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Local Enforcement and Better Forests

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✠ This paper is dedicated to John T. Williams (1958–2004)

Summary. — Current studies of local resource management examine many factors thought to be associated with good resource conditions. Despite the number of studies and the importance of such resources to millions of people worldwide, a lack of theory and hypothesis testing beyond the case level limits the lessons empirical studies offer. We argue that regular monitoring and sanctioning of rules—rule enforcement—is a necessary condition for successful resource management. We test our theory using data regarding 178 user groups and by pairing rule enforcement with other important factors: social capital, formal organization, and dependence on forest products.

Key words — forestry, resource management, monitoring and sanctioning, collective action

1. THE FOUNDATIONS OF SUCCESSFUL RESOURCE MANAGEMENT AT THE LOCAL LEVEL

Since the mid-1980s, extensive scholarship has challenged Garrett Hardin's (1968) earlier assumption that the users of a commons [1] were trapped in inexorable tragedy and unable to engage in sufficient collective action to extract themselves from drastic overuse and destruction (McCay & Acheson, 1987; National Research Council, 1986; Sugden, 1986). Since that time, anthropologists, economists, game theoreticians, historians, and political scientists have built an impressive case for the assertion that local users themselves can—and have—constructed institutions [2] to use their natural resources sustainably (e.g., Baland & Platteau, 1996; Berkes, 1989; Hanna, Folke, & Mäler, 1996; Ostrom, 1990). Empirical studies have found both successes and failures for *all* broad types of ownership regimes: private property, common property, and government property (Dietz, Ostrom, & Stern, 2003; Gibson, Lehoucq, & Williams, 2002; National Research Council, 2002). There is, however, strong

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evidence that simple blueprint solutions imposed by external authorities are not the answer to resource management problems and many other central problems of development (Pritchett & Woolcock, 2003).

The challenge that policy analysts now face is to move beyond the presumption that there is one, or a very limited, set of institutions that works to solve all commons dilemmas and to sort out which factors are most important in achieving successful management of resources—at least at a local level (Grafton, 2000). Dozens of variables have been identified as being associated with higher levels of sustainable management of resources (Agrawal, 2001). Many of these variables help to explain results in individual case studies or small *N* studies. The cost of collecting consistent data for a large number of local resources has made it impossible, until recently, to test the relative importance of particular variables on resource conditions, and thus to move our theoretical understanding forward of why some resource institutions are more successful than others. The issue remains pressing for policymakers, since such natural resources are often critical to the economies of poor rural households and the conservation of biodiversity around the world.

In this paper, we draw on data that has been collected by a network of scholars associated with the International Forestry Resources and Institutions (IFRI) research program for a large number of local forest resources in Africa, Asia, and the Western Hemisphere (see Gibson, McKean, & Ostrom, 2000; Poteete & Ostrom, 2004). We seek to move forward the discussion of the factors conducive to successful commons management by arguing for the necessity of at least one factor—the monitoring and enforcement of rules. We first address why we pose this variable as being necessary (but not sufficient) for the long-run protection of local resources. We will then review recent evidence from experimental and simulation studies about the effect of this variable. We then report on a preliminary empirical test of the essential role of regular monitoring and enforcement by user groups using a relatively large sample size ($N = 178$) based on data collected by the IFRI network.

2. THE PRIMACY OF RULE MONITORING AND ENFORCEMENT

As noted, scholars have identified multiple factors that can lead to successful outcomes on the commons. These can be grouped into four broad categories: characteristics of the resource, characteristics of the group, institutional arrangements (which for some analysts include norms and duties), and the external environment. Essentially, many analysts theorize that each factor affects individual incentives, which in turn influence their decision in the first place to participate in the crafting of an institutional solution or not, as well as their subsequent, even more crucial, decision to conform with their established rules.

Scholars have forwarded dozens of variables using this logic to explain cases of success and failure in the management of natural resources. The well-known factor of "well-defined boundaries for the resource," for example, is posited to influence both (a) the certainty that individuals in a group will have over the benefits and (b) costs they expect to face when considering an institutional solution to a commons dilemma or whether to continue conforming to an existing institution (National Research Council, 2002). Well-defined boundaries should reduce uncertainty as to who will benefit and who will pay the costs; poorly defined boundaries should increase uncertainty and thus retard efforts to find or sustain a collective solution (see the online supplement to Dietz *et al.*, 2003; for strong evidence in this regard). The assumption that the level of dependence is important is a related assertion. If an individual is highly dependent on a resource, one can assume that he or she places greater value on the long-term sustainability of the resource than someone who is not dependent on the resource (Gibson, 2001). Given this, the individual should be willing to pay higher costs now in following rules—and in watching that others follow rules than a person who is less dependent on the resource. Another well-known argument asserts that high levels of social capital, as commonly understood, should decrease both the uncertainty and costs (transaction costs) to individuals and so increase the odds of reaching and maintaining a collective solution, and low levels of social capital might impede, or at least be neutral to, individuals engaged in such efforts. Groups with high levels of social capital should find it easier to sustain the regular monitoring of rule conformance needed for long-term sustainability. Scholars have a long list of variables that they argue are of theoretical significance, which includes a group's interdependence, poverty, homogeneity and size, as well as market pressure, population pressure, technology level, and predictable benefit flow (see the lists of important factors provided by Agrawal, 2001; Baland & Platteau, 1996; Ostrom, 2001; Wade, 1994; reviews these and other works).

While it is almost tautological that rules must be enforced for the possibility of successful resource management, the question of how rules will *actually* be enforced is frequently ignored when other important factors are analyzed and policies are recommended. Yet, all too many "paper parks" have been created by legislation in a nation's capital only to be destroyed by illegal harvesters in rural areas. Illegal harvesters are relatively skilled in locating opportunities to harvest timber illegally from a park whose boundaries are ill-defined and where few resources are allocated to either monitoring or enforcement. In such situations, if a rule breaker is actually caught, they also have strong incentives to offer a side-payment to the monitor that is substantially less than the threatened sanction. Poorly paid staff have a difficult time refusing such extra payments given their low take-home pay.

While rule enforcement does appear to be a necessary condition for the establishment and sustainability of effective forest conditions, a vigorous debate exists concerning who should do the enforcing (e.g., Hockings & Phillips, 1999; Igoe, 2004). Bruner, Gullison, Rice, and da Fonseca (2001) argue that investments by governments in national parks are the most effective means of protecting forests. Others argue that without involving local forest users in protected area activities, including monitoring and enforcement, it is impossible to sustain valuable forested land (Stevens, 1997; Wells & Brandon, 1992).

A key question exists, however, as to whether forest users can overcome the collective-action problem involved in their being active monitors who enforce harvest rules. After all, monitoring compliance to rules is equivalent to contributing to a public good. The person who voluntarily takes on such an activity is investing personal resources in increased rule compliance—a benefit that all forest users enjoy whether or not they contribute to the effort. The clear prediction from a considerable body of theory, starting with the work of Mancur Olson (1965) and extended by work using noncooperative game theory, is that no one should make any effort to refrain from harvesting from an unprotected forest in the first place. Nor should anyone be expected to engage in monitoring and rule enforcement unless they are paid to do so (and monitored by their supervisors as to how well they do their work). Voluntary provision of monitoring and sanctioning is clearly a second-order, free-rider problem (Heckathorn, 1989). Recent research in the experimental laboratory, however, has shown that contrary to the presumption that the users of a resource cannot overcome either first-order or second-order public good problems, many subjects do not behave as predicted by traditional collective-action theory (Ostrom, 1998).

3. RECENT RESEARCH ON MONITORING AND SANCTIONING IN THE LAB

Research by multiple scholars has shown that subjects in experimental laboratory settings who are given an opportunity to engage in the costly sanctioning of others, and who do not keep promises to contribute to solving a collective-action problem, do expend funds in order to sanction others (Abbink, Irlenbusch, & Renner, 2000; Fehr & Gächter, 2000; Moir, 1995; Ostrom, Walker, & Gardner, 1992; Sefton, Shupp, & Walker, 2002). These findings are surprising to many since the experiments are carefully designed to create clear social dilemmas for subjects. Given that subjects would have to give up resources voluntarily to sanction others in these studies, the clear prediction from traditional noncooperative game theory is that subjects will not sanction one another for noncooperation.

Andreoni, Harbaugh, and Vesterlund (2003) have recently explored levels of outcomes achieved under four experimental conditions related to the response options assigned to a second player. In one design, the second player had a choice of rewarding the first player at a cost. In a second design, the responding player had a choice of punishing the first player at a cost. In a third design, they could reward or punish the first player, and in the fourth design, they had neither option. The authors found that players were both willing to engage in costly punishment as well as investing their own payoffs to reward others. Joint returns to the subjects increased substantially, however, when the punishment option was in effect and even more so when both punishment and rewarding were feasible.

Recent work employing evolutionary game theory and computer simulations provides compelling evidence that not only do subjects voluntarily contribute resources to monitor and sanction others who are noncooperative in collective-action settings, but that rule enforcement is necessary to maintain cooperation; it is also evolutionarily stable. Kameda, Takezawa, and Hastie (2003) go further and explore the problem of free riding in enforcement. Using evolutionary game theory and computer simulation, Kameda *et al.* demonstrate that rule enforcement can actually be rational for most individuals if there are at least a few ''intolerant enforcers'' in a group who punish second-order free riders. One can think of the vigorous gossipers in a group as a kind of intolerant enforcer (Gintis, 2000).

Boyd, Gintis, Bowles, and Richerson (2003) also attempt to explain ''altruistic punishment.'' Given that rational individuals should not incur the costs of enforcement, Boyd *et al.* find puzzling the consistent results in laboratory and field settings that individuals do indeed cooperate even when individually costly to them. They show, however, that an important asymmetry exists between altruistic cooperation and altruistic punishment. The payoff disadvantage of altruistic cooperators relative to defectors is independent of the frequency of defectors, whereas the cost disadvantage for altruistic punishers declines as they drive defectors away and they become rarer in a population. This difference allows for the evolution of enforcers even in populations engaged in one-time, anonymous interactions. Further, they find enforcement evolutionarily stable even in large populations, whereas previous theories argued that such cooperative behavior can be sustained only in small groups (Axelrod & Hamilton, 1981; Clutton-Brock & Parker, 1995).

Thus, there is both theoretical and empirical support from collective-action experiments regarding the efficacy of voluntary rule enforcement by individuals of each other's behavior. For several decades, strong empirical support existed for the essential role of local monitoring and enforcement in the extant case study literature. Only a few meta-analyses, however, have been undertaken (see, in particular, Lam, 1998; Tang, 1992). In every case that the present authors have read regarding the management of common-pool resources, successful outcomes have included an account of rule enforcement (or at least no account of the lack of rule enforcement). In this paper, we attempt to augment the case and laboratory studies constructing a better—although still preliminary—empirical test for the importance of voluntary monitoring and enforcement related to the sustainability of forest resources.

4. HYPOTHESES

From our own review of the extensive case study literature on the importance of local user involvement in the governance of resources and the results of laboratory experiments, we pose one general hypothesis: local users' monitoring and enforcement leads to better forest conditions. It is important to note that by rule enforcement we do not necessarily mean only official enforcement by outside official agencies. What we do mean are the activities undertaken by members of a group to enforce some accepted rules. Some of our user groups are in fact local units of forestry departments, thus our approach may include official agents' enforcement of *de jure* rules. But our approach also includes user groups that enforce their own *de facto* sets of rules, like a community's allowance of every local household to grace cattle in the community forest, even when these rules might contradict national law.

Of course, in the short-run, rule enforcement by local users may not always be associated with good outcomes. For example, forests in very poor condition could be the ones that are assigned to user groups, as has happened in the Terai region of Nepal (Nagendra, 2002). Users may then begin to develop effective rules and monitor them, but it may take many years before a forest is in good condition. Our argument, instead, is about a long-term outcome: rule enforcement is necessary to solve a commons dilemma over time.

Following this general hypothesis, we can construct additional hypotheses about the relationships among rule enforcement and other factors considered very important in explaining forest conditions.

Hypothesis A: If rule enforcement is sporadic—even if a user group has *high* levels of social capital—forest conditions are more likely to be poor.

Hypothesis B: If rule enforcement is regular—even if a user group has *low* levels of social capital—forest conditions are more likely to be good.

We thus theorize that consistent rule enforcement by members of a user group necessarily produces good outcomes in forest management. Whether or not a user group has a high level of social capital or not, it will still need to monitor whether its members are actually conforming to their own agreements about how to manage a resource and sanction those who do not. Without such enforcement, agreements may become meaningless within a short time.

We argue that the same pattern holds in the relationships between enforcement and formal organization of a user group, and between enforcement and a group's dependence on forest resources: where rule enforcement is regular, we expect better forests; where it is sporadic or nonexistent, worse forests. Regardless of a group's level of formal organization or of a group's dependence on a forest's resources, the regularity of rule enforcement should be more important in determining forest conditions.

5. MEASUREMENT AND METHODS

We test our theory using the data produced by the IFRI research program. The IFRI research program is a multilevel, multicountry, over-time study of forests and the institutions that govern, manage, and use them. IFRI collaborators use the same 10 research protocols to collect data about community-level rules, as well as socioeconomic, demographic variables, and physical factors that affect human incentives and behavior, and the impact of this behavior on local forest ecologies. It is one of the first research programs that combines systematic forest mensuration techniques with data about local institutions as well as socioeconomic and demographic variables. Currently, the IFRI program has 13 Collaborating Research Centers (CRCs) that have completed research at more than 180 sites. More studies are in process (see Ostrom & Wertime, 2000; Poteete & Ostrom, 2004).

Each CRC associated with the IFRI network selects a set of forests within a country that is governed by a variety of formal and informal arrangements. At the time of a site visit, a team composed of social and biological scientists spends between two to four weeks in a particular site. During the day, teams engage in extensive group discussions with diverse local forest users and with officials at multiple levels as well as take a sample of forest plots so as to obtain detailed forest mensuration data on the trees, shrubs, and groundcover present in the site. In the evening, the team discusses and codes the answers they have received from many different individuals to core questions related to group economic and social structure and activities: rules, rule making, and enforcement; conflict and conflict resolutions; and historical information about the forest and the settlement(s) in which forest users live. This information is then entered into a structured database; our data cover the period 1991–2000.

For this study, the unit of analysis is a user group. In the IFRI research protocol, a user group is a group of people who harvest from, use, or maintain a forest, and who share the same rights and duties to products from a forest whether or not they are formally organized. An IFRI user group could range from a few individuals who take mushrooms from a forest illegally to a forestry department that cuts timber. An IFRI forest is an area of at least .5 ha containing woody vegetation exploited by at least three households and governed by the same legal structure. Forests do not have to be any sort of official reserves or parks; they need only meet the criteria above. Thus, both a nationally designated forest reserve and a one hectare plot of woody vegetation could be considered a forest. For the analysis in this paper, we have limited ourselves to data collected at the time of the first data collection visit by colleagues associated with the IFRI research network. These first research visits were to forests located in 12 countries (Bolivia, Brazil, Ecuador, Guatemala, Honduras, Kenya, India, Mexico, Nepal, Tanzania, Uganda, and the United States).

For each of the forests included, we have identified the one or more user groups per forest. The 178 resultant user groups included in this study utilize 220 forests and vary substantially in their level of activities, organization, and age. Some user groups do not meet with one another at all and do not share any level of activities. Twenty-nine sets of users do not undertake any collective activity in regard to the forest they use. In Loma Alta, Ecuador, for example, the user groups participated in few or no activities as groups *per se*: the hunters went to the community's cloud forest to kill game, the farmers planted *paja toquilla* in the forest (for use in making panama hats), and the local timber cutters went to the forest to cut valuable trees (Gibson & Becker, 2000). Seventy-five user groups have organized themselves sufficiently to hold at least some meetings, elect officials, and undertake at least some joint activities. In the community user group of "Maple" located in Indiana, USA, the group met frequently and made detailed rules about their forest's use (Gibson & Koontz, 1998). Five formally constituted user groups do not undertake any collective activities at all. And the groups range in age from three years to over 100 years.

For our preliminary tests, we have chosen four explanatory variables: (a) the regularity with which individuals in a user group monitor or sanction others' rule conformance (which we call rule enforcement), (b) the group's social capital, (c) the group's dependence on forest resources, and (d) whether the group is a formal organization or not. Rule enforcement is measured by a scale based on information about how frequently the user group undertakes monitoring and sanctioning efforts. IFRI teams code the frequency of each user group's monitoring and sanctioning as never, occasionally, seasonally, or year-round. For this analysis, we dichotomized this variable by re-coding the categories "never" or "sporadic" as "sporadic," and "seasonally" or "year-round" as "regular." This variable does not discriminate between what kinds of rules are enforced or the rules' origin. Moreover, while different rules may require different levels of effort to enforce adequately, this variable seeks to capture at a very general level a measure of effort by a user group to establish rules in their forest.

Social capital is always a difficult concept to measure. Nevertheless, we attempted to capture this concept by combining a number of variables regarding the frequency of cooperative activities that user groups undertake in a forest. These activities are cooperative harvesting, cooperative processing, cooperative marketing or sales, and financial contracts. The frequency measures that we used in the protocol have the categories never, occasionally, seasonally, and year-round. We add the occurrence of each of the cooperative activities for each user group to obtain a measure of social capital, which is then dichotomized at the mean.

While nearly a fourth of the households in our user group sample are considered poor by local standards, and while a great wealth of case studies document how poor households rely on local natural resources including forests for their livelihoods (e.g., Jodha, 1992), we found no relationship between poverty—either at the household or user group level—on forest condition. Further, we argue that a better test of this relationship would include the dependence of households on a forest, not poverty *per se*. Thus, for our measure we add the percentage of needs that individuals in a user group claim are met by a forest. The IFRI protocol asks teams to estimate the user group's dependence on the forest for the categories of food, biomass, timber, and firewood. We added these percentages together and then dichotomized at the mean.

We derive a measure of a user group's formal organization from an IFRI team's categorization of the group as whether or not they have created a formal organization that has meetings and officials. This variable is a dummy variable.

We employ three different dependent variables in this study regarding forest condition. Since forests vary dramatically across ecological zones (tree density, number of species, biomass, etc.), we employ the assessments of user groups and local professional foresters. We asked user groups if they thought the forest was very abundant, somewhat abundant, about normal for this area, somewhat sparse, or very sparse. We then dichotomized their responses. An initial test of the accuracy of their assessments is reported in Varughese and Ostrom (2001). Professional foresters were also asked to rank the subsistence value of the forest as substantially above normal, above normal, normal, below normal, or substantially below normal for a forest of its kind given its particular topography and ecological zone. The forester also ranked the forest regarding its commercial value in the same manner. Descriptive statistics for all the dependent and independent variables are found in Table 1.

Our original intent in analyzing almost 200 forests and their user groups from the IFRI research program data set was to perform regressions to provide structural interpretations of the relations between rule enforcement, other variables considered important in the commons literature, and forest condition, which would be the dependent variable (see Ostrom & Wertime, 2000). A structural model can be interpreted as a causal model as long as the analyst provides the correct specification. Of course, this condition cannot be known, so the analyst must consider thought experiments to know how realistic the specification may be (see Leamer, 1978, 1983). In doing so, we faced significant impediments to creating a structural model for our data and theory.

A very common problem in the analysis of policy and policy outcomes is selection bias (Achen, 1986; Heckman, 1974). Since the data are nonexperimental, we cannot manipulate rules to find out their effect on forest condi-

Table 1. *Descriptive statistics of variables used in tests*

Variables	Description	Min	Max	Mean	Std. dev.
Dependent variables					
Forest condition—user group	User group ranking of forest condition, dichotomized at mean of five-point ranking	0	1	.59	.49
Forest condition—subsistence	Forester ranking subsistence value of forest, dichotomized at mean of five-point ranking	0	1	.65	.48
Forest condition—commercial	Forester ranking commercial value of forest, dichotomized at mean of five-point ranking	0	1	.52	.50
Independent variables					
Rule enforcement	Dichotomized user group's monitoring and sanctioning frequency. "Never" or "sporadic" recoded "sporadic;" "seasonally" or "year-round" as "regular"	0	1	.39	.49
Formal organization	Dummy variable of whether or not user group has formal organization	0	1	.47	.50
Social capital	Sum of frequencies of group's cooperative harvesting, cooperative processing, cooperative marketing or sales, and financial contracts, dichotomized at mean	0	1	.38	.49
Dependence on forest	Summed percentages of user group needs met by forest for food, biomass, timber, and firewood, dichotomized at mean	0	1	.46	.5

tions. Thus, we are not sure if there is a real correlation between rules and forest conditions, whether the statistical correlation is due to the effect of sanctioning, or that groups are more likely to have rules if the forest is in bad condition. There would also be a large amount of loss of information due to missing data on one or more variables (Little & Rubin, 1987). We would need to impute values instead of deleting cases because we would delete so many cases that a regression with even a relatively small number of regressors would have few degrees of freedom. Finally, the data have a multilevel structure (user group and forest) that can make inferences in regression problematic.

Typically, statistical fixes for problems and assumption violations in regression are developed in isolation from other problems. In our situation, we have several major issues confounding our data analysis. Furthermore, our number of cases relative to explanatory variables, less than 200, is actually quite small for dealing with these problems, especially the problem of selection bias. Thus, rather than try to estimate a structural regression model, we choose to approach the problem a bit differently. Instead, for our preliminary tests, we develop three-way tables and perform simple chi-square tests of independence on all subtables.

6. RESULTS

Since we have three dependent variables and three independent variables, we produced nine tables from our data. Each table contains a tabulation of forest condition by two factors and provides their correlation. We test our inferences using chi-square tests of significance for each of the two subtables in each table; conditional probabilities provide information about the strength of the relationships. We reproduce only the first three tables to give readers a sense of our methods, but report on the results of all nine tables in our text (all tables can be had by contacting the first author). The series of tests provide systematic support for our hypotheses.

Table 2 provides our tabulation of cases of users' assessment of forest condition by social capital and rule enforcement. The results show that rule enforcement and forest condition are correlated, regardless of the level of social capital. The conditional probabilities do not vary much from one subtable to another, and the results for each subtable are significant at the .01 level. Thus, following our hypothesis, it is highly unlikely for forest conditions to be good if there is only sporadic rule enforcement, and that this relationship exists whether or not social capital is high or low.

Table 2. *Social capital, rule enforcement, and forest condition*[a]

Social capital	Rule enforcement			Total
	Forest condition	Sporadic	Regular	
Low	Low	41	10	51
	High	19 (p = .32[b])	16 (p = .61[b])	35
	Total	60	26	86
High	Low	22	10	32
	High	6 (p = .21[b])	14 (p = .58[b])	20
	Total	28	24	52
		Value	Df	Significance
Chi-square tests				
Low	Chi-square (N = 86)	6.707	1	.010
High	Chi-square (N = 52)	7.436	1	.006

[a] Cell entries represent number of cases, N = 138.
[b] The reported probability values are conditional probabilities of the row variable given the value of the column variable.

Table 3. *Formal organization, rule enforcement, and forest condition*[a]

Formal organization	Rule enforcement			Total
	Forest condition	Sporadic	Regular	
Low	Low	56	7	63
	High	11 (p = .16[b])	5 (p = .42[b])	16
	Total	67	12	79
High	Low	11	16	27
	High	14 (p = .56[b])	30 (p = .65[b])	44
	Total	25	46	71
		Value	Df	Significance
Chi-square tests				
Low	Chi-square (N = 79)	4.017	1	.045
High	Chi-square (N = 71)	.584	1	.445

[a] Cell entries represent number of cases, N = 148.
[b] The reported probability values are conditional probabilities of the row variable given the value of the column variable.

Table 3 displays data using the variables users' assessment of forest condition, rule enforcement, and whether or not a user group is formally organized. In this case, consistent with our hypothesis, rule enforcement is important and statistically significant for groups that are not formally organized, i.e., better forests are associated with higher levels of rule enforcement. We find no significant relationship between forest outcomes, rule enforcement, and groups that are formally organized, although the relationship is in the hypothesized direction.

Table 4 paints a very similar picture to that of Table 2. Rule enforcement is significantly associated with forest condition whether or not a group's dependence on the forest is light or heavy, and all the relationships are statistically significant at the .01 level. Rule enforcement, and not dependence, is more important in relation to forest condition.

The results using foresters' appraisals of the subsistence and commercial conditions of forests, rather than users' judgments, provide additional support for our hypotheses. In all the chi-square tests using these two dependent variables, there were no cases in which relationships between variables were significant and contrary to our hypotheses: all combinations

Table 4. *Forest dependence, rule enforcement, and forest condition*[a]

Forest dependence	Rule enforcement			Total
	Forest condition	Sporadic	Regular	
Low	Low	17	9	26
	High	7 (p = .29[b])	17 (p = .65[b])	24
	Total	24	26	50
High	Low	44	12	56
	High	17 (p = .28[b])	17 (p = .59[b])	34
	Total	61	29	90
		Value	Df	Significance
Chi-square tests				
Low	Chi-square (N = 50)	6.559	1	.010
High	Chi-square (N = 90)	7.908	1	.005

[a] Cell entries represent number of cases, N = 140.
[b] The reported probability values are conditional probabilities of the row variable given the value of the column variable.

were either significant and in the predicted direction, or insignificant.

In the case of the forests' commercial condition as evaluated by foresters, rule enforcement was significantly correlated with forest conditions (for low social capital, $p < .05$, for high social capital $p < .07$). The enforcement measure was also significant when paired with those user groups that were not formally organized ($p < .06$). When forest dependence was low, enforcement also emerged as a significant correlate of forest condition.

In the tests in which we employed the foresters' ranking of the subsistence condition of the forest, we found no significant relationships between tests that used rule enforcement and social capital. Rule enforcement had a significant relationship with forest condition in those cases where user groups were formally organized ($p < .02$) and where dependence on the forest by user groups was low ($p < .02$).

These results indicate that monitoring is more important than three of the other frequently stressed variables assumed to lead to the improvement of forest conditions. Thus, regardless of levels of social capital, formal organization, or forest dependence, regular monitoring and sanctioning are strongly associated with better forest conditions. But, can we claim that rule enforcement is a necessary condition? That is, if rule enforcement was necessary, shouldn't we find no cases in which low enforcement is associated with good forest conditions? But we do, in fact, see some cases of sporadic rule enforcement with high forest conditions in our sample. We believe there are three reasons for this. First, as the data are obtained from a relatively short field trip, there will of course be some measurement error, of both independent and dependent variables. The second reason is due to the constraints imposed by our one-time measures. At the time researchers entered the field, a user group may have established regular monitoring but have been given a poor forest to start with: a situation that we do know happened in Nepal with the Leasehold Forestry project (see Karmacharya, Karna, & Ostrom, 2004). Similarly, a user group's monitoring may be becoming increasingly sporadic, which will lead to poor forest condition over time; but at the time of measurement, the forest was in good condition. The third reason is that a group may be enforcing its rules but not yet developed the set of rules needed to achieve a good forest condition in this social–ecological setting. As we mention earlier in the paper, we argue that rule enforcement is necessary to achieve a long-term condition of improved forest conditions. Thus, to better test our theory, we will need longitudinal data from these cases.

7. DISCUSSION

In this study, we try to deduce what factors associated with successful resource management at the local level are necessary as contrasted to simply being important factors. We argue that in equilibrium, rule enforcement must be present for successful outcomes on the landscape. The temptation to defect on other members of a group is always present in a dilemma setting. Once one or two participants start to take more than the rules authorize, others tend to follow in their footsteps. Rule enforcement thus is a necessary condition to effective resource management where such resources are being used. We find support for our hypothesis when using a relatively large data set collected from 12 countries using the same research protocols, all from the IFRI research program. Employing simple statistical tests, we find that rule enforcement by the local user group is significantly correlated to forest condition whether or not user groups are formally organized, dependent on the forest for a series of resources, or possess social capital. Further, this is true in government-owned forests as well as in community-owned or co-managed forests. We found such significant relationships whether we used the user group's or a professional forester's assessment of forest condition.

There are several directions in which we can push this analysis. First, in the long-run, we want to create a regression-based model that can take into account the data problems described earlier. This should be possible as the data set continues to include more information about the existing cases. To remove some of the endogeneity problems presented by cross-sectional data, and to provide better evidence for the necessity of rule enforcement (or any other factor), we will use cases for which we have data for two points in time. The number of these cases is slowly growing in the IFRI dataset, as IFRI partners return to their original sites. Currently, there are about 30 cases with two visits, so we are very close to having the ability to use these data in an across-time structural model. We also continuously receive data from partners, which helps to fill in the missing data.

We will also analyze how different variables directly and indirectly influence the ability of groups to enforce their rules, in distinction to those factors that affect rule-making, collective-action problems. If rule enforcement is indeed a necessary factor, then those things that influence a group's enforcement should be examined very closely. A number of group characteristics are likely to affect both the ability of groups to overcome their collective-action problem as well as increase their ability to monitor and sanction their members; i.e., analytically, it may make a great deal of sense to explore these different collective-action problems separately, for their logic is different (Ostrom, Gardner, & Walker, 1994). For example, clear boundaries may help individuals overcome the rule-making, collective-action problem by increasing their ability to calculate an expected flow of benefits by knowing what and who are involved in decision making. But boundaries have a different logic for the second collective-action problem of rule enforcement: clear boundaries reduce the costs of enforcement in most cases. Consequently, many of the dozens of factors enumerated by scholars as important to natural resource management may affect rule enforcement, and this relationship needs to be explained and tested. In fact, the ability to enforce rules may itself impact the first-order, collective-action problem: if a group can come up with rules, but does not think it can enforce them efficiently, then these rules may not even be constructed. Clearly, even knowing the necessity of rules, we have a great deal of work ahead of us.

NOTES

1. In this paper, we use the word "commons" interchangeably with common-pool resources. We focus here on smaller-scale natural resources, although commons exist at multiple scales and in all aspects of human society.

2. We use the words "institutions" and "rules" interchangeably, á *la* North (1990).

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