Use of Traditional Ecological Knowledge in Marine Conservation

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Abstract: *Traditional ecological knowledge (TEK) represents multiple bodies of knowledge accumulated through many generations of close interactions between people and the natural world. TEK and its application via customary ecological management plans can be useful in modern conservation programs. I disaggregate the term TEK into its constituent parts and show several ways in which TEK can strengthen research designs by increasing locality-specific knowledge, including environmental linkages occurring in those localities. Examples of the uses of TEK in conservation include folk taxonomy in systematics in Micronesia, species knowledge for conservation in Kiribati, and fishers' knowledge of ecological interactions for reserve design in Belize. When conservationists recognize the utility of TEK, they can engage in an equitable exchange of knowledge and foster shared responsibility with indigenous people. These types of exchanges can also provide an opportunity for indigenous people to develop a scientific infrastructure.*

Key Words: capacity building, ethnobiology, folk knowledge, marine conservation, research design

Uso del Conocimiento Ecológico Tradicional en la Conservación Marina

Resumen: *El conocimiento ecológico tradicional (CET) representa múltiples cuerpos de conocimiento acumulado a lo largo de muchas generaciones de estrechas interacciones entre humanos y el mundo natural. El conocimiento ecológico tradicional, y su aplicación por medio de planes consuetudinarios de manejo ecológico, puede ser útil para programas modernos de conservación. Desagregué el término conocimiento ecológico tradicional en sus componentes y muestro varias formas en las que el CET puede reforzar al diseño de investigaciones al incrementar el conocimiento en una localidad específica, incluyendo relaciones ambientales que ocurren en esas localidades. Ejemplos del uso de CET en conservación incluyen la taxonomía tradicional en sistemática en Micronesia, el conocimiento sobre especies a conservar en Kirbati y el conocimiento de pescadores sobre las interacciones ecológicas para el diseño de reservas en Belice. Cuando los conservacionistas reconozcan la utilidad del CET, se podrán involucrar en un intercambio equitativo de conocimiento y promover responsabilidades compartidas con grupos indígenas. Estos tipos de intercambio también pueden proporcionar una oportunidad para que grupos indígenas desarrollen una infraestructura científica.*

Palabras Clave: conocimiento tradicional, conservación marina, desarrollo de capacidades, diseño de investigación, etnobiología

Introduction

Working within a multidisciplinary context, conservation biologists often find themselves playing the roles of anthropologist, political advisor, economist, and sociologist. Accordingly, conservation biology as a discipline is becoming more catholic in the disciplines it includes. Carrying out conservation programs within constraints set

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by local cultures is not only a morally laudable goal but is also increasingly seen as one of the most important factors in the success of a conservation project (Vieitas et al. 1999; Evans & Birchenough 2001; Bowen-Jones & Entwistle 2002).

Researchers increasingly recognize the value of so-called traditional ecological knowledge (TEK), which is defined as "a cumulative body of knowledge, practice and belief evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment" (Berkes et al. 2000: 1252). Traditional ecological knowledge, which is site specific, represents the information necessary for cultural survival, accumulated through trial and error over many years.

Although not every indigenous culture possesses TEK, many peoples do have rich cultures and are in possession of a rare body of knowledge. To acquire this knowledge conservationists must develop mutually respectful relationships with indigenous peoples and enter into a dialogue on terms set by the holders of TEK.

The application of TEK and customary ecological management practices to conservation issues has reemerged in recent years. During this renaissance, traditionally Western ideas of conservation have been melded with indigenous knowledge and management ideas to form multicultural plans of action (Gadgil et al. 2000; Huntington 2000; Pierotti & Wildcat 2000; Thomas 2001). A particularly promising endeavor has been the application of traditional forms of marine tenure in Pacific Island cultures to establishing marine conservation programs in that region. This body of knowledge, once feared lost (Johannes 1978), has been the basis for a new body of conservation literature (Johannes 2002).

The emergence of these kinds of conservation programs has spurred a debate about whether or not indigenous peoples actually are conservationists (Diamond 1986). Some argue that such actions as resource rotation, food taboos, and self-imposed harvest limits are not indicative of conservation programs but are instead results of optimal harvesting (Alvard 1998). These authors further caution about confusing sustainability, which is brought about by small population sizes, with conservation, which is a premeditated restriction of short-term goals to optimize long-term gain (Smith & Wishnie 2000, but see Colding & Folke 1997; Hviding 1998). This debate has in turn led to conflicting views of the role of indigenous peoples in conservation programs (Redford & Stearman 1993; Colchester 2000; Redford & Sanderson 2000; Schwartzman et al. 2000).

It is important to highlight the difference between TEK and its application through customary management practices (conservation minded or otherwise). Although the two concepts are related, the successful management of an area is predicated on the wise application of knowledge. Thus, TEK is the intellectual antecedent of those practices, and customary ecological management practices are management plans based on applied TEK. Much work, particularly in the marine realm, has focused on the integration of customary ecological management practices into conservation planning (Johannes 1982; Zaan 1985; King & Faasili 1999; Glaesel 2000; Colding & Folke 2001; Davis & Wagner 2003). I argue that by examining the underlying intellectual components of TEK, researchers may find new kinds of data to help test hypotheses, and I provide several examples from the marine realm on how TEK has been used to aid real-world conservation programs.

Disaggregating Traditional Ecological Knowledge

Traditional ecological knowledge does not represent a single body of knowledge; rather, it is a useful construct that represents knowledge gathered from undertaking several different pursuits, such as hunting, medicinal collection, preparation for spiritual ceremonies, or maintenance of a household economy. These pursuits are generalized activities found in many traditional societies and characterize ways in which indigenous peoples interact with the natural world. These interactions, carried out over countless generations, are the genesis of TEK.

Traditional ecological knowledge is accrued through trial and error. The actions that allowed for the optimal completion of a task (in itself a culturally defined metric) are passed down from generation to generation. For example, if a fisher was consistently able to maximize return on catches (the optimal completion of the task of fishing), that individual would pass his or her method along to the next generations of fishers. Techniques or fishing grounds that were not fruitful would fade out of memory. Thus, indigenous peoples who retain TEK are holders of a body of knowledge crafted for centuries by the specifics of completing tasks in the environment in which they have been living (Berkes et al. 2000; Davis & Wagner 2003). Furthermore, because TEK is created in an iterative fashion, it can reflect modern changes in peoples' environment or culture (Ellis & West 2005).

The use of TEK in the form of customary ecological management practices has been recognized as a potentially powerful conservation mechanism, particularly in countries where indigenous cultures are still largely extant (Harkes & Novaczek 2002; Hickey & Johannes 2002). Community support for conservation plans consistently emerges as one of the most important factors in maintaining the plans' long-term efficacy, and programs that incorporate customary ecological management practices in their design draw more support from local peoples (King & Faasili 1999; Evans & Birchenough 2001; Johannes 2002; Aswani & Hamilton 2004). Results of studies in Samoa (King & Faasili 1999), Vanuatu (Hickey

& Johannes 2002), Fiji (Hoffmann 2002), the Solomon Islands (Aswani & Hamilton 2004), Belize (Heyman et al. 2001), Hawaii, and other areas of the Pacific (Johannes 2002) suggest that local-based management can have beneficial impacts for the marine environment and that, in comparison, community-based management plans tend to work better than top-down (usually Western) approaches to conservation (Cox 2000).

Examining the underpinnings of these management plans also has the potential to aid researchers in a variety of fields. Therefore, I suggest that TEK will greatly augment conservation programs. Three major advantages of integrating components of TEK into a research program emerge: (1) location-specific knowledge, (2) increased knowledge of environmental linkages, and (3) local capacity building and power sharing (Kapoor 2001).

Location-Specific Knowledge

Many research projects are conducted in remote, infrequently visited areas. Local people can aid researchers by furnishing more discriminatory information about species presence and distribution (Poizat & Baran 1997), particularly about specific areas such as juvenile habitats (Aswani & Hamilton 2004) or spawning aggregations (Johannes 1981). Because of their remoteness, many of these sites are poorly studied, and indigenous peoples may be the only source of local biological information, particularly when species checklists in certain countries may not have been recorded on a fine enough scale. Additionally, in areas where the flora and fauna of a region is not well described, indigenous people may have knowledge of species or interactions not recorded in the scientific literature (Heyman et al. 2001).

Increased Knowledge of Environmental Linkages

Because many indigenous peoples view their environment in a holistic fashion, they may be aware of linkages between various ecological processes, multiple species, and abiotic factors that influence species biology (Nabhan 2000; Vogt et al. 2002). For example, when Silvano and Begossi (2002) examined Piracicabaian Indian views of aquatic trophic structures, they found that the food web constructed by the indigenous peoples closely matched the one formalized by university researchers but additionally described several migratory movements of fishes that were previously unknown to Western science. The knowledge of these environmental linkages is the result of a long-term association with a specific area and may not be immediately apparent to those not intimately familiar with the area.

Local Capacity Building and Power Sharing

For cultural reasons, the discourse of scientific research (especially in the tropics) represents a predominantly one-way transfer of knowledge and power (Conklin & Graham 1995; Brosius 1999; Drayton 2000; Kirsch 2001; Stepan 2001). Developing local capacity through training, education, and cultural empowerment can help reduce these inequities. Creating a research program in which indigenous people are equal partners with scientists is critical to the overall intellectual development within the host country. When indigenous peoples are integrated into research programs, they develop feelings of ownership of that research project. Its goals and successes may become a matter of pride and the programs are more successful (Smith & Berkes 1991; Koya & Naseer 1999; Vieitas et al. 1999; Evans & Birchenough 2001; Clarke et al. 2002; Obura et al. 2002; White et al. 2002). There are cautionary tales about research programs that did not properly include community attitudes in their research (e.g., Nigh 2002). The use of TEK in a conservation program is not about a one-time extraction of information. Instead, its use presents the opportunity for a long-term collaboration and development of information.

Applicability

Conservation biology is a second-order science that draws expertise from academic disciplines and operates on a variety of scales (Fig. 1). TEK has the potential to augment Western scientific research programs at each of these scales.

Traditional ecological knowledge falls into three major subcategories that pertain to ecological research: folk taxonomy and systematics, population-level knowledge, and ecological relationships. Each of these three subcategories can be applied, in a nonmutually exclusive fashion, to a variety of different biological sciences. By learning from traditional peoples with alternative worldviews, researchers may gain insight from areas outside their primary scientific discipline.

Folk Taxonomy and Systematics

The Linnaean system of classification, although useful for organization, is an artificial construct. There is no such thing in nature as a genus; therefore, there is no a priori reason to dismiss other forms of classification, provided they prove illustrative of relationships between organisms. Folk systematics looks at the ways in which different cultures organize their world. Investigating these systems of classification is useful in delineating the views of indigenous peoples about how organisms are grouped and how their culture relates groups of species to the larger world (Boster & Johnson 1989; Berlin 1992).

Investigating whether a culture organizes a particular fauna by morphology or function may help conservationists gather information as to which species are targeted and economically or culturally important, even if that

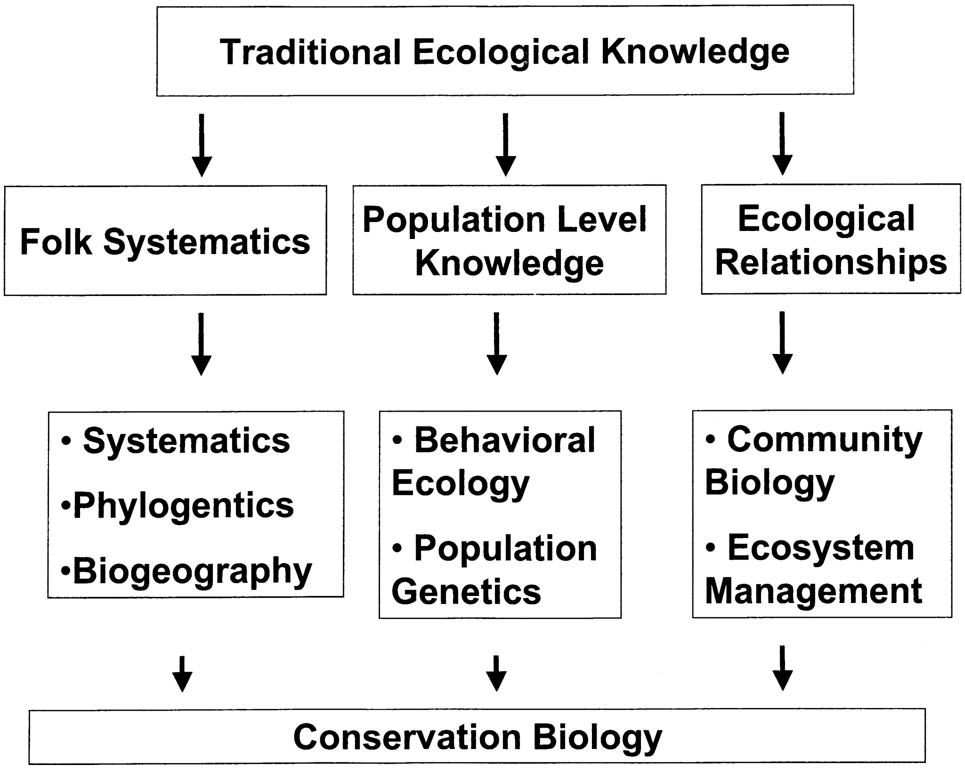

Figure 1. Applicability of traditional ecological knowledge to various biological disciplines.

researcher is not witness to the harvest (Costa-Neto & Marques 2000). Similarly, results of multiple studies suggest a positive relationship between the perceived importance of a taxon to a culture and the number of words used to describe it (Berlin 1973; Paz & Begossi 1996; Seixas & Begossi 2001).

An illustrative example of how folk taxonomy and nomenclature can aid conservation research is in the species name list provided by Lobel (1978) for Fanning Island in the central Pacific. The people living on the small islands generally make their living through inshore reef fisheries with occasional offshore trips in sea canoes for tuna. The people are of both Gilbertese and Ellice Island descent and therefore have two distinct dialects. Fish are a large part of their lives, and this is reflected in their language. For example, Ellice Island speakers have different names for different size classes of tiger shark (*Galeocerdo cuvier*)—*te kili* (small), *te babatababa* (large), and a more generic term, *te mango*. Gilbertese speakers have two names for milkfishes (*Chanos chanos*)—*te baneawa* (small, to 20 cm) and *te awatai* (large, 20+ cm); and three names for a species of jack (*Caranx melampygus*)—*te kuia, te rereba*, and *te urua* (large, medium, and small, respectively). Because both fishes are important food sources, these species are of special importance to these fisherfolk and their language reflects a higher level of specificity for them than for species with little economic importance, such as "surf perches" (Kuhliidae) (which have only a single name in each language that refers to the entire family; Lobel 1978).

Folk taxonomies are evident in the culture of fishers from Maine to Rhode Island (U.S.A.). They have different names for the baitfish Atlantic menhaden (*Brevoortia tyrannus*). Small menhaden, up to 11 cm, are referred to as *bunker, peanut bunker*, and *baby bunker*. Larger menhaden, up to 47 cm, are referred to as *pogy* (C. O'Keefe, personal communication). In both Micronesia and New England the diversity of names for a particular fish implies that those organisms are of interest to local fishers. From a conservation perspective, this name diversity would be a good starting point to characterize resource use (Berlin 1992).

Data gathered through interviews must be handled differently from data generated empirically. For example, the rudderfishes (Kyphosidae) represent an important inshore fishery at Fanning Island. The several species present within this genus, however, are morphologically very similar, and discriminating among them poses a challenge even for trained ichthyologists (P. Lobel, personal communication). In addition, not every individual is privy to a body of knowledge; therefore, informers may not be able to present a complete ethnographic list.

Although classification lists may offer insight into species usage, they should be verified across a broad segment of the community because different people (e.g., children, fishers, and postreproductive women) may have different knowledge tenures. Finally, whenever dealing with information gathered from interviews, researchers must be cautious about accepting information at face value. Experience within the community and recommendations from peers will help researchers identify the sources of information (Huntington 2000; Davis & Wagner 2003).

Population-Level Knowledge

Traditional ecological knowledge can also be applied to studies focused on population-level issues, such as behavioral ecology, population genetics, and population-level biology. Traditional people who harvest from their environment through cultivation or hunting can be keenly aware of their impacts on populations, particularly in oceanic islands where the eternal frontier philosophy does not exist (sensu Flannery 2001; Hickey & Johannes 2002).

Because of their dependence on local resources, indigenous peoples may know of natural fluctuations in population size, habitat specificity, or dietary preferences that are not yet recorded in scientific literature. Local fishers often have detailed information into the biology of their targets. For example, they can provide insight on spawning and mating behaviors and on ontogenetic shifts in populations (Johannes 1981; Aswani & Hamilton 2004).

The I-Kiribati are the indigenous people of Kiribati, a country in the tropical Pacific. They have a long history of customary ecological management practices (Zaan 1985; Lawrence 1992), but the impact of these practices diminished during British colonial rule and has continued to fade after independence (Johannes & Yeeting 2001). The majority of the people live in the capitol, Tarawa, which is situated along a lagoon. One of the most important traditional food sources for the I-Kiribati has been bonefish (*Albula glossodonta* and other *Albula* spp.), which have density-dependent spawning runs from inside the lagoon to offshore mating areas. Several development projects, such as building a causeway across one of the spawning runs, have depleted the populations of bonefish in Tarawa. Six of seven runs have become extinct (Johannes & Yeeting 2001). Other fishing stocks have become depressed (Beets 2001) and the community has raised concerns about management processes.

At the community's request, researchers came to Kiribati to help manage the resources in a collaborative fashion. Older residents of Tarawa remembered the old systems of customary marine tenure and realized that they could help generate future management plans. The older fishers remembered where the productive areas of the lagoon were and retained useful information about the species' behavior before and after mating, including the use of specific habitat types and susceptibility to different fishing practices (Johannes & Yeeting 2001).

This information was integrated into a government-sponsored community management plan. Although the traditional forms of management served as the foundation of this new conservation plan, there was an interesting ontological shift. Informants reported that the old forms of marine tenure were about food allocation rather than conservation (Johannes & Yeeting 2001). Yet the old methods were applicable to the new problem. The restoration of these areas would not have been possible without the elder fishers' knowledge of bonefish behavior. Additionally, because no official catch-per-unit data had been recoded in this lagoon, there was no record of the collapse or of what historical abundances were like. The application of TEK helped elucidate this example of the shifting baseline syndrome (Dayton et al. 2000) and proved useful in the formation of new community-based ecological management practices.

Ecological Relationships

In addition to being aware of population-level biology, the practices of some traditional peoples may reflect knowledge of specific multitaxa interactions ranging from host-parasite relationships to forest succession. For example, the Ntumu, who practice swidden agriculture in Cameroon, leave particular species in place to facilitate the ecological restoration of their forests (Carrière 2002). Similarly, peoples' TEK about disturbance has been influential in the development of traditional management plans. By developing multitaxa crops and by having multiple small plots, Polynesian peoples guard against cyclones by spreading risk throughout agricultural systems (Colding et al. 2003). The !Kung San populations of southern Africa alternate between a mobile hunting and gathering lifestyle and a more sedentary herder and cultivator lifestyle based on decades-long environmental fluctuations (Lees & Bates 1990).

Traditional peoples may possess a wealth of knowledge about the interactions of species gained through many years of observations, and this knowledge may be useful in guiding biologists in ecological restoration or management regimes (Nabhan 2000). An example of protected-areas management that had its origin in TEK has been applied to Gladden Spit in Belize. Gladden Spit is an area of the Mesoamerican Barrier Reef located off the coast of Belize, which has long been known by fishers as a spawning aggregation site for mutton snappers (*Lutjanus analis*). Local fishers have known of this area since at least the 1920s (Heyman et al. 2001), but the aggregations remained unreported in the scientific literature until 2001.

In addition to its value as a spawning site for snappers, Gladden Spit is also home to a seasonal aggregation of the whale shark (*Rhinocodon typus*). These large sharks come to feed on the clouds of gametes released by the spawning snappers. It is difficult to observe whale sharks because of their largely pelagic lifestyle, and this area is an ideal site for collecting data on whale shark migrations and social biology. With the help of national and international conservation organizations, Gladden Spit has been designated a marine reserve, and many local fishers supplement their incomes by serving as dive guides for the burgeoning dive industry in Placencia (Heyman et al. 2001; R. Graham, personal communication).

Gladden Spit's designation as a marine reserve should help protect its long-term sustainability. Its discovery by researchers and subsequent gazetting, however, resulted from the knowledge of local fishers. Additional examples of spawning sites that have gained protected-area status through the interaction of traditional fishers and researchers can be found in Palau (Johannes et al. 1999), the Solomon Islands (Aswani & Hamilton 2004), and Glover's Reef in Belize (Sala et al. 2001). The world is too big for scientists to sample intensively, and the knowledge of local people is necessary for identifying areas of special concern.

Cautions

There is one caveat to integrating TEK into a research program. Traditional ecological knowledge is a heterogeneous body of knowledge; therefore, not every person in an indigenous community is likely to hold (or divulge) the culture's entire TEK. This causes potential methodological problems. Often a researcher may not know who is in possession of the required TEK (Huntington 2000; Davis & Wagner 2003) or even if that holder can be found, and profound cultural differences may hamper the transfer of knowledge (i.e., sexual division of knowledge, concerns about intellectual property rights, or simply wariness on behalf of the informer; Huntington 2000; Moran et al. 2001; Nigh 2002).

Conclusions

Traditional ecological knowledge is complex and represents the accumulated knowledge about species, environments, and their interactions accrued and passed down over multiple generations. It is a term that encompasses knowledge from a variety of activities, including (but not limited to) hunting, medicinal products collection, household economy and trade, and spiritual divination. The application of TEK has led in some cases to the establishment of formalized customary ecological management practices, which in recent years have drawn attention from biologists as theoretical frameworks on which to build management and conservation plans. I argue that TEK represents a rich body of knowledge that researchers can tap to both bolster their own research plans and to conduct research in a more equitable and culturally sensitive fashion. Traditional ecological knowledge is not disseminated quickly, and it requires a certain amount of trust. The acquisition and application of TEK, then, offers an opportunity for building truly collaborative, mutually respectful long-term relationships (Cox 2000).

A major impediment to the development of research programs integrating TEK has been the way in which data are presented. Anthropologists and biologists are trained in different methods and are familiar with interpreting different kinds of data. This has led to a divide in the way these data are shared (J.A.D. and A. Henne, unpublished data) and interpreted. Increasing the role of social scientists in conservation biology and conducting research with multidisciplinary teams should help further the integration of TEK and conservation biology.

There is no doubt that species are becoming extinct and that ecosystems are being dramatically altered (Casey & Myers 1998; Jackson et al. 2001), and as a discipline conservation biology is struggling with economic and political inertias that facilitate these tragedies. If people conserve only what they care about, then engendering care about conservation issues comes from a feeling of power to enact a change. Using TEK allows a mutually beneficial relationship to be created between conservation biologists and local people. Conservation biologists gain access to bodies of knowledge that are site specific and generated through long-term association with the area. In turn, local people gain a feeling of ownership over the project and an opportunity to become engaged with a larger debate about sustainability.

Conservation biology is constantly evolving to better address a complex and dynamic suite of threats to biodiversity. As part of that evolution, we must seek out new techniques and disciplines that will allow us to adequately respond to the varied threats facing the world's ecosystems (Song & M'Gonigle 2001; Mascia et al. 2003). The use of TEK represents such an approach, with the potential to greatly augment existing conservation programs and help shape new ones.

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