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CONSERVATION ECOLOGY

Report

Synergy Between Traditional Ecological Knowledge and Conservation Science Supports Forest Preservation in Ecuador

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ABSTRACT. Meeting the desires of individuals while sustaining ecological "public goods" is a central challenge in natural resources conservation. Indigenous communities routinely make common property decisions balancing benefits to individuals with benefits to their communities. Such traditional knowledge offers insight for conservation. Using surveys and field observations, this case study examines aspects of indigenous institutions and ecological knowledge used by rural Ecuadorians to manage a forest commons before and after interacting with two U.S.-based conservation NGOs: Earthwatch Institute and People Allied for Nature. The rural farming community of Loma Alta has legal property rights to a 6842-ha watershed in western Ecuador. This self-governing community curtailed destruction of their moist forest commons, but not without the influence of modern scientific ecological knowledge. When Earthwatch Institute scientists provided evidence that forest clearing would reduce water supply to the community, villagers quickly modified land allocation patterns and set rules of use in the forest establishing the first community-owned forest reserve in western Ecuador. This case demonstrates that synergy between traditional knowledge and western knowledge can result in sustaining both ecosystem services and biodiversity in a forest commons.

INTRODUCTION

A central challenge for sustainable societies is balancing the individual use of shared natural resources with sustaining the "public goods" inherent in resources. For example, if we decide to sell Pacific old-growth forests on public lands, we give up public goods like water purification, soil retention, reductions in fire hazard, and unique biodiversity. Recently, anthropologists concerned with conservation have studied indigenous cultures, searching for knowledge and norms on which to premise ecologically sustainable relationships between people and the natural world (Nabhan 1997). Gadgil and Berkes (1991) review numerous traditional resource management practices and systems that sustain biodiversity and ecosystems and build social capital; they conclude that these should not be discounted by western conservationists.

Indigenous knowledge (IK) and "traditional" knowledge are terms that describe knowledge specific to a given culture or society (Warren and Rajasekaran 1993). The development of IK is a dynamic process that changes with the availability of resources and the demands of local communities. Traditional knowledge is acquired by local people through the accumulation of experiences and informal experiments, and through an intimate understanding of the environment in a given cultural context. Traditional knowledge can be an information base for a society, facilitating communication and decision making, and serving as a foundation for local institutions (Warren and Rajasekaran 1993). Most of the time, IK is transferred orally; hence, documentation of such knowledge is a somewhat new area for exploration by scientists.

Traditional ecological knowledge (TEK) is a construct within IK that focuses more on a local culture's conceptualization and interactions with their biotic and abiotic environment (Gadgil and Berkes 1991, Nabhan 1997). TEK encompasses everything from cursory awareness of natural histories associated with local wildlife to cultural norms for land management and resource allocation. There are many cases showing that indigenous peoples have norms and TEK that conserve and enhance tropical forests or other natural resources (see Chernala 1989, Becker and Ostrom 1995, Nabhan 1997, Becker and Leon 2000), making it an important focus for conservation. The indigenous knowledge of a substantial number of traditional (non-westernized) societies maintains a high level of human health, while also sustaining natural resources in good condition (Cunningham 1991), offering a diverse set of institutional solutions for ecological sustainability. However, Gadgil and Berkes (1991) remind us that

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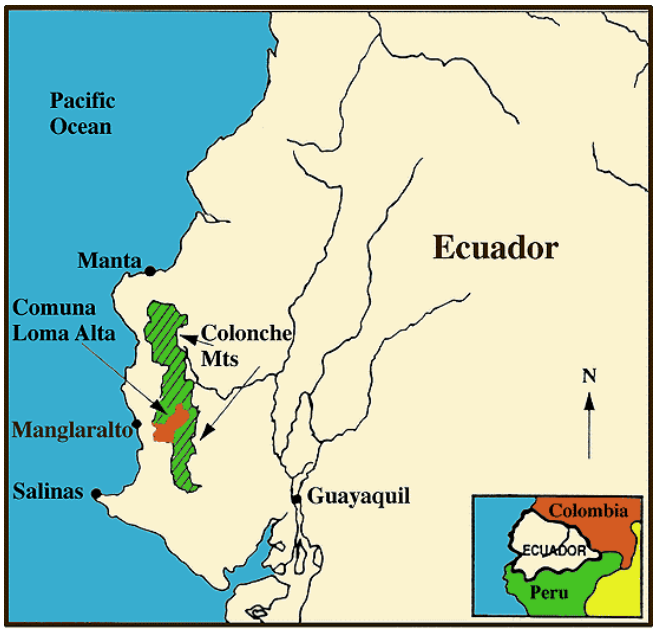
indigenous resource management "may not always make ecological sense," and may even be maladaptive in some situations.

Fig. 1. Map of western Ecuador showing the Colonche Hills and location of the Loma Alta watershed. Note that the highland forests of the watershed receive fog from the Pacific Ocean.



This paper explores a case study in western Ecuador in which interactions between indigenous and scientific ecological knowledge yielded collective action to preserve ecosystem services and biodiversity at Loma Alta, a communally owned watershed. We contend that neither traditional ecological knowledge nor western scientific knowledge was sufficient to have accomplished the task of forest preservation, and we attempt to identify the key elements of TEK that facilitated forest preservation at Loma Alta. We present the case as follows: (1) background for why Loma Alta became a focus of western science; (2) methods used to learn about local practices that influence forest resources in the Loma Alta watershed; and (3) results and interpretation about TEK and traditional institutions at Loma Alta. Within the results and interpretation section, we address the following questions:

1. As of 1995, why and how had TEK and traditional institutions sustained one of the largest moist forest patches in the Colonche Hills of western Ecuador? Was this outcome sustainable?

2. According to western scientific standards of conservation biology, what would be the best strategy for protecting biodiversity in one of the largest moist forest patches in the Colonche Hills?

3. When, and in what context, did TEK parallel scientific ecological knowledge in this case?

4. What aspects of TEK facilitated the integration of modern scientific knowledge and led to conservation of biodiversity at Loma Alta?

The information presented in this paper is based on ten 2–3 month field seasons at Loma Alta and Rio Blanco that took place between May 1994 and December 1999. As of publication, the protected area described in this paper is managed by local people and is monitored annually, with assistance and some monetary support from western scientists and NGOs external to the community (see also Becker 2002).

Background: Common property studies at Loma Alta, Ecuador

In the early 1900s, families living in seaside villages adjacent to the Colonche Hills (Fig. 1) expanded inland and claimed small watersheds under a system of kin-based communal tenure. In 1936, these indigenous communities were given legal tenure to watersheds under national law. Here, people experimented with a variety of crops and devised rules for land allocation that were suited to the microhabitats on the windward slopes of the Colonches, habitats heavily influenced by differential capture of coastal fog (Becker 1999). Tropical dry forests in the lowlands were cleared and replaced by settlements, roads, and a blend of subsistence and market agriculture. Today, the flat and arid lowlands are irrigated and planted in tomatoes and peppers, which are sold in Guayaquil, 160 km to the southeast. In contrast, the windward slopes between 300 and 800 m are not inhabited, yet are exploited liberally, but only by community members, for forest products including timber, vegetable ivory, and game. The windward slopes and peaks of the Colonches, where fog capture is greatest (Becker 1999), are important for the cultivation of Panama hat fiber, known locally as "paja toquilla," and scientifically as *Carludovica palmata*. Two stages of Panama hat production take place in rural coastal communities: straw production and weaving (Pachacuti 2002). Moist forest clearing for this crop has been substantial in the Colonche Hills. Transition zones between the arid lowlands and the foggy, wet upper slopes have been

cleared for grazing and cultivation of maize, fruit trees, and other horticultural crops.

With legal property rights to a 6842-ha watershed containing one of the largest remaining moist forest patches in western Ecuador, Loma Alta was interesting for research on common property and was strategic for tropical forest conservation (Becker 1999). The community of Loma Alta had decades of experience with local decision making and had a clear stake in the long-term sustainability of the goods and services associated with their forest commons (Schlager and Ostrom 1993). Forest products (timber and game), land, and water were all part of the local economy, and traditional institutions for negotiating use rights for these resources were in place. According to common property theory, communities with secure land tenure, traditional institutions, and economic value for natural resources have a strong foundation for designing sustainable conservation systems (Ostrom 1990, Bromley et al. 1992, McKean 1996).

By early 1990, biologists had rediscovered the unique floral and faunal diversity in the Colonche Hills and wrote about the need to preserve it. Dodson and Gentry (1991) reported that >95% of the primary forests had been cleared in western Ecuador; their maps revealed four small patches of moist forest left in the Colonches. Conservation International's rapid assessment program, (RAP; Parker and Carr 1992) brought more global attention to the floral and faunal endemism and diversity of the Colonche Hills. Hilgert and Andrade (1995) identified a moist forest patch owned by the indigenous communities of Loma Alta, Dos Mangas, and Olon as the largest remaining patch of moist forest in western Ecuador, south of Manta. This patch, centered around Cerro La Torre, is located in the Tumbesian Endemic Bird Area (EBA), a region harboring at least 55 endemic bird species, which is ranked in the top 10 priority sites for bird species conservation in the world (Best 1992, Becker and López-Lanús 1997). Thus, by 1995 the moist forests in the Colonche Hills had substantial interest for conservation scientists. Indigenous villagers began to interact with a new kind of missionary: conservation biologists with a western scientific viewpoint. Based on global surveys of biodiversity (Stattersfield et. al. 1998), conservation scientists believed the forests in the Colonche Hills should be preserved with as little fragmentation as possible.

METHODS USED TO LEARN ABOUT TEK AT LOMA ALTA

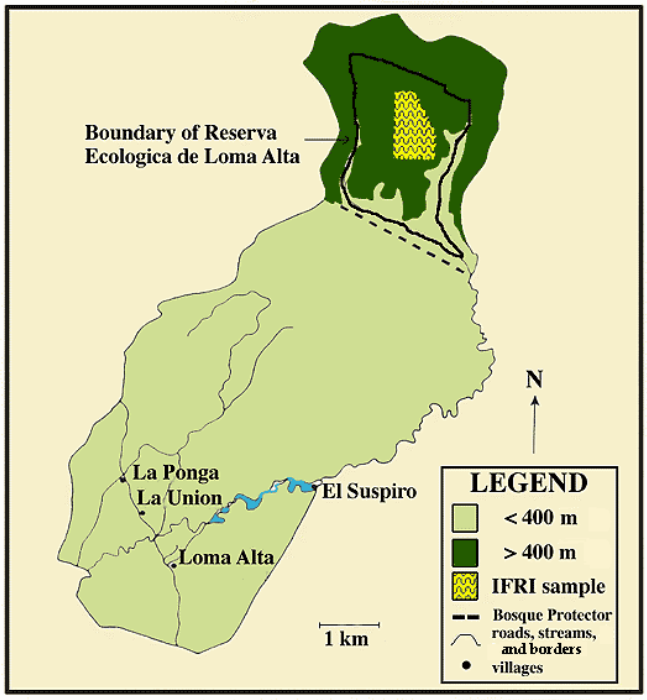
The Loma Alta watershed has about 1650 ha of relatively mature tropical forest, considered to be a special type of cloud forest referred to as *garúa* forest (Cañadas 1983). First described by Chapman (1926) and further in Best and Kessler (1995), *garúa* forests are formed by a positive feedback loop between vegetation and fog and mist. Fog capture is proportional to the surface area of vegetation, so stands of large trees and epiphytes trap an order of magnitude more water from fog banks than do areas of pasture or crops (Becker 1999). *Garúa* forest is a self-perpetuating, luxuriant collection of trees and epiphytes that thrive on mist and fog. Common woody genera in Loma Alta's *garúa*forests include *Beilschmiedia*, *Cordia*, *Rheedia*, *Ocotea*, *Ficus*, *Gleospermum*, *Quararibea*, *Psychotria*, and *Cercropia* (Elao 1996).

In 1993–1994, author Becker joined the International Forestry Resources and Institutions (IFRI) research program at Indiana University (Ostrom 1998, Gibson et al. 2000), and helped to establish People Allied for Nature (PAN), an NGO in New York City. PAN's mission is to protect wildlife and their habitats in Ecuador by working with local communities. PAN was invited by the community to work at Loma Alta in 1994. The IFRI research approach was pilot-tested at Loma Alta, providing PAN with a theoretical framework for understanding people–forest relationships in the watershed. During June to August, 1995, the IFRI research team was based in the Loma Alta watershed, visiting and living in villages and camping in the upland forest commons to collect data about rules of forest use, actual forest use, and forest condition (Gibson and Becker 2000).

The IFRI research method combines social and natural science approaches, and consists of observations and informal interviews with individuals and groups to determine socioeconomic and institutional variables that impact forest condition at a local level. These variables include: forest user groups and their products and indigenous institutions that influence land use (Gibson et al. 2000). The social science information is related to biophysical data about forest condition at the stand and landscape level. The details of methods used at Loma Alta have been published elsewhere (Ostrom 1998, Gibson et al. 2000), along with many of the socioeconomic trade-offs faced by the local community if they were to embrace conservation over

traditional land use (Becker 1999, Gibson and Becker 2000). This paper focuses more on the two-way integration or synergy between two knowledge frameworks that created the protected area at Loma Alta: local indigenous knowledge and globally oriented conservation knowledge based on western science.

Fig. 2. Map of the Loma Alta watershed, Ecuador, showing location of settlements, boundaries of the community's forest reserve, elevation, and the boundary of nationally designated protected forest. Loma Alta's southern boundary borders the Valdivia river (called Rio California on some maps).



Starting in 1995, PAN organized an environmental education effort at Loma Alta with the aim of enhancing local awareness about nature conservation. On a monthly basis, an Ecuadorian environmental educator visited leaders and community groups to convey information about the value of forest and wildlife conservation. PAN's goal was to convince leaders and community members to make a protected area in the moist *garúa* forest commons. In 1996, community leaders invited PAN members to make a presentation at a monthly community meeting, the listening and decision-making arena of the indigenous community. At this meeting, a video about the importance of fog capture was presented; PAN leaders urged the community to make a protected area defined by the two major tributaries of the Rio Valdivia (Rio Seco and Chorillo) and the northern boundary of the community (Fig. 2). The community voted to hold several additional meetings to debate the pros and cons of establishing a protected area before making a decision.

The major concern expressed by community members was that voting for the protected area would change traditional allocation and use of land in most of the *garúa* forest, which could negatively affect livelihoods. Some people were opposed to the reserve because traditional hunting and all timber harvesting would be precluded in about 1000 ha of the forest, > 50% of the *garúa* forest. People with land allocations in the proposed protected area were worried that they would not be allowed to maintain or expand their Panama hat fiber fields. Gibson and Becker (2000) concluded that local people ultimately supported the reserve because the benefits of water and land security, as well as potential benefits of interacting with a conservation organization, were thought by the majority of the community to outweigh the potential negative costs to a few livelihoods. No one actually lives in the protected area, timber harvesting and hunting opportunities exist outside of the reserve, existing hat fiber plots are permitted in the reserve, and new opportunities exist in nature tourism. Negative impacts on livelihoods and those affected are discussed in greater detail in *Results and Interpretation.*

To learn more about traditional ecological knowledge in the region of the Colonche Hills, social science surveys were conducted during several Earthwatch Institute research projects. (Earthwatch Institute links volunteers with scientists to provide funding and field assistance for a variety of natural and social science projects around the world.) Our first Earthwatch survey, completed June–August 1997, was aimed to determine if the ecological knowledge and attitudes toward forest protection differed between residents of Loma Alta, where PAN's conservation activities had been focused, and residents of Rio Blanco, a community 20 km to the north that had not been exposed to environmental education. If respondents at Loma Alta had more knowledge about and value for ecosystem services and biodiversity than people in Rio Blanco, this would suggest that "new" or "external" scientific knowledge had been incorporated at Loma Alta. We recognize that a before-and-after design in the surveys would provide more certainty than a comparative approach, but such attitude surveys were not an original research goal.

El Suspiro was the focal settlement in the Loma Alta watershed (Fig. 2). Both Rio Blanco and El Suspiro have similar socioeconomic and cultural traits, and have communal tenure to moist forest in the Colonches. The questionnaire consisted of 10 open-ended questions about the value of moist forest, use of moist forest, attitudes toward wildlife species, reasons for liking or disliking particular wildlife species, and which wildlife species are eaten and declining (Becker 2002). A second survey (Appendix 1) was completed at Loma Alta during December 1999. This survey focused on attitudes about the role of PAN in managing the community ecological reserve. In this paper, we focus on responses to survey questions that relate to traditional practices affecting forest stewardship and that help to clarify TEK. In both surveys, heads of households were randomly selected. Participation in all surveys was voluntary, and respondents were interviewed by villagers or by bilingual volunteers trained to conduct the surveys.

RESULTS AND INTERPRETATION

Traditional ecological knowledge and indigenous institutions at Loma Alta

The IFRI findings suggested that local institutions and indigenous ecological knowledge were not sustaining biodiversity and ecosystem function at Loma Alta to an extent desired by scientifically trained western conservation biologists. Despite having secure land tenure, value for forest resources, and a long tradition of community-level decision making, indigenous institutions and ecological knowledge at Loma Alta were failing to prevent deforestation and degradation in the forest commons (see also Gibson and Becker 2000). Still, indigenous institutions at Loma Alta were managing the moist forest in a multiple-use framework sensitive to local economic realities. Loma Alta's *garúa* forest was not part of an indigenous framework to conserve the forest, yet aerial photos and indigenous oral tallies of land use suggest that in 1995 about 70% of the 1650 ha remained in substantial forest cover. Why was this much left, given the drastic deforestation found in the rest of Ecuador (Dodson and Gentry 1991)?

The simplest answer to this question is that communal tenure restricts access. Although private lands in western Ecuador were being endlessly divided and resold for use by a fast-growing national population, indigenous communal lands were allocated and subdivided among extended families that had sufficient land to cope with internal population growth. Out migration from the indigenous community has reduced pressure for endless subdivision or expansion of allocations on communal lands. About half of the young adults at Loma Alta leave the community in order to find paying jobs in towns or cities (IFRI 19995, *unpublished data*). The distance from settlements to the *garúa* forest and the fact that the forest is a miserable place to live make it unattractive for development. Labor costs to exploit the forest are relatively high, and few indigenous people have capital to risk on timber harvesting. Also, the most marketable timber species were selectively cut in the 1970s when the community negotiated contracts with private timber companies that have since moved their operations north to larger old-growth forests of the Esmeraldas province. More relevant to this paper's thesis, moist forest at Loma Alta has remained because indigenous land allocation and traditions of use have favored keeping some land in forest cover. As we will describe in detail, the major "export" crop of the community, Panama Hat fiber, requires very moist soil conditions and thrives in *garúa* forest openings. Thus, in order to have good hat fiber, one must maintain *garúa* forest. Vegetable ivory from the Tagua palm is also a commodity dependent on *garúa* forest. Too much clearing would destroy conditions for these valuable forest crops. Still, these applications of TEK do not sustain the large blocks of forest needed by wildlife, but favor patchy deforestation and fragmentation.

In the short study afforded by the IFRI project, we found very little evidence that TEK or IK were at work to change the trends in deforestation and degradation. A notable exception was the community's attempt to defend the forest commons from ranchers external to the community in 1986 (Gibson and Becker 2000). This effort involved a community plea to the national government to defend its tenure rights by sending the army to defend the community border. This approach ultimately failed and at least 200 ha of community forest was cleared, burned, converted to pasture, and grazed because the forest "was not being used." In 1995, the community started to allocate the forest commons to young families with the explicit aim of thwarting any further invasion by the ranchers. The plan was that these young and jobless community members would harvest timber for their livelihood, showing use, and that would be sufficient to keep the ranching families from taking the land. There were only three families involved in this strategy, and it seemed that this would only lead to more

confrontation on the boundary and more deforestation, so it was not compatible with PAN's goals for forest preservation.

Land allocation in moist forest was liberal. Individuals received permission for use rights after requesting them at a monthly meeting. No one we spoke with knew of any instance when a request for land had been denied, and there had even been a few cases of use rights allocated to non-community members. There was no sense that resources were limited. People wishing to grow crops (Panama hat fiber or corn) were typically allocated 10 ha, whereas those planning to harvest trees were allocated up to 30 ha. A family could make a living from 1–3 ha of hat fiber, leaving 70–90% of the parcel in forest. Farmers traditionally leave forest surrounding the hat fiber to "attract rain," TEK related to the fact that trees are important for moisture in the uplands. In contrast, parcels used for timber harvesting were selectively cut, resulting in a thinned forest throughout a larger patch.

In the context of modern conservation biology, the outcome of TEK, especially traditional forest allocation practices at Loma Alta, was undesirable. This was one of the last large forest patches left in the entire Colonche range. Traditional land allocation and use was fragmenting and degrading the forest. Eventually, species that avoid edges and require interior forest conditions would be extirpated (Lovejoy et al. 1986, Schelhas ang Greenberg 1996). Selective cutting and conversion to hat fiber plantations on windward hills would also reduce fog capture and decrease the total amount of water contributed to the lowlands (Becker 1999), a negative outcome for ecological and economic sustainability for all of the people living in the Loma Alta watershed.

A system to protect large blocks of forest had not been crafted via TEK, but why not? Perhaps there were no local direct experiences indicating the costs to the community of losing the mature forest. This seemed unlikely, given that many people in the community told us stories about other communities that had lost their water supply after completely clearing their moist upland forests. Gibson and Becker (2000) surmised that conflicting goals of users and respect for individual's needs to make an income prevented successful rule-making to constrain use and preserve forest (Gibson and Becker 2000). Fiber growers wanted to replace forest with a crop, whereas woodcutters wanted to keep cutting trees, but both user groups needed to make a living. Still, the consequence of removing forest was part of local ecological knowledge when important crops were considered.

Although fog capture was physically obvious in the moist forest, people had not linked this phenomenon with sustaining water in the lowlands in a way that prompted forest conservation for water. This may have been because of TEK about fog. Locals disliked the fog or "garúa" season, and it only took living there for one fog season to understand why. Fog brought on the flu season. It was gray, foggy, gloomy, and cold. With few sunny days, hat fiber could not be dried and vegetable gardens hardly grew. The muddy roads never dried, so everyone had to wear rubber boots constantly and deal with sticky mud on everything. Clothes would not dry and the children could not play outdoors comfortably. In the horticultural areas, fog supported epiphyte communities, especially tiny bromeliads, which plagued every fruit tree crop that community members tried to plant. On hikes with forest users, we heard lamentations about all the work done to plant coffee and citrus, only to end when "the moss and air plants killed our crop trees."

Nobody in the community had the Panglossian appreciation for fog capture that PAN and Earthwatch scientists had, yet they possessed sufficient TEK to grasp the concept that fog capture was an important ecosystem service. Because about 75% of the families irrigated crops in the lowlands, they also quickly recognized themselves as the direct beneficiaries of fog capture. When shown data about the amount of water collected by forest during the fog season (June–November), the elected leaders of Loma Alta immediately called for an "extraordinary" village meeting. PAN and Earthwatch teams presented fog capture results to the community at large and urged the community to make a forest reserve. After several additional meetings between June and August 1996, the community voted to make 1000 ha of the most intact moist forest into a western-style protected area (Fig. 2). Use rights on recently allocated plots were withdrawn, and hunting and tree cutting were forbidden in the reserve. Individuals (only three families) that lost use rights were given first preference for jobs and training as guards and stewards of the new protected area.

What did surveys suggest about TEK and impact of western science at Loma Alta?

During the 1997 survey, 32 heads of households in the settlement of El Suspiro (50%) completed the 10-

question ecological knowledge and attitudes questionnaire. At Rio Blanco, 18 heads of households (64%) completed it.

Values for moist forest. Although 95% of all respondents said that highland forests were important and that they used them, people from Rio Blanco gave more utilitarian reasons for valuing the forest than did villagers from El Suspiro (Table 1). Respondents from Rio Blanco had narrow utilitarian values focused on agriculture. Respondents from El Suspiro emphasized ecosystem services, specifically water conservation, more so than did respondents from Rio Blanco (Table 1; chi-square = 15.9, df = 1, $P < 0.05$). Although nobody from Rio Blanco indicated that beauty was an important aspect of the forest, five respondents from El Suspiro did, showing that they had aesthetic appreciation or "existence value" (Pearce and Moran 1995) for the forest.

Table 1. Responses to the question: Are highland forests important?

	Percentage of respondents, by village	
Response	Rio Blanco (n = 18)	El Suspiro (n = 32)
No	5.6	0
Yes, lumber	11.0	0
Yes, food	5.6	3.1
Yes, protection	0	6.3
Yes, farming	61.1	31.3
Yes, water	5.6	41.0
Yes, beauty	0	15.6
Other	11.0	3.1

These results suggest that the conservation education program offered by PAN and interactions with Earthwatch Institute researchers may have caused a shift in local knowledge and attitude about moist forests. However, given the lack of a before-and-after survey design, we urge cautious interpretation of these results.

Knowledge and attitudes about biodiversity. Respondents from both communities had similar knowledge of biological diversity in the forest. Snakes and big cats were species that they wished were less abundant, because they were dangerous to people and killed livestock. Some respondents desired fewer monkeys, parrots, squirrels, raccoons, and skunks because they damage crops. The majority of respondents wished that deer, rabbits, wild pigs, and forest rodents, all edible, were more abundant. Thus, despite environmental education aimed at generating existence value for wildlife, especially rare birds, utilitarian values about wildlife prevailed in both communities. With regard to biodiversity, TEK at Loma Alta appeared to be little influenced by western scientific knowledge at the time of this survey. Recent community showings of videos about the value of the protected area for bird conservation, school programs about endemic birds and birdwatching, school visits to the forest, and numerous activities promoting nature tourism have probably altered local knowledge and attitutde about biodiversity.

Some of the older residents recalled that drier conditions ensued after the cutting of trees in the lowlands, and could describe numerous declines in wildlife and plants found around settlements over the past 60 years. These changes were not viewed negatively in the manner that conservation biologists view them. Settlements "are safer" now than then, we were told. One woman told us about how she and her women friends always washed clothes at the river in a big group, not so much for socializing but because

they were afraid of being attacked by a jaguar. With no forest around the village, being eaten by a jaguar is now very unlikely.

In the 1997 survey, respondents were also asked to name birds that they "liked" or "found interesting" and to explain why (Table 2). The intention was to see if nongame species promoted by Earthwatch studies had gained popularity in Loma Alta. There were no differences between Loma Alta and Rio Blanco for whether game or nongame bird species were listed. Guan and Chachalaca were consistently listed as favorite game species, whereas parrots, toucans, trogons, and hummingbirds were favorite nongame birds. As shown in Table 2, there was a tendency for women to list more nongame birds then men (chi-square = 3.34, $P = 0.07$, $N = 172$). This was largely because women listed parrots much more frequently than did men. The other types of birds that people of the region talked about were birds of prey, including Condors (which do not frequent the region), woodpeckers, pigeons, and brilliantly colored orioles, referred to as "*Caciques*" (chiefs).

Table 2. Types of birds preferred by men and women in the Colonche Hills, Ecuador.

	Percentage of respondents	
Type of bird	Women ($n = 87$)	Men ($n = 87$)
Cracidae[a]	44.8	50.6
Toucans	13.8	18.8
Parrots	24.0	10.6
Pigeons and doves	6.9	5.9
Trogons	4.6	1.2
Caciques[b]	1.1	3.5
Hummingbirds	2.3	3.5
Antpittas[c]	1.1	2.3
Hawks and eagles	1.1	1.2
Condor/vultures	0	1.2

[a] *Ortalis erythroptera, Penelope purpurascens*
[b] Icteridae
[c] *Grallaria* sp.

Our surveys suggest that whatever wildlife protection norms exist in indigenous communities of the Colonche Hills, they are predominately based on utilitarian relationships. Several families mentioned that they avoid killing female game animals, and that they varied the locations of where they hunted for wild game. This sort of ecological knowledge is not unusual. Much of the ethical management provided to natural systems seems to depend upon use to generate value (Nabhan 1997), with the exception of mythical values. Mythical values may lead to either preservation or extinction of a species. In Guatemala, for example, mythical value for the Quetzal (*Pharomachrus mocinno*) has promoted survival of this species throughout recent times. In contrast, Aye ayes (*Daubentonia madagascarensis*) of Madagascar have nearly been extirpated because local people believe that they are evil creatures.

Comments provided during the first survey illustrate how disconnected TEK and western conservation science were in regard to biodiversity. Community members related that they were quite confused about why the "gringos" were so interested in the forest during the IFRI study in 1995. At one meeting, PAN directors emphasized that they wanted to protect the "richness" of plants and animals in the forest. Several community members said they thought that gold or oil had been discovered, when the visitors spoke of the "richness" of the forest.

1999 survey. The second survey about the Loma Alta Ecological Reserve was completed by 61 household decision makers (10 women, 51 men). In reply to two open-ended questions about the purpose of the reserve, 57% of the respondents emphasized preservation of biodiversity, 38% listed ecosystem services (water and soil conservation), and the remaining three respondents listed tourism, science, and defense of property rights. When prompted to rank the most important benefits of the reserve, the majority (65% of the respondents) indicated that water conservation, employment, and land security were all equally important. Water conservation was ranked as the most important benefit by only 28%. Employment and land security were ranked as most important by < 5% of the respondents. By 1999, many people at Loma Alta shared the values of the western conservation scientists for biodiversity and ecosystem services, but also appreciated that the conservation effort supported traditional desires: securing their land holding. (PAN resolved the conflict with ranchers and regained all of the community lands illegally used as pasture. PAN also raised money to plant trees on the pasture, making local employment opportunities in reforestation.)

IK and institutions. Reliance on experience to reinforce knowledge was clearly the norm at Loma Alta. On several different occasions, even after the reserve had been in existence for several years, individuals came before the community council requesting permission to cut a tree in the reserve, a clear breach of the rules. Such behavior was baffling from the perspective of the legally oriented western viewpoint, but at Loma Alta, knowledge is gained through interaction and oral communication. Actively going to the reserve, having repeated interactions with guards, and contesting rules at the community meetings were the mechanisms by which local knowledge of rules and the degree to which the rules really apply in the community were learned. Signs and codes that work in western parks and policy settings are not effective in rural Ecuador. Likewise, printed environmental education materials aimed at adults did not seem to be very effective in changing knowledge about local biodiversity. Oral cultures have a communication system that involves a long time frame. Although the transition of oral to written traditions may have many benefits, Gupta (1994) argues that it has weakened the social process of learning.

CONCLUSIONS

Is it morally acceptable for global conservation to disrupt and reconstruct the livelihoods of an indigenous culture? This question is at the heart of conservation and development interactions around the globe, and this paper offers a slice of realism to the debate. In this case, TEK and IK at Loma Alta facilitated the existence of the first community-protected area in western Ecuador. This outcome depended on transfer of scientific knowledge through traditional oral processes via traditional institutions. Because of the community forum for listening and a tradition of openness to outsiders, appreciation for fog capture, what Daily (1997) would call one of nature's services, was rapidly incorporated into TEK at Loma Alta. Locals already possessed TEK about the positive influence of fog capture for some of their crops, so they quickly recognized its importance for water supply in the watershed. Once incorporated into TEK, this new appreciation for fog capture facilitated a shift from a predominately utilitarian relationship with *garúa* forest to a relationship premised on water conservation and forest stewardship for an ecosystem service. Thus, forest protection at Loma Alta resulted from a synergy between indigenous knowledge and institutions and western conservation science. Synergy was also evident when the Loma Alta community embraced conservation strategies in order to strengthen its land tenure rights along the northern boundary.

Synergy is further exemplified in the way in which the scientists learned to participate in traditional meetings. Western scientists tailored presentations to share their knowledge effectively at community meetings, within the context of the indigenous culture. They switched from written reports to using oral presentations complemented by video. More recently, Ecuadorian and U.S. scientists have presented plays and videos at community meetings to share information about endemic and endangered birds found in the community's *garúa* forest and in the dry shrublands near settlements.

The discourse between TEK and western science is not benign in cultural impacts, and it is useful to reflect on the overall impact that the nature reserve might have on livelihoods and culture at Loma Alta. Had local citizens and leaders of Loma Alta rejected the ecological knowledge supplied by western science, they might have eventually experienced a decline in their water supply, along with a loss of species. Less

water would endanger livelihoods, because most people in Loma Alta rely on irrigated agriculture for producing food that they use and sell. According to villagers at Loma Alta, the change in currency from the Sucre to the U.S. dollar has made rural life more difficult (C. D. Becker, *unpublished field notes*). Prices that farmers receive for agricultural goods like Panama hat fiber, tomatoes, watermelon, and other crops have fallen and daily wages (about $5 per day as of February 2003) have not kept pace with rising costs of transportation, cooking fuel, water, and non-farm goods. Locals say that rural life has become more expensive, and that having an alternative source of income from nature and scientific tourism are welcomed (C. D. Becker, *unpublished field notes*). Leaders at Loma Alta are currently working with the regional government and NGOs to promote the protected area in hope of attracting national and international tourists.

Much TEK has been severely eroded by national and international development policies and interaction with western cultures (Pinkerton 1981, Barbosa 1996). Some scholars worry that western science creates conflicts for traditional ecological knowledge and may even destroy it. However, the two sources of understanding have some common ground: they both rely on direct observation, experience, experimentation, and interpretation. What western science has to offer that TEK lacks is a broader appreciation of context beyond the local level that may actually favor local sustainability and, thus, cultural survival. What TEK has to offer that western science lacks is depth of experience in a local context and a window to cultural interpretations that may be unique and wonderful, yet reasonable. These knowledge systems can be complementary, and it seems naïve to think that thwarting interaction between them would be desirable.

Viewing western influence as purely negative is not productive for biodiversity conservation or for ecologically sustainable development. Very few human societies are isolated from interaction with other societies, especially given computer connections, and cultural exchange can be a source of new ideas for solving old problems (Stronza 1999, Wood 1999). Gupta (1994) stated that time and space for oral discourse must increase if institution-building between western and traditional cultures is to occur. Our study suggests that oral synergy between scientific knowledge and TEK can play a positive role in sustaining biodiversity and nature's services, and may, given time and space, sustain the cultural norms of an indigenous community.

Responses to this article can be read online at:
http://www.consecol.org/vol8/iss1/art1/responses/index.html

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