for the improvement of the common pool resource. For example, farmers in resettlement schemes could set aside land for conservation by pooling resources instead of operating at plot level, which works against conservation efforts.

Training, benefits and fencing could have important implications for policy formulation and design. For instance, government programmes can target capacity building in terms of institutional capacity and skills development in order to have a positive impact on biodiversity. Therefore, the capacity building efforts of government agencies, NGOs and other stakeholders should complement each other to ensure that the necessary resources are mobilized and all communities receive the necessary training and resources. Both the extent to which communities benefit from wildlife conservation and the extent to which they are allowed to make important decisions about how benefits are distributed and used by the community affect incentives to conserve wildlife. Fencing the national park has a detrimental effect on the CAMPFIRE project and the lives of people whose livelihoods depend on wildlife conservation.

References

Akpalu, W., and P. Martinsson. 2011. Ostracism and Common Pool Resource Management in a Developing Country – Young Fishers in the Laboratory. *Journal of African Economies* 21(2): 266-306.

Agrawal, A. 2001. Common Property Institutions and Sustainable Governance of Resources. *World Development* 29(10): 1649-1672.

Baum, C. F., A. Lewbel, M. E. Schaffer, and O. Talavera. 2013. Instrumental Variables Estimation Using Heteroskedasticity-based Instruments. United Kingdom Stata User's Group Meetings 2012 07, Stata Users Group.

Berkes, F., T. P. Hughes, R. S. Steneck, J. A. Wilson, D. R. Bellwood, B. Crona, C. Folke, L. H. Gunderson, H. M. Leslie, J. Norberg, M. Nyström, P. Olsson, H. Österblom, M. Scheffer, and B. Worm. 2006. Globalization, Roving Bandits, and Marine Resources. AAAS. *Science* 311: 1557-1558.

Berkes, F., and C. Folke, eds. 1998. Linking Social and Ecological Systems – Management Practices and Social Mechanisms for Building Resilience. Cambridge University Press.

Brundtland, G. et al. 1987. Our Common Future. Report of the World Commission on Environment and Development, United Nations.

Cardenas, J. C. 2003. Real Wealth and Experimental Cooperation - Experiments in the Field Lab. *Journal of Development Economics* (70): 263-289.

Cardenas, J. C., J. Stranlund, and C. Willis. 2000. Local Environmental Control and Institutional Crowding-Out. *World Development* 28(10): 1719-1733.

Chhatre, A., and A. Agrawal. 2008. Forest Commons and Local Enforcement. *PNAS* 105: 36

Eltringham, S. K. 1994. Can Wildlife Pay its Way? *Oryx* 28: 163-168.

Fehr, E., and S. Gächter. 2000. Fairness and Retaliation: The Economics of Reciprocity. *Journal of Economic Perspectives* 14: 159-181.

Fischbacher, U., and S. Gatcher. 2010. Social Preferences, Beliefs and the Dynamics of Free Riding in Public Goods Experiments. *American Economic Review* 100(1): 541-556.

Fischbacher, U., S. Gachter, and E. Fehr. 2001. Are People Conditionally Cooperative? Evidence from Public Goods Experiments. *Economic Letters* 71: 397-404.

Gibson, C., and S. Marks. 1995. Transforming Rural Hunters into Conservationists. An Assessment of Community Based Wildlife Management in Africa. *World Development* 23(6): 941-957.

Godoy, R., K. O'neill, S. Groff, P. Kostishack, A. Cubas, J. Demmer, K. Mcsweeney, J. Overman, D. Wilkie, and N. Brokaw. 1997. Household Determinants of Deforestation by Amerindians in Honduras. *World Development* 25(6): 977-987.

Hardin, G. 1968. The Tragedy of the Commons. *Science* 162: 1243-1248.

Herrmann, B., C. Thöni, and S. Gächter. 2008. Antisocial Punishment across Societies. *Science* 319(5868): 1362-1367.

Hodgson, G. M. 2006. What Are Institutions? *Journal of Economic Issues*, 60(1): 1-25.

Kreuter, U., M. Peel, and E. Warner. 2010. Wildlife Conservation and Community-based Natural Resource Management in South Africa’s Private Nature Reserves. *Society and Natural Resources* 23: 507-524.

Lewbel, A. 2012. Using Heteroskedasticity to Identify and Estimate Mismeasured and Endogenous Regressor Models. *Journal of Business and Economic Statistics* 30(1): 67-80.

Masclet, D., C. Noussair, S. Tucker, and M. C. Villeval. 2003. Monetary and Nonmonetary Punishment in the Voluntary Contributions Mechanism. *American Economic Review* 93(1): 366-380.

McCarthy, N., C. Dutilly-Diane, and B. Drabo. 2002. Cooperation, Collective Action and Natural Resource Management in Burkina Faso – A Methodological Note. CAPRi Working Paper No. 27, CGIAR.

Menard, S. 1995. Applied Logistic Regression Analysis - Sage University Series on Quantitative Applications in the Social Sciences. Thousand Oaks, CA: Sage University.

Mouillot, D., and Lepretre, A. 1999. A Comparison of Species Diversity Estimators. *The Society of Population Ecology and Springer* (41): 203-215.

Murphy, J. J., and J. C. Cardenas. 2004. An Experiment on Enforcement Strategies for Managing a Local Environmental Resource. *Journal of Economic Education* 31(1): 47.

Muir-Leresche, K., and R. H. Nelson. 2000. Private Property Rights to Wildlife – The Southern Africa Experience. University of Zimbabwe, University of Maryland and ICER.

Mushunje, A., A. Belete, and G. Fraser. 2003. Technical efficiency of resettlement farmers of Zimbabwe. Paper Presented at the 41st Annual Conference of the Agricultural Economic Association of South Africa (AEASA), Pretoria, South Africa.

Nagendra, H. 2002. Opposite Trends in Response for the Shannon and Simpson Indices of Landscape Diversity. *Applied Geography* (22): 175-186.

National Research Council. 2002. The Drama of the Commons. Committee on the Human Dimensions of Global Change, edited by E. Ostrom, T. Dietz, N. Dolsˇak, P. C. Stern, S. Stovich, and E. U. Weber. Division of Behavioral and Social Sciences and Education. Washington, DC: National Academy Press.

Neter, J., W. Wasserman, and M. H. Kutner. 1989. Applied Linear Regression Models. Homewood, IL: Irwin.

Nikiforakis, N., H. T. Norman, and B. Wallace. 2007. Asymmetric Enforcement of Cooperation in a Social Dilemma. Department of Economics Working Paper 982, University of Melbourne.

North, D.C. 1991. Institutions. *Journal of Economic Perspectives* 5(1): 97-112.

O'brien, R. M. 2007. A Caution Regarding Rules of Thumb for Variance Inflation Factors. Quality & Quantity. *Springer* 41: 673-690.

Oslon, M. 1965. The Logic of Collective Action – Public Goods and the Theory of Groups. Harvard University Press Volume CXXIV.

Ostrom, E. 2010. Analysing Collective Action. International Association of Agricultural Economists (IAAE).

Ostrom, E. 2009. A General Framework for Analysing Sustainability of Social-Ecological Systems. *Science* 325:419-422.

Ostrom, E. 2007. A Diagnostic Approach for Going beyond Panaceas. Centre for the Study of Institutions, Population & Environmental Change. *PNAS* 104(39).

Ostrom, E., M. A. Jansses, and J. M. Anderies. 2007. Going beyond Panaceas. *PNAS* 104(39).

Ostrom, E. 2003. How Types of Goods and Property Rights Jointly Affect Collective Action. *Journal of Theoretical Politics* 15(3): 239-270.

Ostrom, E. 1994. Institutional Analysis, Design Principles and Threats to Sustainable Community Governance and Management of Commons. In *Community Management and Common Property of Coastal Fisheries in Asia and the Pacific: Concepts,* *Methods and Experiences*, edited by R. S. Pomeroy. Manila, Philippines: International Center for Living Aquatic Resources Management.

Ostrom, E. 1990. Governing the Commons: The Evolution of Institutions for Collective Action - The Political Economy of Institutions and Decisions. Cambridge University Press.

Pennings, J. M. E., and R. M. Leuthold. 2000. The Role of Farmer's Behavioural Attitudes and Heterogeneity in Futures Contracts Usage. *American Journal of Agricultural Economics* (82)4: 908-919.

Rustagi, D., S. Engel, and M. Kosfeld. 2011. Conditional Cooperation and Costly Monitoring Explain Success in Forest Commons Management. *Science* 330(6006): 961-965.

Songorwa, A. N. 1999. Community-Based Wildlife Management (CWM) in Tanzania. Are the Communities Interested? *World Development* 27(12): 2061-2079.

Thuiller, W., O. Broennimann, G. Hughes, J. R. M. Alkemade, G. F. Midgley, and F. Corsi. 2006. Vulnerability of African Mammals to Anthropogenic Climate Change under Conservative Land Transformation Assumptions. *Global Change Biology* 12: 424-440.

Wade, R. 1994. Village Republics - Economic Conditions for Collective Action in South India. San Francisco, California: Institute for Contemporary Studies.

Wade, R. 1987. The Management of Common Property Resources: Collective Action as an Alternative to Privatization and State Regulation. *Cambridge Journal of Economics* 11: 95-106.

Annexes

Table A.1. List of variables identified as relevant for studying complex SESs

Social, Economic, and Political Settings (S) S1- Economic development. S2- Demographic trends. S3- Political stability. S4- Government resource policies. S5- Market incentives. S6- Media organisation.	
Resource Systems (RS)	Governance Systems (GS)
RS1- Sector (e.g., wildlife, forests, pasture, fish)	GS1- Government organisations
RS2- Clarity of system boundaries	GS2- Nongovernment organisations
RS3- Size of resource system*	GS3- Network structure
RS4- Human-constructed facilities	GS4- Property-rights systems
RS5- Productivity of system*	GS5- Operational rules
RS6- Equilibrium properties	GS6- Collective-choice rules*
RS7- Predictability of system dynamics*	GS7- Constitutional rules
RS8- Storage characteristics	GS8- Monitoring and sanctioning processes
RS9- Location	
Resource Units (RU)	Users (U)
RU1- Resource unit mobility*	U1- Number of users*
RU2- Growth or replacement rate	U2- Socioeconomic attributes of users
RU3- Interaction among resource units	U3- History of use
RU4- Economic value	U4- Location
RU5- Number of units	U5- Leadership/entrepreneurship*
RU6- Distinctive markings	U6- Norms/social capital*
RU7- Spatial and temporal distribution	U7- Knowledge of SES/mental models*
	U8- Importance of resource*
	U9- Technology used
ACTION SITUATIONS [Interactions (I) → Outcomes (O)]	
I1- Harvesting levels of diverse users	O1- Social performance measures (e.g., efficiency, equity, accountability, sustainability)
I2- Information sharing among users	
I3- Deliberation processes	
I4- Conflicts among users	
I5- Investment activities	O2- Ecological performance measures (e.g., overharvested, resilience, biodiversity, sustainability)
I6- Lobbying activities	
I7- Self-organising activities	
I8- Networking activities	O3- Externalities to other SESs
Related Ecosystems (ECO) ECO1- Climate patterns. ECO2- Pollution patterns. ECO3- Flows into and out of focal SES.	

Source: Source: Extracted from Elinor Ostrom (2007: 15182)

*NB: *Subset of variables found to be associated with self-organisation.*

Table A.2. Sample size by community

Ward	Name of community	No. of interviews	Target	Households
Ward 10	Gondweni	10	20	400
	Muthlanguleni	10	20	420
Ward 12	Gonakudzingwa (Area 1)	1	2	6
	Gonakudzingwa (Area 2)	2	5	14
	Gonakudzingwa (Area 3)	4	10	23
Ward 13	Chamabvuwani	9	30	625
	Malifumune	6	10	236
Ward 14	Kotsvi/Sengwe	9	12	492
Ward 15	Dhumisa	18	15	320
	Hlarweni	25	15	108
	Malipati	10	10	260
	Mugiviza	3	10	178
	Samu	8	10	89
Ward 22	Chizvirizvi	10	10	81
Ward 23	Nyangambe	13	15	181
Ward 29	Mutandahwe	19	35	2000
Ward 30	Mahenye	29	30	960
Ward 4	Sibizaphanzi	10	10	350
Ward 5	Chitete	10	20	1000
	Chitsanzeni	12	10	311
	Tinhongeni	10	10	278
Ward 8	Chehondo	30	20	350
	Chihosi	8	10	250
	Chipachini	3	10	200
	Dopi	14	10	220
	Lisese	10	10	144
	Machiloli	10	10	71
Ward 9	Chingele	9	15	360
	Machindu	15	25	557
Total		336	419	10560

Source: Survey data Aug 2013

Table A.3. Important stakeholders and their role in community wildlife conservation

Variable	Obs	Mean	Std. Dev.	Min	Max
Important stakeholders					
Rural District Council	336	0.961	0.193	0	1
National Parks	336	0.875	0.331	0	1
Professional Hunter	336	0.732	0.444	0	1
Zimbabwe Republic Police	336	0.289	0.454	0	1
Traditional leaders	336	0.262	0.440	0	1
PARSEL	336	0.330	0.471	0	1
Environmental Management Agency	336	0.313	0.464	0	1
Veterinary Department	336	0.0595	0.237	0	1
AGRITEX	336	0.0565	0.231	0	1
Community Development Association	336	0.161	0.368	0	1
Malilangwe Trust	336	0.134	0.341	0	1
Hippo Valley Conservancy	336	0.0298	0.170	0	1
Save Conservancy	336	0.0387	0.193	0	1
Africa Wildlife Foundation	336	0.0387	0.193	0	1
Mean number of stakeholders	336	4.280	1.698	2	9
Role of the Rural District council in the CAMPFIRE project (RDC)					
RDC has the appropriation authority	336	0.732	0.444	0	1
Monitoring & enforcement/patrols	336	0.390	0.488	0	1
Major decision-making organ	336	0.886	0.500	0	1
Select PH and issue licenses	336	0.813	0.391	0	1
Enact bylaws	336	0.881	0.324	0	1
Who is involved in setting the rules?					
Local communities	336	0.461	0.499	0	1
Rural District Council	336	0.789	0.409	0	1
National Parks	336	0.548	0.498	0	1
Wildlife Management Committee	336	0.310	0.463	0	1
Traditional leaders	336	0.265	0.442	0	1

Source: survey data Aug 2013

Table A.4. Community involvement in wildlife management

How community is involved?	Obs	Mean	Std. Dev.	Min	Max
Anti-poaching activities	336	0.595	0.492	0	1
Whistleblowing	336	0.363	0.482	0	1
Employ game guards with guns	336	0.223	0.417	0	1
Use resource monitors (volunteers)	336	0.244	0.430	0	1
Veldt fire management	336	0.423	0.495	0	1
Awareness campaigns	336	0.967	0.178	0	1
Quota setting	336	0.324	0.469	0	1
Live cropping	336	0.125	0.331	0	1

Source: survey data Aug 2013

Table A.5. Community characteristics

Variables	No		Yes		Total	
	Freq	**%**	**Freq**	**%**	**Freq**	**%**
Bundle of rights enjoyed by the community						
Use rights	206	61.3	130	38.7	336	100.0
Decision-making rights	223	66.4	113	33.6	336	100.0
Ability to enter or exit and to exclude unentitled parties						
Are you able to enter or exist WMC	306	91.3	30	8.7	336	100.0
Are you able to exclude *unentitled parties*	223	66.4	113	33.6	336	100.0
Benefits from wildlife conservation						
Is the community entitled to benefits?	22	6.5	314	93.5	336	100.0
Household received cash dividends	259	77.1	77	22.9	336	100.0
Existence of a wildlife management plan and constitution						
Wildlife Management Plan	250	74.4	86	25.6	336	100.0
Constitution	47	14.0	259	86.0	336	100.0

Source: survey data Aug 2013

Table A.6. Number of rules, meetings and activities

Variable	Obs	Mean	Std.	Min	Max
Number of WMC meetings	336	3.58	1.62	0	12
Number of WMC activities	336	0.860	1.141	0	8
Number of WMC major rules	336	13.89	10.90	0	32
Number of WMC minor rules	336	33.04	27.44	0	78
Total number of WMC rules & regulations	336	46.87	38.09	0	110
Number of other NRM rules	336	6.846	5.304	0	19.25
Number of NRM meetings	336	2.48	1.50	0	5.25
Number of NRM activities	336	3.24	3.16	0	12.5
Number of non-NRM rules	336	14.34	4.57	7.5	25
Number of non-NRM meetings	336	4.00	1.45	2	7
Number of non-NRM activities	336	8.59	3.83	2	15
Extent to which rules are recognized by society	336	3.51	2.75	0	8
Extent to which rules are recognized by authorities	336	6.10	4.32	0	10
Number of poaching incidents	336	7.955	6.192	0	22

Source: survey data Aug 2013

Table A.7. Durbin-Wu-Hausman test for endogeneity

a) For the first model (cooperation and institutions)			**b) For the first model (biodiversity and cooperation)**		
inst_res	=	0	cooperation_res	=	0
F (1, 322)	=	0.540	F (1, 322)	=	11.53
Prob > F	=	0.461	Prob > F	=	0.0008

Table A.8. VIF test result for the models below

Variable	VIF	1/VIF
Model 1- with overall institutional index		
year of establishment	5.720	0.175
Trust	4.340	0.230
inst index	3.170	0.316
number of stakeholders	2.520	0.397
punishment [0 = Exo, 1 = Endo]	2.330	0.428
group size	1.910	0.523
tenure	1.860	0.538
resource size	1.350	0.740
ethnicity	1.310	0.763
wealth index	1.150	0.869
Mean	VIF	2.570
Model 1- with disaggregated institutional index		
governance	8.000	0.125
clarity	6.300	0.159
year of est.	5.700	0.175
monitoring	4.900	0.204
trust	4.490	0.223
fairness	4.100	0.244
punishment	2.900	0.345
number of stakeholders	2.680	0.373
group size	1.900	0.526
tenure	1.860	0.538
ethnicity	1.550	0.646
wealth index	1.360	0.735
Mean	VIF	3.750
Model 2 – cooperation and biodiversity		
cooperation	5.060	0.198
benefits	4.650	0.215
average number of years in school	2.980	0.336
fence	2.580	0.388
number of poaching incidents	2.240	0.447
average age of household head	1.950	0.512
distance to nearest urban centre	1.850	0.541
information sharing index	1.770	0.565
Training [0=no, 1=yes]	1.630	0.613
distance to the fence	1.600	0.625
average number of years living in the area	1.120	0.891
social capital index	1.080	0.926
Mean	VIF	2.430

Source: survey data Aug 2013

Table A.9. Model 1 - Relationship between ability of a community to self-organise and institutions (IV results with overall institutional index)

Number of obs	336
F (10, 325)	223.22
Prob>F	0.0000
Centered R2	0.8191
Uncentered R2	0.9378

cooperation	Coef.		Robust Std. Error.
institutional index	0.557***		0.17732
group size	0.00472**		0.00197
Trust	1.151***		0.89365
Ethnicity	0.231		1.13534
wealth index	0.0254		0.03424
year of establishment	1.181***		0.32834
punishment [0 = Exo, 1 = Endo]	11.23***		2.17076
resource size	-0.000287***		9.84e-05
number of stakeholders	1.741**		0.70265
Tenure	-7.465***		2.15325
Cons	-12.62**		5.12134
Under-identification test (Kleibergen-Paap rk LM statistic):			72.208
	Chi-sq(10) P-val	=	0.0000
Weak identification test (Cragg-Donald Wald F statistic):			19.373
Hansen J statistic (over-identification test of all instruments):			10.574
	Chi-sq(9) P-val	=	0.2308
Breusch-Pagan test for heteroskedasticity	chi2(1)	=	18.543
	Prob > chi2	=	0.0000

Source: survey data Aug 2013

Table A.10. Model 1 - Relationship between ability of a community to self-organise and institutional characteristics (IV results with institutional characteristics)

Number of obs	336		
F (9, 326)	320.2		
Prob>F	0.0000		
Centered R2	0.844		
Uncentered R2	0.946		

cooperation	Coef.		Std. Err.
clarity index	0.195		0.1375
fairness index	-0.515**		0.1501
governance index	0.603***		0.1683
monitoring index	0.245***		0.1032
group size	0.00205*		0.0015
Trust	1.496***		0.7567
Ethnicity	-0.594		0.9600
wealth index	0.0642**		0.0278
year of establishment	1.166***		0.2674
punishment [0 = Exo, 1 = Endo]	9.815***		2.5282
resource size	-0.000366**		0.0002
number of stakeholders	0.557**		0.5965
Tenure	-12.17**		4.8550
Cons	-3.016		4.0721
Under-identification test (Kleibergen-Paap rk LM statistic):			54.450
	Chi-sq(10) P-val	=	0.0000
Weak identification test (Cragg-Donald Wald F statistic):			16.281
Hansen J statistic (over-identification test of all instruments):			9.5841
	Chi-sq(9) P-val	=	0.2623
Breusch-Pagan test for heteroskedasticity	chi2(1)	=	29.172
	Prob > chi2	=	0.0000

Source: survey data Aug 2013

Table A.11. Model 2 - Relationship between biodiversity and ability of a community to self-organise (IV model results)

Number of obs	336
F (13, 322)	283.38
Prob>F	0.0000
Centered R2	0.807
Uncentered R2	0.9224

biodiversity	Coef.		Robust Std. Error.
Cooperation	0.00758***		0.00215
training [0=no, 1=yes]	0.208***		0.07624
Benefits	1.25e-05***		3.37e-06
distance to nearest urban centre	0.0126***		0.00130
distance to the fence	0.0131***		0.00205
social capital index	0.00710***		0.00202
average age of household head	-0.381***		0.13510
average number of years in school	-0.0892***		0.02345
average number of years living in the area	-0.00597**		0.00247
Fence	-0.00490***		0.00182
Information sharing index	0.210***		0.04552
Cons	10.34***		3.34702
Under-identification test (Kleibergen-Paap rk LM statistic):			139.319
	Chi-sq(10) P-val	=	0.0000
Weak identification test (Cragg-Donald Wald F statistic):			25.420
Hansen J statistic (over-identification test of all instruments):			0.0430
	Chi-sq(9) P-val	=	0.8352
Breusch-Pagan test for heteroskedasticity	chi2(1)	=	21.94
	Prob > chi2	=	0.0000

Source: survey data Aug 2013

Table A12. Model 2 - Relationship between biodiversity and cooperation with age squared

biodiversity	OLS	IV
cooperation	0.00575***	0.00758***
	(0.00346)	0.00415
training [0=yes, 1=no]	0.215***	0.208***
	0.0745	0.0762
Benefits	1.61e-05***	1.35e-05***
	4.56e-06	5.37e-06
distance to nearest urban centre	0.0132***	0.0136***
	0.00145	0.00140
distance to the fence	0.0145***	0.0133***
	0.00342	0.00254
social capital index	0.00724***	0.00730***
	0.00221	0.00232
average age of household head	-0.347***	-0.312***
	0.123	0.135
age^2	0.00347***	0.00368***
	0.00125	0.00138
average number of years in school	-0.0825***	-0.0791***
	0.0216	0.0223
average no. of years living in area	-0.00527**	-0.00586**
	0.00207	0.00236
Fence	-0.00434***	-0.00582***
	0.00199	0.00172
Information sharing index	0.252***	0.2302***
	0.0408	0.0443
Cons	8.520***	10.251***
	3.034	3.456

Source: survey data Aug 2013

NB: Standard errors shown in brackets

* Significant at 10% ** Significant at 5% *** Significant at 1%

Bootstrapping

Table A13. Model 1 - Relationship between ability of a community to self-organise and overall institutional index

Bootstrap replications (200)

------1-------- --------2-------- --------3------- --------4----- --------5---- 200

	OLS	IV
Number of obs	336	336
Replications	200	200
Wald chi2 (10)	3533.93	-
Prob>chi2	0.000	-
R-squared	85.37	-
F (10, 325)	-	223.22
Prob>F	-	0.0000
Centered R2	-	0.8485
Uncentered R2	-	0.9479

cooperation	Observed Coef.	Bootstrapped Std. Err.	Observed Coef.	Bootstrapped Std. Err.
institutional index	0.129***	0.0501	0.595***	0.109
group size	0.00121	0.0016	0.00452**	0.00188
Trust	3.120***	0.5523	1.205***	0.662
Ethnicity	-1.172	0.9825	0.223	0.849
wealth index	0.0673**	0.0318	0.0364	0.0280
year of establishment	1.672***	0.2556	1.151***	0.260
punishment [0 = Exo, 1 = Endo]	12.99***	1.7365	11.311***	1.781
resource size	-0.000150**	7.58e-05	-0.000267***	8.33e-05
number of stakeholders	1.552**	0.7267	1.832**	0.730
Tenure	-8.657***	1.9852	-7.046***	1.663
Cons	-12.04**	5.0241	-12.25**	5.158
Under-identification test (Kleibergen-Paap rk LM statistic):				68.935
		Chi-sq(10) P-val	=	0.0000
Weak identification test (Cragg-Donald Wald F statistic):				12.194
Hansen J statistic (over-identification test of all instruments):				18.252
		Chi-sq(9) P-val	=	0.3528
Breusch-Pagan test for heteroskedasticity		chi2(1)	=	18.543
		Prob > chi2	=	0.0000

Source: survey data Aug 2013

Table A.14. Model 1 - Relationship between ability of a community to self-organise and institutional characteristics

Bootstrap replications (200)

------1-------- --------2-------- --------3------- --------4----- --------5---- 200

	OLS		**IV**	
Number of obs	336		336	
Replications	200		200	
Wald chi2 (10)	5371.36		-	
Prob>chi2	0.000		-	
R-squared	0.8838		-	
F (13, 322)	-		300.48	
Prob>F	-		0.0000	
Centered R2	-		0.8671	
Uncentered R2	-		0.9543	
cooperation	Observed Coef.	Bootstrapped Std. Err.	Observed Coef.	Bootstrapped Std. Err.
clarity index	0.023*	0.0539	0.109	0.2753
fairness index	-0.185***	0.0254	-0.524**	0.0411
governance	0.381***	0.1535	0.712***	0.1323
monitoring & enforcement index	0.451***	0.0182	0.336***	0.2143
group size	0.00428*	0.00126	0.00314*	0.1026
Trust	0.740***	0.5580	2.587***	0.8456
Ethnicity	-0.535	0.8854	-0.493	0.9210
wealth index	0.0647**	0.0236	0.0534**	0.0369
year of establishment	1.346***	0.1905	1.057***	0.2442
punishment [0 = Exo, 1 = Endo]	7.284***	1.9253	10.726***	2.4393
resource size	-0.000354**	0.0001	-0.000475**	0.0044
number of stakeholders	0.823*	0.5330	0.648**	0.6874
Tenure	-7.526**	3.6375	-15.28**	4.7651
Cons	-10.194***	3.8330	-2.127	4.1830
Under-identification test (Kleibergen-Paap rk LM statistic):				43.361
		Chi-sq(10) P-val	=	0.0000
Weak identification test (Cragg-Donald Wald F statistic):				25.372
Hansen J statistic (over-identification test of all instruments):				7.473
		Chi-sq(9) P-val	=	0.4804
Breusch-Pagan test for heteroskedasticity		chi2(1)	=	38.283
		Prob > chi2	=	0.0000

Source: survey data Aug 2013

Table A.15. Model 2 - Relationship between biodiversity and cooperation

Bootstrap replications (200)

------1-------- --------2-------- --------3------- --------4----- --------5---- 200

	OLS		IV	
Number of obs	336		336	
Replications	200		-	
Wald chi2 (10)	2804.46		-	
Prob>chi2	0.0000		-	
R-squared	0.7238		-	
F (13, 322)	-		283.38	
Prob>F	-		0.0000	
Centered R2	-		0.7217	
Uncentered R2	-		0.9221	
Biodiversity	Observed Coef.	Bootstrapped Std. Err.	Observed Coef.	Bootstrapped Std. Err.
Cooperation	0.00513***	0.00195	0.00902***	0.00300
training [0=no, 1=yes]	0.224***	0.0762	0.198***	0.07650
Benefits	1.46e-05***	3.58e-06	1.12e-05***	4.43e-06
distance to nearest urban centre	0.0120***	0.00137	0.0129***	0.00160
distance to the fence	0.0140***	0.00213	0.0126***	0.00262
social capital index	0.00720***	0.00205	0.00705***	0.00218
average age of household head	-0.343***	0.10923	-0.403***	0.00149
average no. of years in school	-0.0821***	0.02745	-0.00934***	0.02354
average no. of years living in area	-0.00567**	0.00267	-0.00615**	0.00201
Fence	-0.00474***	0.00210	-0.00499***	0.00179
Information sharing index	0.229***	0.04992	0.198***	0.04743
Cons	9.352***	4.18635	10.92***	3.62650
Under-identification test (Kleibergen-Paap rk LM statistic):				138.181
		Chi-sq(10) P-val	=	0.0000
Weak identification test (Cragg-Donald Wald F statistic):				24.338
Hansen J statistic (over-identification test of all instruments):				0.0641
		Chi-sq(9) P-val	=	0.7463
Breusch-Pagan test for heteroskedasticity		chi2(1)	=	21.94
		Prob > chi2	=	0.0000

Source: survey data Aug 2013

Table A.16. Correlation matrix for the variables in the first model

(obs=336)

	Capacity	Institutions	Group size	Trust	Ethnicity	Wealth index	Year project was established	Reciprocity	Project	Punishment	Resource size	Number of stakeholders
Capacity	1											
Institutions	0.740	1										
Group size	0.368	0.102	1									
Trust	0.441	0.353	0.298	1								
Ethnicity	-0.130	-0.258	0.277	-0.128	1							
Wealth index	0.005	0.044	-0.065	-0.093	0.133	1						
Project year	0.541	0.399	0.419	0.185	-0.039	0.012	1					
Reciprocity	0.020	-0.029	0.126	0.047	-0.012	-0.194	-0.0167	1				
Project	0.128	0.046	0.193	0.107	-0.006	-0.047	0.260	0.035	1			
Punishment	0.321	0.572	0.255	0.344	-0.108	-0.043	0.344	0.067	0.017	1		
Resource size	0.156	0.254	0.028	0.098	-0.124	-0.056	0.162	0.013	-0.277	0.299	1	
Stakeholders	0.020	0.410	0.300	0.199	-0.168	-0.033	0.293	-0.029	0.293	0.477	-0.006	1

Source: survey data Aug 2013

Table A.17. Correlation matrix for the variables in the second model

(obs=336)

	Biodiversity	Capacity	Training	Benefits	Distance to the market	Distance to the fence	Social capital	Poaching incidents	Age of household head	Age^2	No of years in school	Residence status of head	Head born in this area	No of years living in this area
Biodiversity	1													
Capacity	0.350	1												
Training	0.446	0.346	1											
Benefits	0.592	0.444	0.414	1										
Distance to market	0.375	-0.157	-0.092	0.135	1									
Distance to fence	0.326	0.281	0.213	-0.018	-0.089	1								
Social capital	0.214	0.202	0.194	0.195	-0.042	-0.043	1							
Poaching incidents	-0.143	-0.332	-0.050	-0.068	0.122	-0.175	0.032	1						
Age of household head	-0.034	-0.073	-0.038	-0.082	0.134	-0.054	0.026	0.033	1					
Age^2	-0.026	-0.076	-0.023	-0.085	0.124	-0.041	0.022	0.039	0.99	1				
No. of years in school	0.066	0.192	0.067	0.191	-0.113	0.068	0.116	0.045	-0.718	-0.704	1			
Residence status of head	0.00	-0.092	0.052	-0.087	0.010	0.061	-0.039	-0.062	0.210	0.207	-0.334	1		
Head born in this area	-0.069	0.040	-0.033	-0.036	-0.136	-0.090	-0.013	-0.195	-0.283	-0.270	0.144	0.039	1	
No. yrs. living in this area	-0.093	-0.093	-0.091	-0.133	0.200	-0.104	0.009	-0.070	0.482	0.465	-0.371	0.082	0.094	1

Source: survey data Aug 2013