Folk Management and Conservation of Marine Resources : Towards a Theoretical and Methodological Assessment

SENRI ETHNOLOGICAL STUDIES 67: 33-50 ©2005
Indigenous Use and Management of Marine Resources
Edited by Nobuhiro Kishigami and James M. Savelle

Folk Management and Conservation of Marine Resources: Towards a Theoretical and Methodological Assessment

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1. INTRODUCTION

This paper focuses on local (or folk) rather than traditional or indigenous knowledge and management for several reasons. First, traditional knowledge and management, by definition, limits us to that which has been passed down through generations. This is a problem because the time depth of specific human behaviors is difficult to ascertain, especially in locales where attributing something to the ancestors lends weight to its acceptance. In those cases, people may say it was practiced or known by their fathers and grandfathers simply to provide it with some legitimacy.

Second, indigenous knowledge and management is limited by the requirement that it is developed locally, with little or no outside influences. Determining if something originated in a specific locale can also be subject to error. There is a tendency for people to lay claim to certain behaviors as being their own rather than someone else's, and how better to do this than to claim that they invented it themselves when, in fact, it was introduced from the outside[1]. In today's world, with so much intersocietal information flow resulting from ease in long-distance travel and mass communication, it is difficult to determine the origin of any behavior without historical or archeological research. Finally, it is local (or folk) knowledge that influences current behavior, and it is current behavior that is significant for understanding a community's relationship with its environment. Ruddle [1994, 1993] uses similar arguments for the use of "local" rather than traditional or indigenous knowledge for many of the same reasons. Hence, this paper focuses on folk knowledge and management, which includes both traditional and indigenous knowledge and management.

Descriptions of folk knowledge are nothing new. Anthropologists have been recording people's belief systems since the earliest days of the discipline, and in the 1950s and 1960s these descriptions became more formalized under the category of ethnoscience (see ROMNEY and D'ANDRADE [1964]). Although some of this formalization of folk knowledge was used by other disciplines (e.g., farming systems, [CONKLIN 1957]], it had no impact on marine sciences until Johannes wrote his seminal piece on traditional fisheries management in Polynesia and published his book on traditional knowledge in Palau [JOHANNES 1978, 1981]. His work had a significant impact in the discipline of fisheries management because he was a marine scientist and was read by other marine scientists.

Soon, folk knowledge and management were topics of discussion in fishery management circles. Funds became available for seminars and conferences, which in turn led to funding of research on these topics, and folk knowledge and management became somewhat of a fad. Researchers were discovering folk knowledge and management essentially everywhere, often employing unspecified methods and making unwarranted interpretations. Some interpreted these "findings" as indicating a "conservation ethic" and "conservation" of marine resources among traditional peoples. However, the main problem was that for the most part these studies provided no evidence that the folk knowledge and management (if it actually existed) resulted in conservation (that is, whether the resource was actually maintained or improved). Further, there was no convincing evidence that there was a conservation ethic (that is, whether the people under investigation stated that the traditional management was directed at conservation).

This fad was potentially harmful to the serious study of folk knowledge as carried out by ethnoscientists. As presented by some, it created expectations that could not be fulfilled. Many of the marine biologists that unhesitatingly accepted folk knowledge and management as a potential solution to the difficult problems of resource management in developing countries became skeptical when it failed to produce results. They observed continuing destruction of resources in the very areas where there were overly zealous reports of folk knowledge and management. Anthropologists are now in a position where they have to defend their descriptions and interpretations of folk knowledge and management. The only way this can be achieved is by providing evidence at higher levels of reliability and validity than they have up to the present.

2. THE EXAMPLE OF FISHERS' FOLK KNOWLEDGE AND MANANGMENT

Fishers' knowledge is a constantly evolving phenomenon. Every day they are making observations and applying these observations to future behavior. There is no question that they have extensive knowledge about their environment. The literature contains many accounts of complex taxonomies and descriptions of behavior of marine organisms that form part of the pool of knowledge maintained by fishers. Their success in hunting these organisms is a reflection of this knowledge. They also have detailed knowledge and understanding of other oceanographic phenomena such as currents, waves, etc. as well as their erosive power. They also know that reefs and vegetation protect coastal areas from erosion. An important question that needs to be addressed is for what purposes are they using this knowledge?

As a means of stimulating debate on this issue, it is argued here that folk knowledge and

management among fishers is directed at maintaining or increasing the wellbeing of the fishers. If conservation of the resource is a by-product of this knowledge and/or management, it is usually not intended. In this sense, they differ little from most other users of natural resources. We will provide some examples from recent fieldwork to support this claim. With respect to preservation of corals and mangroves, it was noted that fishers in a Bajau fishing village in North Sulawesi, Indonesia, which is renowned for its fishers who use underwater explosives as a fishing technique (bomb-fishers), did not practice their destructive fishing method in the coral reefs off the coast of their village. When asked why, they said that the corals protect them from the waves that come with a seasonal monsoon[2]. Without further query, they also noted that they did not cut mangroves behind the village so as to protect them from another seasonal wind that came from the opposite direction. These fishers lived on a thin strip of land only a few meters above sea level. Nevertheless, they do cut mangroves and bomb-fish in other areas, despite the fact that they know that both are habitat for various organisms that they hunt (Pollnac's field observations 2000).

Turning to fish stocks, off the coast of Bentenan in North Sulawesi, Indonesian fishers target spawning aggregations of yellow tail scad in August and September [POLLNAC et al. 1997]. They know that they are preventing effective spawning, but they also know that it is the most efficient place and time to capture large amounts of fish. Further, milkfish fry fishers along this same stretch of coastline capture many other types of fry as by-catch. Rather than throw the by-catch, which includes the fry of many other important food fish, back in the sea, they dump them on the sand where they die. When asked why, they state that they would just have to separate them out of the catch again if they let them live. Finally, fishers in the Philippines use their knowledge of rabbit-fish spawning grounds to capture billions of just hatched siganids for the fermented fish paste market with full knowledge that these same fry would grow into larger fish which they also target.

Fishers also use their knowledge in the development of local use rights, which some refer to as an aspect of local management. But in this case, the management is directed at personal gain, not conservation. For example, fishers in Talise, North Sulawesi have identified channels through which pelagic fish travel at certain times of the year. They have developed a system of local use rights to guarantee their exclusive right to set nets in these channels. The tenure is directed at exploitation, not conservation (Pollnac's field observations 2002). Almost two decades ago, Polunin [1984] concluded that traditional marine tenure was directed at control and exploitation of the resource, not conservation, and the observations made in North Sulawesi reinforce his conclusions. In sum, fishers undoubtedly have extensive knowledge about fish behavior, but it is used to capture, not conserve fish.

While the debate concerning indigenous fishers as conservationists has been relatively muted with respect to marine environments, it has been quite lively with respect to terrestrial hunters. There is a plethora of research that calls into question the notion that sustained harvesting was the result of conservation practices rather than a consequence of lower demand due to lower population densities or poorly developed distribution networks. This type of apparent conservation has been referred to as "epiphenominal" [HUNN 1982; ALVARD 1995]. Further, Ruttan and Borgerhoff-Mulder review a significant amount of literature that indicates that "...foragers choose the prey that maximizes economic returns per unit time spent foraging...weakening the

notion that populations living in apparent harmony with their environments necessarily practice conservation" [1999: 622]. For example, Alvard's [1995] research clearly indicates that Amazonian hunters do not select prey based on characteristics (e.g., sex, age, or size) that would minimize impact on populations.

Until reliable evidence to the contrary is provided, it is argued here that much of the apparent "evidence" for conservation behavior among fishers is epiphenominal in nature. It is also argued that fishers, like Alvard's Amazonian hunters, are optimal foragers. Given these assertions, it is important to assess what it is about fishing in marine environments that lead to optimizing, non-conservationist approaches.

2.1. Marine Environments and Folk Knowledge and Management

There are aspects of marine environments that require additional variables to be considered in the development and testing of a theory of fisher folk knowledge and management. One important consideration is that in most cases, the prey of marine fishers is usually either invisible or hard to see because it is below the surface of the water[3]. This relative invisibility in combination with the fact that most fish are mobile make it difficult, if not impossible, to target specific sizes or gender for conservation purposes; hence, it is less likely that fishers would make such conservationist choices than the hunters studied by Alvard [1995] and others. As a result, it can also be argued that marine species are even more unpredictable in time and space than terrestrial prey and thus are more likely to be hunted opportunistically. Restraint for conservation—that is, forgoing a harvest today for a larger one in the future—just doesn't make sense.

Another theoretical consideration relates to one of Pinkerton's [1989] criteria for management of the commons: perceived crisis in the resource. With a relatively invisible, mobile prey, it is difficult if not impossible to judge quantity of resource. Harvests are so variable that when harvests decrease, fishers are prone to assume that the fish are elsewhere, or that they have just been unlucky. For example, Zerner [1994] notes that when catches are low amongst fishers in the Central Maluku Islands, Indonesia, they believe it is due to the status of the fishers' relationship with local spirits, not a decrease in the resource. The fish are still there, but the spirits are keeping them away from their gear. Other fishers, although they may not lay the blame on spirits, also attribute changes in catch on luck or not being in the right place at the right time. This attitude is clearly related to the variability in catch that can be attributed to a mobile, relatively invisible prey.

Since they cannot see the prey and oceans are so large, it has led fishers to believe that there are so many fish in the large expanses of oceans, that no matter how much they harvest, the prey will not be exhausted. For example, in 2002 over half the fishers in six villages in North Sulawesi, Indonesia, agreed with the following two statements (80 and 55 percent respectively): (1) "There are so many fish in the ocean that no matter how many we catch, there will always be enough for our needs" and (2) "Human activities do not influence the number of fish in the ocean." Their perceptions of changes in the amount of fish harvested do not even impact their responses to these questions. For example, 40 percent of the sample (N=330) indicated a decrease in the amount of fish harvested today in contrast to three years in the past. Sixty percent reported either no change or an increase. Forty percent of the former and 41 percent of the latter *disagreed* with the statement "Human activities do not influence the number

of fish in the ocean," a difference that is not statistically significant ($\chi 2 = 0.002$, df = 1, p = 0.97). Only 19 percent of those who perceived a decrease in catch disagreed with the statement, "There are so many fish in the ocean that no matter how many we catch, there will always be enough for our needs." Sixteen percent of those who perceived either no change or an increase in catch, disagreed with the statement. This small difference is also not statistically significant ($\chi 2 = 0.499$, df = 1, p = 0.48). One would think that at least those who see a decrease in the amount of fish captured would understand the impact of fishing effort on catch, but they respond in a manner similar to those who see either no change or an increase in capture. The fishery in North Sulawesi is in relatively good shape, a fact that probably influences the fishers' optimistic outlook. Nevertheless, since the fishers cannot readily assess the status of the fish stocks for reasons outlined above, this relatively optimistic approach to the fishery can persist until it is essentially too late to do anything but take drastic steps such as closing the fishery.

Another important characteristic distinguishing marine from terrestrial environments is that except for inshore or island or reef studded areas, it is rather flat and featureless—a characteristic of a fluid surface. Hence it is relatively difficult to define an area for ownership as is possible in terrestrial environments. Additionally, the prey's usually unobserved mobility adds a further complication in terms of claiming ownership. Finally, the energy potential of a large body of water, which includes its erosive power, can result in storms which may result in changes in nearshore features that completely change the distribution of species, effectively nullifying the concept of "tenure". For example, at one time in one region along Mexico's Pacific coast, productive sites for shrimp fishers' cooperatives were fixed in the same manner as they were for agricultural *ejidos* (cooperatives). Lagoon boundaries in this region are subject to erosion and spatial shifting in contrast to the permanence of agricultural land boundaries. Within a period of several years, a shrimp cooperative could loose all of its productive waters; hence, the cooperatives failed due to this aspect of the marine environment that mitigates against tenure [McGuire 1983].

Given these examples of how aspects of marine environments might mitigate against development of an ethos of conservation among fishers, we can move to a consideration of their impact on the development of method and theory. The above examples indicate only some of the variables that must be reconsidered in terms of developing a theory of fisheries folk knowledge and management (FK and FM). But obtaining valid and reliable information on these variables and testing their impacts on FK, FM and the status of the resource can be complex.

3. METHODS: SPECIFYING VARIABLES

The limited, but important, considerations above suggest that it would be prudent to begin as a skeptic—to deny that the existence of FK or FM indicates that there is a conservation ethos among indigenous fishers. What kinds of important questions do we have to address to either support or refute this denial? The first is whether the alleged FK or FM is really local. A second concerns the distribution of this information among the people in the research area. Is it "folk" if only one or two community members report the phenomena and others have no knowledge of it? A third is whether the FK or FM actually reflects a conservationist ethic. A final, yet extremely important question, is does the FK or FM actually result in conservation of the

resource.

Considering the last question first, our skepticism has been increased by some relevant data that has some time depth—something that is needed in assessing impacts on resources. Oceania has frequently been used as the exemplar for indigenous conservation; hence, it is important to note that a growing body of environmental and archeological evidence clearly indicates that human settlement of Oceania was accompanied by vast environmental changes [KIRCH 2000, 1994; KIRCH and HUNT 1997]. Natural flora were replaced by a complex of plants carried by the early settlers. Land clearing for agriculture resulted in erosion and sedimentation that, in some cases, extended the coast seaward hundreds to thousands of meters. This same sedimentation probably resulted in smothering of adjacent coral reefs and reductions in other species that thrive in clear waters; e.g., the oyster whose shell was important in shell hook construction. Furthermore, analyses of faunal remains associated with human settlements provide clear evidence of phenomena associated with overexploitation; e.g., decreasing organism size to the point of being replaced with other target species.

Of course this does not provide evidence that there was neither FK nor FM —it just suggests that if there was, it appears that it did not result in the conservation of resources. But it does not rule out the possibility that there may have been some misinterpretation of the evidence (or lack of evidence) provided for FK or FM. Could there be something wrong with the "evidence"? We obtain evidence by asking questions, usually of people, but sometimes by observation or examining the literature. How are errors made in this process?

4. ASKING QUESTIONS

The first thing we can question is the evidence itself. One problem is that, with marine researchers presently scattered throughout various areas of the world, it is becoming increasingly difficult to identify reliable sources of information for FK. Some researchers come from disciplines outside the social sciences, and have not received training in even the most basic methods of obtaining reliable information from people. For example, one has to be careful in the selection of informants as well as in the phrasing of questions. Information must be cross-checked to determine reliability. If possible, attempts should be made to determine if informant behavior actually reflects information provided in informant interviews.

The following example makes these important methodological considerations clearer. Several years ago one of us (Pollnac) attended a meeting held at a marine science laboratory in South East Asia. One of the senior authorities on FK was also present. The lab was adjacent to a small-scale fishing community, and this senior authority asked biological scientists at the lab if he could interview a local fisher who was knowledgeable about fish and traditional fishing methods. He was led to a "traditional" fisher whom he proceeded to interview, with an interpreter, for about an hour. He then added this information to his copious store of FK. But, can we be justified in assuming he really collected FK? In other words, was the information collected "folk" knowledge or knowledge of an unspecified source residing in only one individual?

A brief example should be sufficient to justify this concern. One of us (Pollnac) was involved in composing a brief description of the human ecology of a small bay in northern Jamaica. He commenced his research by compiling a list of knowledgeable fishers with the

assistance of people from the nearby marine laboratory. In the process of interviewing one of the older, well informed fishers about changes in technology, he was told that they stopped deploying beach seines because the seines indiscriminately took all the marine organisms and negatively impacted the resources. Being a skeptic, the researcher returned to this issue later in the interview and pressed for additional reasons for abandoning beach seining. The informant then added that catches were so small in comparison to the cost of the net and cost of labor (i.e., shares to fishers) that the seines were no longer economically viable—a reasonable response. A subsequent interview with a fisher (who had not been specifically recommended as an informant) indicated that the seines were abandoned after workers involved in the construction of a pier for large boats left pieces of metal and other debris on the bottom, which snagged the nets. Other fishers in the community agreed with this compelling explanation.

What if the researcher was not a skeptic? What if he/she was looking for evidence of FK to support his/her research agenda? He/she would have gladly accepted the conservationist explanation of the old, knowledgeable fisher without questioning his motives or sources of information. This old fisher had spoken to many researchers from the marine lab, had internalized some of their knowledge and values, and fed them back to unsuspecting researchers.

What are the lessons that can be learned from this example? First, villagers with the least contact with marine scientists or conservationists should serve as key informants if we are looking for FK or FM. Second, information should be collected from several villagers, interviewed apart, not as a group. The interviews should take place in as brief a period of time as possible to reduce the chances of sharing post-interview information, which may influence the results. None of this is new to anthropologists. The problem is that the fields of FK and FM have been invaded by individuals with minimal or no training in social science research methods. They ask leading questions and/or cease interviewing when they obtain responses reflecting their ideological viewpoint—a potent combination of improper interview methods that can result in obtaining supporting "evidence," whether real or imaginary. This example addresses several of the questions posed at the beginning of this section: Is the alleged FK or FM really traditional or even local? And, what is its distribution among the people in the research area?

Another issue involves the reliability of informants' explanations for their behavior. This relates to another of the questions posed above: does the FK or FM actually reflect a conservationist ethic? For example, in the mid-1970s in Costa de Parajos, Gulf of Nicoya, Costa Rica, multi-filament net fishers complained that the mono-filament gillnets used by fishers from Puntarenas caught too many fish and would affect their own harvest. They even sneaked out at night, when the nets were set, and cut the nets. This could be interpreted as a conservation-directed response, and indeed, the fishers said that was their intent. Nevertheless, two years later when the village was revisited, almost all the net fishers were deploying mono-filament gillnets. When they had access to the nets, they suddenly became acceptable. We could refer to this phenomenon as a "sour grapes, pseudo-conservation explanation." Psychological theory can be used to explain this phenomenon, but that is beyond the scope of the present paper

The above observations were made during somewhat lengthy fieldwork in a limited area in Costa Rica (6 months over two years). Given this information, how should we interpret Johannes' statement, "Gillnetting is prohibited in some villages (in Vanuatu). The explanations given were uniform: 'it catches too many fish'" [JOHANNES 1998: 171]. Gill nets were prohibited

("tabooed") at all times in one village and for specific species in three more [JOHANNES 1998: 170]. Johannes' interpretation is based on interviews conducted in 27 villages over a period of 3 weeks. Despite the fact that an assistant conducted interviews in two of the villages, Johannes still averaged less than one day of research in each village. We respect his attempt to conduct such a survey, but informants sometimes respond in ways to either please the interviewer or make themselves look good. In these cases the responses may reflect little about actual behavior. It requires some time depth in terms of observation and triangulation of responses to overcome this problem.

In another example R. Stoffle et al. [1994: 363] describe the conservation strategies of small-scale fishermen in the Dominican Republic as follows:

> "Buen Hombre fishermen traditionally have employed sustainable methods of fishing that appear to derive from a conservation ethic [B. STOFFLE 1994; B. STOFFLE et al., 1994]. Interviews with key experts indicate that fishermen recognize the potential adverse effects of indiscriminate fishing practices on reef fish populations. Small fish are *not* (emphasis ours) targeted by fishermen; only rarely are they captured in fish pots. Expert fishermen explain that small fish are avoided in order to allow them to grow to an appropriate size. Small fish are not ideal for consumption or sale because of low proportion of flesh. Large fish provide high returns in terms of the amount of energy expended to catch them. This fishing behavior may suggest an energy maximization strategy on the part of "optimal foraging" fishermen [BEGOSSI, 1992]. Avoidance of small fish and other seafood species also implies that fishermen are cognizant of the effects of overfishing on population reproduction."

R. Stoffle et al. [1994] make assertions about the sustainability of fishing methods (in this case primarily spearfishing), the presence of a 'conservation ethic', and the avoidance of small fish, as an indication of knowledge of fish reproduction on the basis of a small number of interviews with 'key experts'. The primary purpose of any good research design is the elimination of as many alternative explanations and hypotheses as possible [STINCHCOMBE 1987]. The simple qualitative interviews conducted in the case of the Buen Hombre fishermen rule out any number of alternative explanations as to what the fishers said, or for that matter the behavior observed by the researchers. As they themselves admit, the selection of larger fish by these small-scale fishers may be due to market demand for larger fish (especially if one imagines what would remain of a small fish after being speared), but astonishingly, they do not see this as a contradiction or an alternative explanation to their own assertions concerning the conservation ethics of these fishers. Further, and probably more damning, is the fact that they attribute the avoidance of small fish as an indication of fishermen's knowledge of fish reproduction. On the face of it this may seem reasonable, but as any fisheries biologist or ecologist knows, reproduction can vary dramatically depending on a species life stage, and it is often the case that larger fish are the most fecund and therefore the most important for maintaining populations. If, for example, fishers would have told the researchers in interviews that they did not spear larger, egg-bearing females (i.e., knowing the sex and spawning times of a species), this would have been much more convincing as an indication of knowledge, *but not necessarily behaviors*, that may in fact contribute to the conservation of a given species.

One further problem alluded to above concerns the motivations underlying informant

responses. Often fishers respond to researcher's questions in politically expedient ways that reflect little of their actual FM beliefs or behaviors. In an earlier section of their paper, R. Stoffle et al. [1994] state that "the future of this ecosystem is in doubt" [STOFFLE et al. 1994: 361] that the "local population" of Buen Hombre could live in a sustainable way if not for outside pressures, especially from non-local, illegal net (*chichorros*) fishers. In light of a possible lack of ecological knowledge motivating informant's responses concerning selectivity for larger fish, politics may be a more powerful motivation. By claiming the conservation high ground (i.e., we let the little fish grow up even though we could take them), the fishers of Buen Hombre may be attempting to influence resource management powers concerning their conflicts with outside interests, particularly the illegal and "destructive" net fishers. (e.g., R. Stoffle et al. [1994] state that local fishers attribute the disappearance of the manatee to large nets.) Ultimately it is not clear whether fishers' selection of larger fish is due to a 'conservation ethic,' a 'political ethic,' 'economic pragmatism,' or is just simply 'political-ecological rhetoric.' Given the evidence presented by R. Stoffle et al., it is difficult to determine.

There are interview techniques that can overcome some of these difficulties. They include attitude scale construction and the use of projective techniques. The problem is that few investigators of fisheries FM or FK are familiar with these concepts and techniques (among some notable exceptions are Kuperan Viswanathan's [1994] use of projective techniques to investigate compliance behavior).

5. DEVELOPING THEORY

Developing a theory of fisheries FK or FM involves more than asking questions. Theory involves a set of interrelated variables, and we need to do more than simply assume that when one of the variables changes, so does the other in the predicted direction. Testing these relationships is also a part of the method that is generally ignored in fishery FK or FM.

As a means of achieving objectivity, the researcher, like any good scientist, should attempt to disprove the research hypothesis. The idea of disproving hypotheses is nothing new in scientific investigation. In analyses of survey data for testing hypotheses, researchers routinely choose significant levels of 0.05, which means that they will reject the null hypothesis of no difference only if the odds are less than one in twenty that the observed difference could have occurred on the basis of chance alone. For example, Alvard's [1995] study, which could serve as a model for testing hypotheses and building theory concerning maritime FK and FM, sets out alternative harvesting criteria (prey choice) that are consistent with both the conservationist and optimal foraging hypotheses. His null hypothesis is that "...harvesting is proportional to the frequency of the prey types in the population" [ALVARD 1995: 795]. He then collects harvesting data to determine if prey type composition differs statistically from expectations on the basis of the null hypothesis.

Similarly, Sosis [2002] notes that Ifaluk fishers do not always fish patches with the highest average catch rates, but instead occasionally fish alternative areas with lower catch rates. This could be interpreted as a conservation measure[4], but Sosis developed a series of hypotheses to explain this behavior[5] and collected data (catch/effort statistics) to test the hypotheses. Among several interesting results, he found that the previous day's return rate was a good predictor of

patch switching. It is this type of hypotheses generation and testing that should be used to develop and test FK and FM theory. Finally, Aswani [1998] tested alternative hypotheses concerning behavioral patterns of Roviana fishers in the Solomon Islands, and concluded that the results were consistent with optimal foraging model predictions. We clearly need more of this kind of research if we are to build reliable theory for FK and FM.

How can we apply this type of methodology in testing and building theory concerning FK and FM? We first turn to a proposition generated by Ostrom [1990]. Ostrom proposes that a low level of community heterogeneity is related to successful collective management of the commons—an example closely related to FM. We could include her proposition in our theory of fishery FM, but it should be tested first. Ruttan and Borgerhoff Mulder [1999] note that in a heterogeneous population where conservation behavior may not be in the best interests of all individuals, it may be achieved by coercion, especially by a more powerful elite. Ruttan and Borgerhoff Mulder's analyses of data concerning conservation practices among African pastoralists support their proposition. Hence, they argue that community involvement in resource management occurs in a situation that is heterogeneous with respect to status and power. This proposition, which contrasts with Ostrom's [1990], can be further tested on the distribution of various FM techniques in Oceania.

In the concluding chapter to Gary Klee's *World Systems of Traditional Resource Management* [1980], traditional cultures' abilities to adapt to their environments are linked to their ability to conserve. As Klee states: "Their survival over thousands of years is proof enough that they were good conservationists" [1980: 283]. Similar to Klee, Johannes [1978] had much experience with traditional cultures (although as a biologist), particularly in the Pacific, and considered many of the traditional resource management practices there as being conservationist in nature. As he saw it:"...the natives of Oceania, knowing that their precious fisheries could easily be depleted, devised centuries ago a variety of measures designed to guard against this eventuality" [1978: 350]. Further, he suggested the idea of a "conservation ethic" among Pacific Islanders and extolled the conservation virtues of marine tenure systems. Finally, it is implicit in Johannes's writings that these societies consciously engaged in conservation, as opposed to conservation being a by-product of other economic or social processes (i.e. epiphenomenal).

Given the time it was written, there are many commendable points in Johannes' 1978 article, but from an anthropological perspective something is not quite right. Why was it that these people could cooperate in the management of natural resources when so many others had failed? The answer lay, in part, in the early writings of Marshal Sahlins [1958] concerning a comprehensive comparison of social stratification in Polynesian. We re-examined Johannes' data in light of Sahlin's classification of Polynesian islands into three basic hierarchical categories of social stratification. We were particularly interested in the relationship between social stratification and the forms and degree of conservation measures found among the islands.

Table 1 shows a typology of various features related to social stratification found among islands classified within each of three categories. What is clear is the difference in the three levels with respect to the control of elites in a variety of types of production and in the form of punishment for violations of rules concerning resource extraction, particularly by lower status individuals. If we analyze Johannes' islands in terms of levels of stratification across all forms of conservation measures, there is a statistically significant difference ($\chi 2 = 6.609$, $p = 0.037$)

Table 1. Features related to social stratification for Sahlins' three categories of Polynesian islands.

	Island Group I	Island Groups IIa, IIb	Island Group III
Ranking System	*Complex (3 levels or possibly 4 levels [outcasts, slaves])*	*Moderately Complex (2.5 levels)*	*Simple (2 levels)*
Stewardship of Resources	*Pre-eminent by High Chiefs*	*Pre-eminent by High Chiefs*	*Elders*
Supervision of Household Production by Chiefs	*Direct*	*Control of Communal Production, but not Household*	*None, Communal Lands Managed by Community Elders*
Insignias of Rank	*Elaborate*	*Less Elaborate*	*Nonexistent*
Despotism	*Arbitrary*	*Limited Chiefly Authority (Consult Elders)*	*Total Lack of Arbitrary Power by Chiefs*
Distribution of Resources	*Hierarchical*	*Somewhat Hierarchical (2 levels)*	*Elders & Reciprocal Exchanges*
Punishments and Dispossessions	*Severe (e.g., violations including death on the spot)*	*Mostly Supernatural & Dispossession of Lower Statuses Possible*	*Supernatural*

in the distribution across the three levels, with Group I having the most frequent incidents of conservation measures (Figure 1). These forms of conservation include the closing of areas, closed seasons or banning fishing during spawning, allowing a portion of the catch to escape,

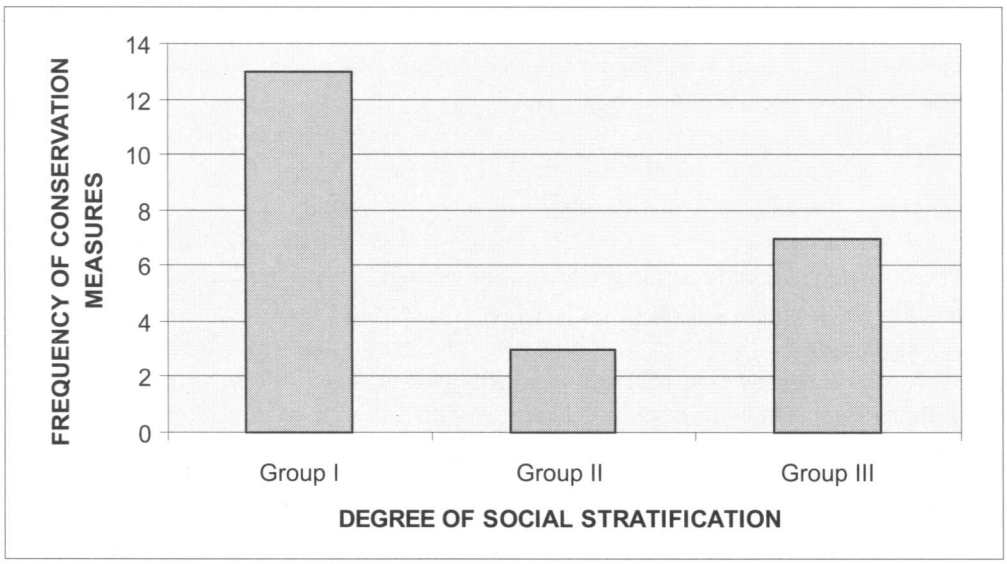

Figure 1. Cross classifying Johannes' Islands with respect to stratification and number of conservation measures (both intrusive and passive).

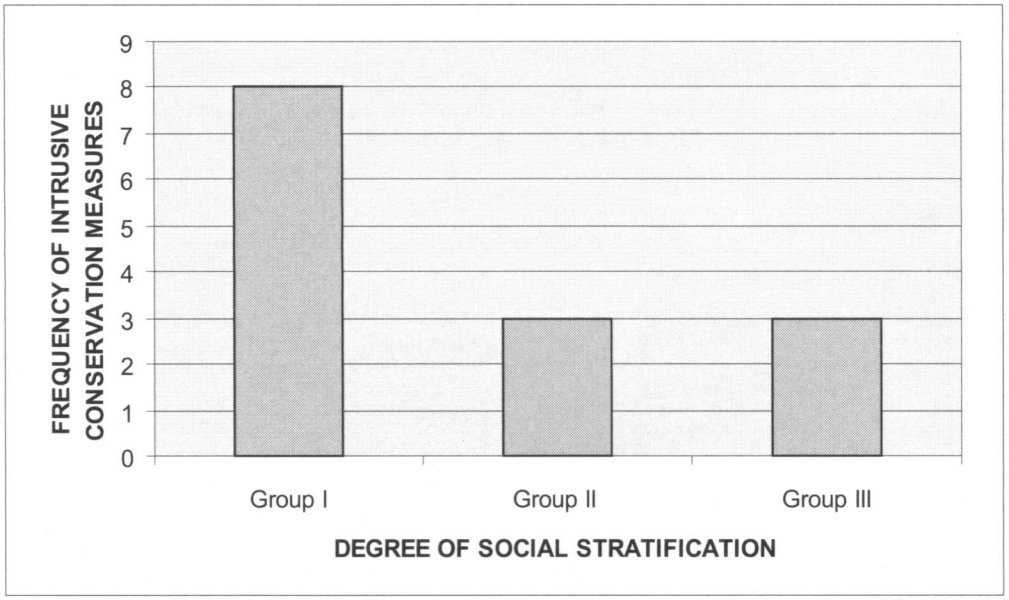

Figure 2. Cross classifying Johannes' islands with respect to stratification and number of intrusive conservation measures

holding excess catch in enclosures, bans on the taking of small individuals, and various other restrictions. These measures vary dramatically in their possible direct impact on resource conservation.

Some of the measures are more direct or intrusive (e.g., closures), while others are more indirect or passive (e.g., allowing a portion of the catch to escape). If only those conservation measures that are more direct or intrusive are taken into consideration, we find that Group I accounts for most of the distribution of measures across the three levels of stratification islands (Figure 2). If the more similar Group I and Group II islands (i.e., similar in terms of the stewardship of resources and levels of stratification) are combined, the difference is significant ($\chi 2 = 4.57$, exact $p<0.04$).

Although this analysis is statistically problematic for a number of reasons, particularly a lack of an adequate sample size (a possibly biased comparison due to the lack of a random sample of islands), the exercise is nevertheless informative. This is particularly the case given the fact that the island of Pukapuka accounts for 67 percent of the Group III observations of conservation measures. The Tuamotus, a large island archipelago, accounts for a single observation (the more passive holding excess catch in enclosures until needed, in a sense a kind of Polynesian refrigerator) within Group III islands. The more stratified societies (Island Group I) had higher incidences of limited access type rules, particularly of an intrusive or direct kind. Punishments among Group I islands for resource violations were quite extreme, often involving death to transgressors as opposed to the supernatural sanctions of Group III islands.

Much of the resource extraction (in the form of tribute or a kind of tax) among Group I islands was accumulated by high chiefs for redistribution and support of various chiefly levels and craft production. Such redistribution contributed greatly to a high chief's prestige and power.

Finally, many of the Group I islands increased in societal complexity, developing from chiefdoms through to state level societies. Thus, the bulk of Polynesian examples (Group I islands) cited by Johannes as having conservation practices, particularly of a direct kind, can be characterized as resource management controlled by a highly centralized state system that generally benefits the elite and middle managers at the expense of the common person. Further, cooperation is coerced and manifested in a formalized system of severe sanctions for noncompliance.

The theoretical explanation for systems of FK and FM can be more complex and elaborate than portrayed in much of the literature. There are, once again, a number of possible alternative explanations to many of the arguments. This is a particularly important issue for the development and testing of theories on the presence or absence of FK or FM that directly contributes to the conservation of resources (i.e., a model that accounts for the variation in the distribution of conservation measures across the islands). In the Johannes case above, what is interesting from a theoretical standpoint are the possible reasons for the presence and absence of various conservation measures across the different islands (e.g., resource rich high volcanic islands versus resource poor low coral islands). In this case it may be related to degrees of social stratification or it could be more a matter of norm compliance as a function of social integration and social sanctions. Alternately, larger populations require more explicit controls to reduce or avoid conflict—conflict over marine resources being one example. These explicit controls would be realized in the types of FM reported by Johannes and Klee. Further, the more direct or intrusive measures would be most needed where populations are greatest. The Group I islands have by far the largest populations, providing another alternative explanation for the distribution of FM measures in Polynesia.

Berkes [1999] discussed other possible theoretical explanations for Johannes's observation such that, in the pan-Pacific region, some Pacific Islands have "environmental awareness" while others, such as the Torres Strait's people do not. Berkes speculates it may have something to do with the nature of feedback mechanisms, which allow individuals to learn the state of the resource in a more timely manner. As a part of this notion, individuals on smaller islands would receive quicker feedback than those on larger islands. Although an interesting and quite testable idea, the proposition completely ignores inevitable variations in environmental (i.e., small islands may vary dramatically in terms of productivity due to rainfall and other climatic and geographical considerations), social (e.g., norms, social stratification), and cultural (e.g., environmental knowledge) factors. Hence, we have a number of potential explanations for the distribution of FM measures in Polynesia. To select between them, it is necessary to develop testable hypotheses and conduct further research. Whatever theoretical position one takes, it is important to pursue an adequate and falsifiable theoretical framework for explanations of FM and FK, avoiding tautological explanations or mere simple descriptions noting the presence of conservation ethics or measures.

Hence, neither the African pastoralist research nor the data from the Pacific Islands examined above support Ostrom's proposition that a low level of community heterogeneity is related to successful collective management of the commons. Further, Pollnac et al. [2001] report no relationship (all correlations were very weak with $p>0.05$) between population heterogeneity and successful community based marine protected areas in the Philippines—an example of collective management. Hence, we have findings that conflict with Ostrom's proposition and

which could be significant to the development of a theory of FM. Clearly we need more research. In contrast, Pollnac et al. [2001] provide quantitative data which support Pinkerton's [1989] proposition that a perceived crisis in a resource will stimulate local action to preserve that resource, hence providing another building block in our developing theory of fishery FM. These few examples illustrate the types of research necessary for developing a credible theory of FK and FM.

6. CONCLUSIONS

We are not arguing that FK and FM do not exist. They do, and there are reliable accounts in the literature. We are arguing that some of the accounts are questionable due to inadequate or unspecified methods, and that this situation should be improved. We are also arguing that we have to go beyond mere description of an instance of FK or FM and explain why it exists in some areas and not others. For example, Johannes [1998] collected valuable information on village-based conservation measures in 27 villages in Vanuatu. There are differences in the restrictions across the various villages, but we have no way of determining what these differences are related to. We find the same problem in an excellent description of FM (authority, rights, rules, and sanctions) related to reef fishing by Ruddle [1996], and we discussed the same limitations with regard to Johannes [1978] above. We should be explaining differences in structure and form of FK and FM as a function of differences in the social and physical environment. The only way this can be done is by examining FK and FM across a range of sites (societies, communities, etc.) manifesting both the absence and a variety of FK and FM. Ideally, the information would be collected systematically, using the same methods across the variety of sites. There are some researchers who might object to these methods, who argue that institutions such as FK or FM are the result of mostly unpredictable sequences of antecedent human behavior, where the final results could be changed by any change in any step in the sequence. Hence, according to them, the existence of a given instance of FK or FM must be explained as a consequence of its unique history. Taken to the extreme, this approach denies the existence of general processes that influence the outcomes of human behavior. The question as to whether there are general processes involved or that each case is a unique instance of human behavior is an empirical question. As such, it can only be resolved by comparative field research such as that advocated here.

Although FK with respect to the fishery can be quite extensive, we must be careful in its indiscriminant application to present day problems in resource management. While it is politically correct to empower fishers, to allow them to use their FK in decision-making in coastal management projects, it might not be correct! For example, in a very recent analysis of factors influencing the sustainability of integrated coastal management projects in 42 villages in the Philippines, Pollnac, et al. [2003] found that perceptions of post-project increases in fish abundance were negatively related to resource decisions made by users' associations ($r = -0.524$, $p < 0.01$), not related to community decision making ($r = -0.193$, $p > 0.05$) and positively related to decision making by project staff ($r = 0.430$, $p < 0.01$). This example is the result of approaching an important question in fishery management using the type of comparative field research advocated here.

There is also the problem of linking knowledge to conservation outcomes (i.e., the dependent variable). Knowledge of biological or ecosystem function alone does not necessarily constitute either a 'conservation ethic' or conservationist behaviors, as an ethic would imply. The question then becomes: does folk ecological knowledge actually contribute to behaviors that are in fact conservationist and sustainable? Answers to this question involve a detailed examination of the relationships among FK (i.e., ecological knowledge), FM (i.e., traditional conservation practices), and actual resource conservation (i.e., sustainable populations). As such, it will often require longitudinal fieldwork involving the collection of both social and biological data. If we are to claim that something leads to conservation or sustainable harvests then it requires a corresponding assessment of actual population dynamics of the species of interest. This is no different than assessing the conservation outcomes of scientific resource management efforts.

The whole notion of the 'noble savage' and its resource analogy, the 'ecological Indian,' have been challenged from a number of quarters [e.g., KREECH 1999]. Pinker's [2002] recent book on the nature vs. nurture controversy illustrates this well in its attempts to stem the tide of politically correct critiques of evolutionary psychology, biology, and sociobiology that he sees as having inhibited scientific research into the possible genetic underpinnings of who we are as human beings. Similarly, there have been strong reactions to the seemingly universal proclamations, such as those implied by Hardin [1968], that people are incapable of cooperation in the extraction of common property resources. Although it is becoming clear that genetics plays a powerful role in who we are as human beings, it is by no means the entire story.

In a similar vein, as a species, our abilities to cooperate, our notions of fairness, and our tendencies towards pro-social behaviors should be open to empirical scrutiny, since individuals behave neither strictly in terms of self interest nor, for that matter, altruism. What is needed is rigorous research of both an experimental and observational nature that will help us understand ultimately the factors underlying human cooperation in the exploitation of natural resources. Thus, the work of Ostrom and her colleagues [e.g., ORSTROM et al. 1994, ORSTROM 1990] on game theoretic approaches, particularly experimentation, is important and should be pursued further (e.g., extended to larger groups). In addition, some of the more recent work in experimental economics by such people as Henrich et al. [2001], particularly the pursuit of cross-cultural experimentation, is of both theoretical and methodological importance for understanding human variations in fairness and pro-social behaviors. This, in combination with rigorous field research involving collaboration between biologists and social scientists, will help us in ultimately understanding under what conditions humans engage in behaviors that are conservationist.

NOTES

1) This type of behavior is quite common, as illustrated by a recent experience. In October 2002, Pollnac was collecting information concerning traditional marine use rights in Minahasa, North Sulawesi, Indonesia. One example was a stone weir, referred to as a *bonor* by people in one village. The owner was asked where he learned how to construct a *bonor*. He said he just thought of it and did it. He was also asked, where the name *bonor* came from. He said he made it up. Other people interviewed in the village had no other knowledge of *bonor*, but queries in other villages indicated that others had existed

in Minahasa and also in areas to the south. One old man said that his father used the term *bonor* to refer to a high point in a reef, which is what the *bonor* structure resembles.

2) Transects over the coral reefs adjacent to this village stimulated this inquiry. These fishers did practice bomb-fishing further away from their village, but it should be noted that some developed a technique for electronically triggering their bombs so that they could control the depth in the water at which the explosion occurs and reduce damage to the coral.
3) This also makes their extensive knowledge of marine organisms all the more remarkable.
4) And, perhaps a Pacific Islander, many of whom are aware of the interest in their FK, would claim that it was to conserve the fish in that area.
5) For example, one of his series of hypotheses was "Men will not exploit the yellowfin tuna patch on mornings following a day when the mean per capita return rate within the yellowfin tuna patch was below the mean per capita return rate of alternative patches" [2002: 589].

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