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Tibetan sacred sites conserve old growth trees and cover in the eastern Himalayas

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Abstract. Khawa Karpo, in the eastern Himalayas, is a mountain considered sacred throughout Tibet, and is internationally recognized as a global biodiversity hotspot. Numerous areas within this landscape are considered 'sacred' by the indigenous Tibetans of the region, who interact with these sites in ways potentially beneficial to conservation. Our previous remote sensing study indicated that sacred sites are found in habitats with greater species richness, diversity, and endemism than randomly selected non-sacred sites. This study examines the role of sanctity in biodiversity conservation *within* habitats in the Khawa Karpo region by pairing plots within the same habitats in sacred and non-sacred areas. Understory richness, diversity, cover, and number of useful species are measured; for trees, richness, diversity, cover, and density are measured. Results indicate that *within* habitats sanctity does not affect understory plant communities; however, within sacred areas trees are larger ($p = 0.003$) and forests have greater cover ($p = 0.003$) than non-sacred areas. Our results indicate that, whereas placement of sacred areas and preservation of vegetation cover affects useful plants, biodiversity and endemism, *within* habitats sacred sites preserve old growth trees and forest structure. In sum, Tibetan sacred sites are ecologically unique and important for conservation on varying scales of landscape, community, and species.

Abbreviations: GIS – geographical information systems; dbh – diameter at breast height

Introduction

Sacred sites, areas and geographies are nearly universal phenomena (Berkes 1999). Throughout the world, cultures recognize sites endowed with religious, historical, geophenomenal and cultural significance (Devereux 2000). Sacred sites have variously been attributed as having resident deities and spirits (Martin 2000), storing rare and extraordinary flora and fauna (Nair 1981; Baker 2004), inducing exceptionally vivid or lucid dreams (Mulvaney 1999; Stanley et al. 2003) and heightening meditative states (Huber 1999).

Many of these sites occur within natural settings, and the interrelatedness of sanctity and the environment is a frequent theme. Papers from India (Gadgil and Vartak 1975, 1976; Chandrakanth and Romm 1991; Daniels et al. 1993;

Ramakrishnan 1996; Bharuch 1999; Ramanujam and Cyril 2003; Upadhaya et al. 2003; Ghate et al. 2004), and Africa (Lebbie and Guries 1995; Lebbie and Freudenberger 1996; Millar et al. 1999; Mgumai and Oba 2003) demonstrate the biological saliency and utility of sacred areas for biodiversity conservation. In South America, Brown and Mitchel (2000) suggest that areas used for religious rituals in the Andes be designated as conservation sites, while Castro and Aldunate (2003) explore the role of sanctity in a highland Chilean landscape. Martin (2000), and Dunning et al. (1999), among others, discuss North and Central American sacred geographies. In Australia, sanctity has played a pivotal role in determining land tenure (Verran 1998; Mulvaney 1999). Numerous papers on the role of indigenous cultures and beliefs in the sacred landscapes of southwest China have been published in recent years (e.g., Li et al. 1996; Pei and Luo 2000; Xie et al. 2000; Zhang 2000). A study by Liu et al. (2002) demonstrates that restoration of holy hills by Bai villagers in Xishuangbanna has increased plant biodiversity there.

While many authors posit that sacred areas have played important roles in habitat and biodiversity conservation, only in a small subset has this hypothesis been tested quantitatively. Byers et al. (2001) show that sacred forests have persisted longer than non-sacred forests in Zimbabwe, while Godbole (1996) found similar results in India. Virtanen (2002) demonstrates that three sacred forests in Mozambique have higher species diversity and more complex forest structure than non-sacred counterparts. In Tibet, extant sacred tree groves extend well beyond the western limit of other forests, suggesting that sanctity and grazing restrictions may have played a role in preserving forests on the western Tibetan plateau (Miehe et al. 2003). In Indonesia, Reed and Carol (2004) suggest that Iban sacred forests contain more game than non-sacred forests, a finding similar to Decher's (1997) study of biodiversity of small mammals in Ghana's sacred sites; Nair (1981) found four rare plant species not collected for 75 years in sacred groves in Kerala.

The role of sacred sites in Tibetan culture has much to do with Tibetan Buddhist, Bön, and local religious practices and perspectives. Tibetan culture views the entire country – in fact, the environment as a whole – as inextricably bound by the karmic connections linking all living and non-living things (Swearer 1998). This entire metaphysical landscape is considered sacred (Lhalungpa 1990), and sacred geographical features are organized hierarchically, as in the concentric rings of a *mandala*, such that a sacred tree may reside in a sacred grove on a sacred mountain *ad infinitum*. Areas of particular significance for the Tibetan cosmology are typically delimited in several ways: via ritual, such as incense burning, flying prayer flags, and circumambulation; via structures, such as temples, monasteries, *mani* piles and walls, *stupas*, and prayer wheels; or via restrictions on human use, such as limitations or prohibitions on hunting and logging. The *ri-vgag* ('door of a mountain') is physically manifested as a contour line, above which is an entirely sacred realm and below which is a secular realm in which, nonetheless, there are sacred areas and sites (Guo 2000; Litzinger 2004).

Khawa Karpo (6740 m; 28°26′20″ N latitude, 98°41′05″ E longitude) is a peak on the border of northwest Yunnan and Tibet, named for the warrior god it embodies (Figure 1). The mountain is among the eight most revered and important *néri* or pilgrimage mountains in Tibet (Huber 1999; Pei and Luo 2000), attracting circumambulating Tibetan pilgrims from across the globe, particularly in years when the astrological signs for the element water and the animal sheep coincide (most recently in 2003). Khawa Karpo lies in the Hengduan Mountain range of the eastern Himalayas, between the upper Mekong and Salween Rivers, where the major temperate and tropical floras of Asia converge. This confluence of ecotypes results in extraordinary biodiversity; the Hengduan Mountain region is one of only two temperate global 'hotspots' (Mittermeier et al. 1998). Another contributing factor is the region's extreme topographical relief – rising over 4500 m from river valley (~2000 m) to mountain top in as little as 10 km – which results in a vertical array of ecotypes ranging from subtropical scrub in the arid river valleys, through oak, humid mixed, and coniferous forests, to alpine meadows, scree and glaciers on a single mountain slope (Salick et al. 2004).

Previously, we (Anderson et al. 2005, in press) examined the relationships among sacred sites, elevation and vegetation with Geographical Information Systems (GIS). Our results indicated that sacred sites are found in more speciose and diverse habitats than randomly selected non-sacred sites. Furthermore, we found a higher frequency of endemic plants above the *ri-vgag* line than below it. Our study supported the hypothesis that – in addition to their religious significance – there is a biological reason for conserving sacred sites, based on their location within habitats of ecological and ethnobotanical importance.

This study builds upon and complements our earlier work by focusing on comparisons *within* habitats rather than among habitats, and by directly measuring many of the same indices in the field rather than through remote sensing. In addition, field-based investigation enabled studies of other ecological parameters, such as cover and tree size. The principal goal of this study is to highlight the intersection between cultural and biological conservation strategies, while comparing how sanctity affects conservation *within* habitats.

Methods

Locations and descriptions of sacred areas were obtained from Sangbo (2002) and from semi-structured informal interviews with local villagers. Within sacred areas, plot locations were selected using random numbers, and a 100 m^2 circular plot (adjusted for slope) was established. Plot coordinates and elevation (measured with a Garmin eTrex Global Positioning System (GPS)), slope, and aspect were measured for each plot. Tree species, size (diameter at breast height or dbh) and total cover (total basal area) were recorded for all trees ≥10 cm dbh. Three 1 m^2 square subplots were located within each larger plot (along opposite edges and in the center) in which herb and shrub species and

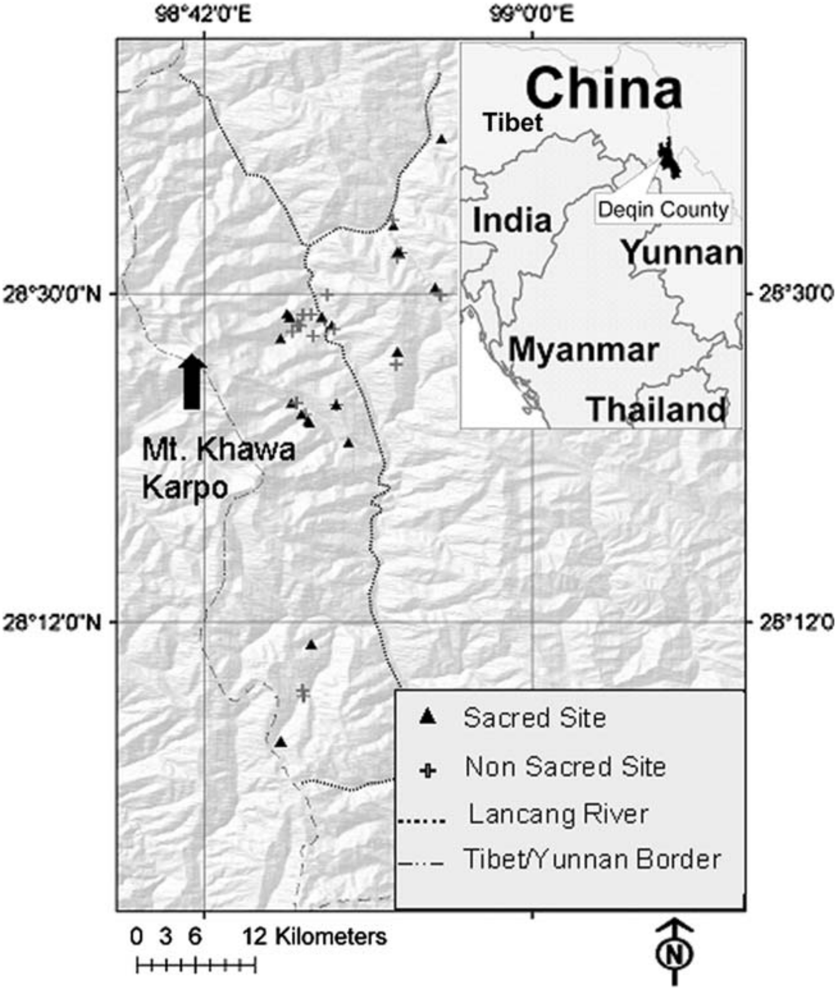

Figure 1. Sample sites near Khawa Karpo and the Lancang (upper Mekong) river. Khawa Karpo is considered a sacred mountain in Tibetan religion and is an important pilgrimage site.

cover (estimated) were recorded. Herbarium vouchers of each species were collected for identification, with duplicates deposited at the Kunming Institute of Botany (KUN), the Shangri-la Alpine Botanical Garden (SABG), and the Missouri Botanical Garden (MO). Tibetan doctors provided the Tibetan name, traditional uses and preparations of each species.

For each sacred plot sampled, an analogous non-sacred plot was selected (Table 1) in a nearby location. The non-sacred plot matched the sacred area in elevation ($\pm$200 m), slope ($\pm$5°), aspect, and habitat (e.g. Spruce forest). Non-sacred plots were sampled as above.

Species richness – number of species/100 m^2 for trees and number of species/3 m^2 for understory shrubs and herbs – and diversity (Shannon-Weiner H') were calculated (Barbour et al. 1987). Using SPSS Version 12.0 (2003), normality and equal variance were tested; paired *t*-tests were used with normal and equal variance data, and Wilcoxon Sign Rank non-parametric two related samples tests with non-normal or unequal variance data. Cover values for each herb and shrub species in the three 1 m^2 subplots were averaged. The Tibetan doctors identified all recorded tree species as useful; in contrast, only a subset of total herb and shrub species were considered useful. Consequently, statistics for useful herbs and shrubs were tested separately from statistics for all herbs and shrubs, while for trees the same statistics sufficed for both.

Results

Understory vegetation *within* habitats is not significantly affected by sanctity for any measured value. Species richness ($t = 0.247$, df = 31, $p = 0.807$), useful species richness ($t = -0.804$, df = 31, $p = 0.427$), understory cover ($t = -1.257$, df = 31, $p = 0.218$), useful understory cover ($t = -1.773$, df = 31, $p = 0.086$) and species diversity ($t = 0.460$, df = 31, $p = 0.649$) do not differ significantly between sacred and non-sacred plots.

In contrast, trees *within* habitats do show significant differences based on sanctity. Trees in sacred areas have significantly greater total cover (total basal area: $z = -2.931$, $p = 0.003$; Figure 2), and greater tree size (average dbh: $z = -2.979$, $p = 0.003$; Figure 3). Tree species richness and tree species diversity within sacred areas, however, do not differ significantly with sanctity ($z = -0.873$, $p = 0.383$; $z = -0.746$, $p = 0.465$).

Discussion

Tibetan sacred areas near Khawa Karpo accommodate a rich interaction among ecological, cultural, and religious processes. Around the globe, indigenous processes and knowledge can provide potential conservation strategies (Alcorn 1995; Berkes 1999; Salick et al. 2005). While researchers increasingly call for the integration of traditional ecological knowledge with management strategies in order to ground conservation within local beliefs and practices, the relevance of this practice to ecology is an open debate. Results from this case study around Khawa Karpo may help further this discourse.

Sanctity potentially affects conservation in three principal ways: (1) the location of sacred sites *among* habitats within a landscape (sacred sites are located in areas that would also make them appropriate conservation sites); (2) habitat conservation (if within a given area sanctity better conserves habitat); and (3) sanctity conserves species and community structure *within* habitats. Our earlier study (Anderson et al. 2005, in press), based on large-scale, remote

Table 1. Sample sites in the Khawa Karpo region of northwest Yunnan.

Pair	Location	Sanctity	Elevation	Forest type	Sacred site description
1	Adong	Sacred	3405	*Quercus*-dominated mixed forest	Forest on 'field on plateau' sacred mountain
		Non-sacred	3264	*Quercus*-dominated mixed forest	
2	Adong	Sacred	3242	*Quercus* forest	Forest on 'field on plateau' sacred mountain
		Non-sacred	3295	*Quercus* forest	
3	Adong	Sacred	3446	Mixed forest	Forest on 'field on plateau' sacred mountain
		Non-sacred	3309	Mixed forest	
4	Adong	Sacred	3358	Mixed forest	Forest on 'field on plateau' sacred mountain
		Non-sacred	3309	Mixed forest, selectively logged	
5	Adong	Sacred	2709	Dry scrub	Sacred forest on 'Surrender Mountain'
		Non-sacred	2614	Dry scrub	
6	Bucun	Sacred	2088	Spring & surrounding dry scrub	Sacred grove near Bucun spring and temple
		Non-sacred	2142	Spring & surrounding dry scrub	
7	Bucun	Sacred	2088	Spring & surrounding dry scrub	Sacred grove near Bucun spring and temple
		Non-sacred	2142	Spring & surrounding dry scrub	
8	Gonka	Sacred	3570	*Salix* scrub	Sacred alpine meadow near a lake
		Non-sacred	3649	*Salix* scrub	
9	Gonka	Sacred	3577	Riparian forest	Sacred alpine meadow near a lake
		Non-sacred	3627	Riparian forest	
10	Minyong	Sacred	2363	Dry scrub	Sacred forest next to a glacier on the pilgrimage route
		Non-sacred	2382	Dry scrub	
11	Minyong	Sacred	2700	Pine forest	Sacred forest next to a glacier on the pilgrimage route
		Non-sacred	2548	Pine forest	
12	Yubeng	Sacred	3148	Shrubby meadow	Sacred Alpine Meadow
		Non-sacred	3157	Shrubby meadow	
13	Yubeng	Sacred	3148	*Hippophae* forest	Sacred grove
		Non-sacred	3157	*Hippophae* forest	
14	Yubeng	Sacred	3062	Mixed forest	Forest on sacred mountain
		Non-sacred	3100	Mixed forest	

Table 1. Continued

Pair	Location	Sanctity	Elevation	Forest type	Sacred site description
15	Yubeng	Sacred	3455	Mixed conifer forest	Forest on sacred mountain
		Non-sacred	3497	Mixed conifer forest	
16	Yubeng	Sacred	3671	*Rhododendron* forest	Forest on sacred mountain
		Non-sacred	3497	*Rhododendron* forest	
17	Yongzhi	Sacred	2888	Mixed conifer forest	Sacred forest above the village
		Non-sacred	2690	Mixed conifer forest	
18	Yongzhi	Sacred	2894	Mixed conifer forest	Sacred forest above the village
		Non-sacred	2690	Mixed conifer forest	
19	Yongzhi	Sacred	2899	Mixed conifer forest	Sacred forest above the village
		Non-sacred	2700	Mixed conifer forest	
20	Yongzhi	Sacred	3394	*Betula*/conifer forest	Sacred Peacock Mountain
		Non-sacred	3139	*Betula*/conifer forest	
21	Yongzhi	Sacred	3555	Bamboo grove	Sacred Peacock Mountain
		Non-sacred	3345	Bamboo grove	
22	Yongzhi	Sacred	3394	*Betula*/conifer forest	Sacred Peacock Mountain
		Non-sacred	3146	*Betula*/conifer forest	
23	Yongzhi	Sacred	3582	Bamboo/conifer forest	Sacred Peacock Mountain
		Non-sacred	3337	Bamboo/conifer forest	
24	Yongzhi	Sacred	3494	Bamboo/conifer forest	Sacred Peacock Mountain
		Non-sacred	3328	Bamboo/conifer forest	
25	Feilishi	Sacred	3538	*Quercus* forest	Next to the 'Flying Temple'
		Non-sacred	3486	*Quercus* forest	
26	Feilishi	Sacred	3556	*Quercus* forest	Next to the 'Flying Temple'
		Non-sacred	3487	*Quercus* forest	
27	Feilishi	Sacred	3569	*Quercus* forest	Sacred Oak forest next to
		Non-sacred	3488	*Quercus* forest	Khawa Karpo overlook
28	Sinong	Sacred	2497	*Platycladus* scrub	Near censers on Khawa
		Non-sacred	2477	*Platycladus* scrub	Karpo's "dining table"
29	Feilishi	Sacred	2503	*Platycladus* scrub	Near censers on Khawa
		Non-sacred	2469	*Platycladus* scrub	Karpo's 'dining table'
30	Feilishi	Sacred	2772	*Pinus*/*Quercus* forest	Sacred forest next to
		Non-sacred	2749	*Pinus*/*Quercus* forest	the monastery
31	Feilishi	Sacred	2798	*Pinus*/*Quercus* forest	Sacred forest next to
		Non-sacred	2742	*Pinus*/*Quercus* forest	the monastery
32	Feilishi	Sacred	2768	*Pinus*/*Quercus* forest	Sacred forest next to
		Non-sacred	2740	*Pinus*/*Quercus* forest	the monastery

Each of 32 pairs contains one sacred and one non-sacred plot with similar elevation, aspect, slope, and habitat.

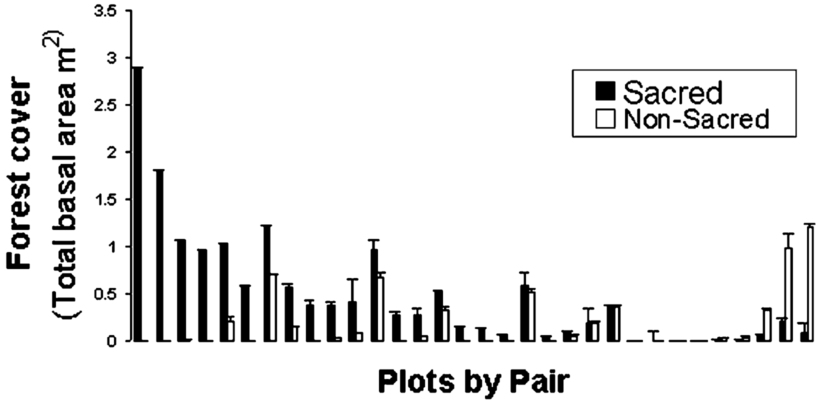

Figure 2. Sacred areas conserve old growth forest: Tree cover (total basal area) in plots located in sacred areas is significantly greater than in plots located in non-sacred areas (Kruskal Wallis, $z = -2.931, p = 0.003$). Error bars denote standard error. Trees with dbh ≥10 cm were measured.

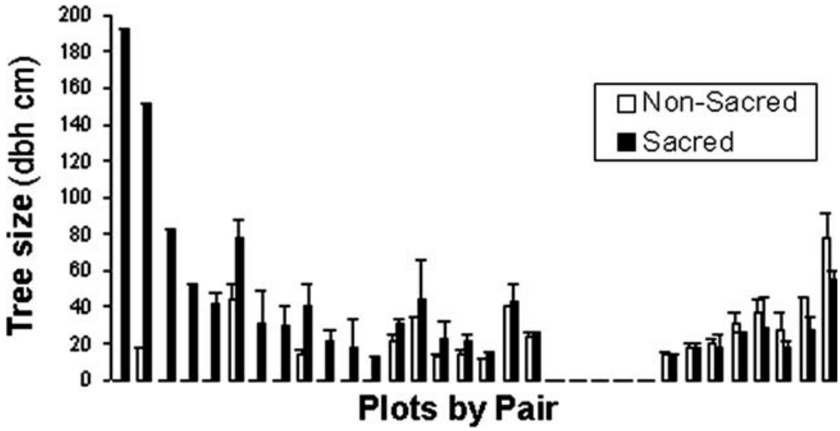

Figure 3. Sacred areas conserve old growth trees: Tree size (average dbh) is significantly greater in plots located in sacred areas than in plots located in non-sacred areas (Kruskal Wallis, $z = -2.979$, $p = 0.003$). Error bars denote standard error. Trees with dbh ≥10 cm were measured.

sensing analysis established that sacred sites aid conservation at a landscape level (1) due to their location in areas with higher numbers of species, useful species, species diversity, and endemism. The role of sacred sites in habitat conservation (2) seems patent (see Figure 4 where the sacred forest in the background effectively conserves the habitat from conversion to pasture in the foreground). With habitat comes species richness, biodiversity, cover, endemism, etc. In contrast, this study focuses on *within* habitat conservation (3) to test a more subtle process. How do sacred sites differ botanically from non-sacred sites, even if habitat is maintained in both?

Figure 4. Sanctity affects habitat conservation and *within*-habitat conservation differently: as demonstrated by the sacred forest (back left), non-sacred forest (back right) and pasture (foreground). Sanctity's role in conserving habitat is clearly demonstrated by comparison of the sacred forest and the pasture. Sanctity's role in conservation *within* habitat, the aim of this study, is subtle, as demonstrated in the similarities between the sacred and non-sacred forests. Nonetheless, this study quantifies the contributions *within* habitats of sacred areas in conserving old growth trees and forest structure.

The lack of significant differences in understory plants between sacred and non-sacred sites that we find here is indicative of how sanctity affects land use in Tibetan society. Though human use regimes in sacred areas are variously restricted from site to site and from village to village, most sacred areas are subject to some form of human use. Grazing and gathering of medicinal plants, fodder, green manure and other non-timber forest products are permitted in many sacred areas. These activities have a disproportionate effect on understory vegetation. As a result, understory plants in sacred and non-sacred areas do not differ ecologically since they are subject to similar anthropogenic and biotic pressures. Likewise, useful plants in the understory of sacred and non-sacred areas are not significantly different because they are tightly correlated with overall species richness near Khawa Karpo (Salick et al. 2004) as elsewhere in Asia (Salick et al. 1999).

Trees, however, tell a different story. The fact that sacred sites shelter significantly larger trees and greater tree cover suggests that sacred sites are effective in conserving old growth trees and forests. This may reflect restrictions on timber extraction. A National Forest Conservation Program in 1998 banned all commercial logging and fires in natural forests (Zhang et al. 2000; Luo et al. 2001), though national law grants local governments autonomy to regulate timber extraction in community forests. Village governments, in turn, designate those forests from which construction materials and firewood may be extracted. Local customs prohibit timber extraction from sacred areas, protecting their old growth trees and forests.

A competing hypothesis is that sacred sites were originally selected for designation as 'sacred' because of unique biological attributes. Many anomalous ecological phenomena have been noticed and sanctified around Khawa Karpo. At the Minyong glacier, individual trees of *Pseudotsuga forrestii* Craib are found at much lower elevations than elsewhere and thus are revered. Local knowledge cites the mythology and spiritual attributes of large burls, springs, discreet glades and trees growing at peculiar angles. Singularly large trees, as well as groves of outstanding trees or rare species, are likewise revered. It is possible that these unusual biological phenomena arose because of their location within sacred (and consequently protected) areas; it is equally possible that areas were deemed sacred because they already encompassed these phenomena.

We feel that the role of Tibetan sacred sites is compelling in conserving old growth trees and forests as shown in this study, and in conserving species, biodiversity and endemic species as demonstrated in our previous landscape study. Nonetheless, it is important to acknowledge the larger significance of Tibetan sacred sites. The culture-nature nexus among Tibetans is complex, nuanced and profound; it reflects historical, religious, cultural, and philosophical beliefs well beyond the scope of this paper, though amply expounded upon by scholars (see Williams (1998) for a thorough bibliography). Though local Tibetan leaders and doctors acknowledge that sacred areas conserve rare and useful plants and protect watersheds, our etic ecological indices ill-fit Tibetan emic worldviews:

> 'Tibetan Buddhists are interested in the essential being of all nature – past, present, future – including not just biodiversity, but also rocks, water, stars and the whole universe. A Tibetan sacred site does not have a function, such as conserving biodiversity; it is a connection with the essential being of a plant, of rocks, of water, of a mountain, of the sky, of the universe. To interpret a sacred site in the limited sense of Western Conservation is to misinterpret Tibetan Buddhism.' Tashi Duojie (2004)

Furthermore, we acknowledge that polarizing designations of 'sacred' and 'non-sacred' are clumsy and problematic. As Lobsang Lhalungpa (1990), p. 32 writes: 'The physical world [is] considered not only the heavenly abode of the cosmic deities but also the sacred habitat of all living beings. All mountains, lakes, rivers, trees and even the elements [are] sacred dwellings of the spiritual forces indeed, the entire country [is] deemed a 'sacred realm'. In this sense, the concept of sampling 'non-sacred' sites is perhaps a disservice to the Tibetan worldview. A more emic outlook would perhaps recognize a 'gradient of sanctity' spanning areas with regional or even global recognition (e.g., the eight sacred mountains) to areas that are little recognized except at the most local scale (e.g., sacred family trees).

Despite this seeming disjunct between scientific and spiritual outlooks on the Tibetan landscape, the role of sanctity in environmental conservation is clear. Biological indices, though useful for generating statistics and conservation policy, are not required to appreciate the role of sanctity in the Khawa Karpo region; simple observation and discussion with local villagers reveals the importance of sacred areas in a rapidly changing landscape. Road construction, an economy shifting towards wage labor, and increased tourism are modifying land use patterns in northwest Yunnan at an unprecedented rate (Litzinger 2004). In light of these abrupt changes, and recognizing the ecological wealth of the Hengduan Mountains, conservation organizations from around the globe are now working with the Yunnan Provincial government to develop conservation strategies and action plans. Sacred sites should play a role in conservation policy.

Many studies have revealed the importance of local cooperation in the conservation process (Brown 2003; Moller et al. 2004). As the activities of conservation groups foment development projects, nature preserves and eco-tourism infrastructure, it is essential that the viewpoints, knowledge and wishes of Khawa Karpo's indigenous inhabitants be considered. Sacred areas are essential to the Tibetan cosmovision, and consequently they have great cultural importance. Yet these areas also possess biological importance, central to environmental conservation. Sacred site conservation has guided local environmental stewardship for millennia. It is this continued stewardship that will ultimately determine the future of this biodiversity hotspot.

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