
Status Review of the Protected-Area System in Myanmar, with Recommendations for Conservation Planning

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Abstract: Myanmar is among the most biologically diverse countries in mainland Southeast Asia. In contrast to its neighbors, large areas of Myanmar's forest cover remain intact, providing a unique opportunity to conserve biodiversity within protected areas. High levels of deforestation, unrestricted hunting, and destructive agricultural practices have resulted in significant wildlife declines and rapid loss of natural habitats. We analyzed the status of 20 of the 31 officially gazetted protected areas in Myanmar within a framework that classified activities incompatible with protected-area status into two broad categories, small and large scale. Small-scale incompatibilities driven by economic necessity and lack of alternatives for local populations within and adjacent to protected areas occurred more frequently than large-scale incompatibilities driven by larger economic interests. Extraction of nontimber forest products was reported in 85% of the protected areas and ranked highest among the 15 identified incompatibilities. Grazing, hunting, fuelwood extraction, and permanent settlements occurred in more than 50% of the parks surveyed. Forty percent of the protected areas had some infrastructure for reserve management (with significant gaps) but insufficient on-site personnel to adequately perform management activities. Thirty-five percent had approximately half their staff trained in basic field techniques, and 60% had a planning document that was yet to be implemented. Older protected areas were affected by a greater number of incompatibilities than recently established protected areas. Major recommendations include the critical need to address the issue of hunting; involving local communities in the management of protected areas and buffer zones; building the technical capacity of protected-area staff; implementing a comprehensive land-use plan focused on stabilizing land use; and amending existing wildlife laws to fulfill international treaty obligations.

Revisión del Estatus del Sistema de Áreas Protegidas en Myanmar con Recomendaciones para la Planificación de la Conservación

Resumen: Myanmar es uno de los países con mayor diversidad biológica en el sureste de Asia continental. En contraste con sus vecinos, extensas áreas de la cubierta forestal de Myanmar permanecen intactas, proporcionando una oportunidad única para conservar la biodiversidad en áreas protegidas. Altos niveles de deforestación, cacería sin restricción y prácticas agrícolas destructivas han ocasionado declinaciones significativas de vida silvestre y la rápida pérdida de hábitats naturales. Analizamos el estatus de 20 de las 31 áreas protegidas decretadas oficialmente en Myanmar en un marco que clasificó actividades incompatibles con el estatus de área protegida en dos grandes categorías (escala pequeña vs. grande). Incompatibilidades de pequeña escala causadas por la necesidad económica y la falta de alternativas para las poblaciones locales ocurrieron más frecuentemente que incompatibilidades de gran escala derivadas de intereses económicos mayores. La extracción de productos forestales no maderables se registró en 85% de las áreas protegidas y fue la mayor de 15 incompatibilidades identificadas. Pastoreo, cacería, extracción de leña y asentamientos permanentes ocurrieron en más del 50% de los parques analizados. Cuarenta por ciento de las áreas protegidas tenía alguna infraestructura para el manejo de la reserva (pero con vacíos significativos) e insuficiente

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Paper submitted May 22, 2000; revised manuscript accepted June 4, 2001.

personal para desarrollar las actividades de manejo adecuadamente. En treinta y cinco porciento de los parques, aproximadamente la mitad de su personal estaba capacitado en técnicas de campo básicas y 60% aún no instrumentaba un documento de planificación. Las áreas protegidas más antiguas fueron afectadas por un mayor número de incompatibilidades que las establecidas recientemente. Las recomendaciones más importantes incluyen: la necesidad crítica de atender el asunto de la cacería; de involucrar a comunidades locales en el manejo de áreas protegidas y de zonas de amortiguamiento; de incrementar la capacidad técnica del personal a cargo de las áreas protegidas; de instrumentar de un plan integral de uso de suelo enfocado a estabilizar su uso y reformar las leyes de vida silvestre existentes para cumplir con las obligaciones de tratados internacionales.

Introduction

High species diversity and endemism, together with vast intact landscapes, make Myanmar one of the most important Indo-Pacific mainland countries for biodiversity conservation (Dinerstein & Wikramanayake 1993). The Himalayan mountains in the north, coral reefs and lowland forests in the south, and an extensive river system contribute to its complex network of ecosystems and high biodiversity (World Conservation Monitoring Centre 1994).

Myanmar is unique among its neighbors in that as much as 30% of its land area is still forested; therefore, it represents an important biodiversity reservoir in Asia (Food and Agriculture Organization 1997). With a relatively small protected-area system, large expanses of unprotected, contiguous forest areas remain in this biogeographically complex region. Depletion of forest cover and unsustainable resource use in neighboring countries has led to increasing pressure on Myanmar's natural resources. Extensive mixed-deciduous forests produce economically important hardwoods such as teak (*Tectona grandis*), making them vulnerable to logging, reportedly the most significant cause of deforestation (Brunner et al. 1998). In addition, unrestricted hunting, fuelwood extraction, destructive agricultural practices, and weak resource-use planning have together resulted in significant wildlife declines and rapid loss of natural habitats (Rabinowitz et al. 1995; Uga 1995; McShea et al. 1999). These pressures are likely to increase dramatically in the face of pressing economic considerations and Myanmar's quest for rapid economic development (Bryant 1997).

Steady declines in wildlife populations in forest reserves and protected areas over the past few decades have resulted primarily from hunting for wildlife trade (Blower 1982, 1985; Martin 1997; Martin & Redford 2000). The few reliable surveys of wildlife populations that exist suggest serious declines due to the effects of habitat loss and unregulated hunting. Species such as the Sumatran rhino (*Dicerorhinus sumatrensis*), tiger (*Panthera tigris*), takin (*Budorcas taxicolor*), musk deer (*Moschus* sp.), gaur (*Bos gaurus*), banteng (*Bos javanicus*), and crocodile (*Crocodylus porosus*) are

among those seriously threatened by hunting (Milton & Estes 1963; Rabinowitz et al. 1995; Rabinowitz 1998; Rabinowitz & Saw Tun Khaing 1998).

Currently, Myanmar has 15,068 km² of protected area in 31 established national parks and wildlife sanctuaries covering 2.26% of the total area of the country (Nature and Wilderness Conservation Division [NWCD] 1999). Until 1996, protected areas constituted <1% of the total national land area, with individual parks ranging in size from 4.53 km² (Wethhtikan Bird Sanctuary) to 2150 km² (Tamanthi Wildlife Sanctuary). Between 1996 and 1999, 12 new protected areas ranging in size from 0.5 km² (Lawkananda Wildlife Sanctuary) to 3812 km² (Hkakaborazi National Park) were added to the system. Formerly, protected areas were established primarily to protect certain species or habitat types and hence were often small in size. Only since 1998 have larger protected areas been set aside with the objective of protecting entire landscapes or ecosystems. Hukaung Valley (6460 km²) and Mahamyaing (3354 km²) have been proposed as wildlife sanctuaries and currently await official approval. With the inclusion of these two areas into the system, protected-area coverage would increase to 3.71% of the national land area. Six protected areas are surrounded by buffer zones: Hlawga (2.7 km²), Popa (103.6 km²) and Lawkananda (0.5 km²) parks, and Shweseztaw (260.6 km²), Minsontaung (15.9 km²), and Chatthin (52.6 km²) wildlife sanctuaries.

Marine conservation efforts have been in effect since early 1927, with the designation of Moscos Island Wildlife Sanctuary for the protection of coastal tropical flora and fauna. Since then, two wildlife sanctuaries and one national park have been designated as marine protected areas. They include Thamihla Kyun Wildlife Sanctuary (1970) for the protection of sea turtles, Meinmahla Kyun Wildlife Sanctuary (1994) for the protection of mangroves and tidal flora and fauna (crocodiles), and Lampi Island Marine National Park (1996) for the protection of coastal flora and fauna, particularly coral reefs.

Myanmar's forest policy (1994) mandates an increase in the country's protected-areas system to contain at least 5% of the total land area, with the long-term goal of including 10% of the total land area (Ministry of Forestry 1994). The policy outlines a general strategy to "select,

establish and manage forest reserves and a protected area system for the permanent protection of natural vegetation, steep slopes, watersheds, habitats for wildlife and areas for production forestry.”

Due to its significant expanses of unprotected forested habitat, Myanmar has high potential for conservation efforts focused on expansion of the existing protected-area system (Dinerstein & Wikramanayake 1993). There have been few systematic analyses of the status of existing protected areas in Myanmar (Food and Agriculture Organization 1983, 1985; Salter 1994), so their role in protecting biodiversity remains poorly synthesized. We analyzed the status of 20 out of the existing 31 protected areas and, based on our results, we make recommendations for the long-term conservation of biodiversity.

The Burmese Forest Department was created in 1856 to assert control over forest use as part of an attempt to scientifically manage Myanmar’s commercially valuable forests (Bryant 1997). The department was created in response to extensive forest depletion caused by *laissez-faire* forestry practices, and its main priority has been to maximize commercial production of timber in Myanmar’s extensive teak forests. The Burmese Constitution, implemented after independence in 1949, defines the state as the “ultimate owner of all lands.” Formal recognition of the importance of conservation has been a relatively recent phenomenon, highlighted by the creation of the Nature and Wildlife Conservation Division of the Forest Department in 1984, which has since assumed responsibility for wildlife conservation and management of protected areas.

Wildlife conservation legislation enacted in Myanmar in 1994 (the Protection of Wildlife and Protected Areas Law) mandates protection of wild flora and fauna and their habitats and representative ecosystems, and recognizes seven categories of protected areas. These do not directly match categories of the World Conservation Union (1994). Myanmar’s categories include scientific reserve (strict nature reserve), national park, marine park, managed nature reserve, wildlife sanctuary, protected landscape, and other protected areas. The existing protected-area network does not include three of the categories listed above: strict nature reserves, managed nature reserves, and protected landscapes.

Wildlife are afforded varying degrees of protection according to their designation: (1) completely protected species may not be hunted except for scientific purposes under a special license; (2) protected species may be hunted but only with special permission; (3) seasonally protected species are subject to traditional subsistence hunting by rural communities only during the open (i.e., nonbreeding) season.

In addition to the Wildlife Law, the Forest Act of 1992 provides the basis of the Forest Department’s renewed mandate and links forestry management explicitly to social and environmental considerations (State Law and

Order Restoration Council 1992). It allows for the protection of forest resources, recognizing two types of forests that together constitute “forest land”: reserved forest (16.38%) and protected public forest (1.68%). The 1994 Forest Policy, designed to complement the Forest Act of 1992, also emphasizes the need to integrate the goals of timber production, wildlife, and environmental conservation (Ministry of Forestry 1994). This policy mandates an increase in the current area of forestland from 18.06% to 30%, excluding protected areas. Although plants and trees within these two forest categories are protected to some extent, even highly endangered species are not protected outside these two categories. Forests outside the two categories are referred to as “unclassified” forests and are not under the jurisdiction of the Forest Department.

Although the Forest Department is responsible primarily for the protection of terrestrial forest biota and habitats, the Fishery Department, Defense Ministry (army and navy), and Ministry of Forestry have joint responsibilities for nonforest and marine resources. The National Commission for Environmental Affairs (NCEA), created in 1990, is concerned primarily with the development and coordination of national environmental policy and coordinating relations with other countries and international organizations on environmental matters (NCEA 1993). Myanmar is a party to the Convention on Biological Diversity (1992) and is therefore required to amend its national laws to incorporate the provisions of the treaty. In 1997 it acceded to the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES) of 1972, but no efforts have been made as yet to implement the treaty provisions (Pant 1998).

Methods

We recorded presence and absence data on situations incompatible with protected-area status (henceforth referred to as incompatibilities) for 20 protected areas between 1996 and 1999. Our sample of 20 sites consisted of three national parks (including one marine national park), nine wildlife sanctuaries (including two wetlands and one mangrove forest), four bird sanctuaries, two wildlife parks, and two “protected areas” (Table 1). National parks and wildlife sanctuaries do not differ from each other in terms of management and use restrictions. The two wildlife parks (Hlawga and Popa Mountain) included in our study were set aside by the Forest Department for purposes of watershed protection and currently serve as recreational areas for the general public. Wildlife conservation is not the primary objective for either of these wildlife parks.

We visited each protected area for an average of 10 days, depending on its size and accessibility. In each visit, we were accompanied by the park warden and

Table 1. List of protected areas—parks, wildlife sanctuaries (WS), and national parks (NP)—in Myanmar.^a

<i>Protected area</i>	<i>Size (km²)^b</i>	<i>Year^c</i>	<i>Small-scale incompatibilities^d</i>	<i>Large-scale incompatibilities^d</i>
Wetthikan Wetland Bird Sanctuary	4.5	1939	1,3,4,5	8,12,14
Hlawga Park	6.2	1982	1,2,5	
Taunggyi Bird Sanctuary ^e	16.1	1930	2,3,4	8,9,11
Minsontaung WS ^e	22.6	1999	2,3,4	
Loimwe Protected Area ^e	42.8	1996	2,3,4,6	8,12
Parsar Protected Area ^e	77.7	1996	2,3,4,6	15
Moyingi WS	103.6	1988	1,3,4,5	14
Shwe-U-Daung	119.1	1918	1,3,4,6,7	11,15
Pyin oo Lwin Bird Sanctuary ^e	127.3	1918	2,3,4,7	8,9,10
Popa Mountain Park ^e	128.5	1989	2,3,4	8,9,10,12,13
Meinmahla Kyun WS	136.7	1994	1,2,3,5	
Lampi Island Marine Park	204.8	1996	3	8,11,13,15
Minwuntaung WS ^e	205.9	1972	2,4,6	8,12
Shwesettaw WS ^e	552.7	1940	1,2,3,4,6	8,9,11,12,15
Inlay Wetland Bird Sanctuary	642.3	1985	1,5	8,13,14
Pidaung WS	698.3	1918	1,2,3,4,6	8,9,10,11,12
Natmataung WS	722.6	1994	1,2,3,6	
Alaungdaw Kathapa NP	1605.8	1989	1,3,4,5	11,13
Tamanthi WS	2150.7	1974	1,3,5,7	
Hkakaborazi NP	3812.5	1998	1,3,4,6	8
Lawkananda Park*	0.5	1997		
Thamihla Kyun WS*	0.9	1970		
Kelatha WS*	24.5	1942		
Moscov Islands WS*	49.2	1927		
Mulayit WS*	138.6	1936		
Kahilu WS*	160.6	1928		
Kyaikhtyoe WS*	180.7	1998		
Chatthin WS*	268.2	1941		
Panlaung-Pyadalin Cave WS*	333.8	1999		
Indawgi Bird Sanctuary*	775.3	1999		
Yakhine Yoma WS*	1755.7	1997		

^aProtected areas not included in the survey are indicated by an asterisk.

^bFigures are from *Nature and Wildlife Conservation Division, Union of Myanmar (1999)*.

^cYear area was legally gazetted.

^dCode definitions: 1, hunting for subsistence and wildlife trade; 2, fuelwood collection; 3, extraction of nontimber forest products (orchids, palm leaves, grass, rattan, honey, mushrooms, bamboo, resin from dipterocarps, corals, and medicinal plants); 4, grazing by domestic cattle, sheep, and horses; 5, fishing (crabs, prawns, and fish); 6, shifting cultivation; 7, mining; 8, permanent human settlements; 9, roads and railway lines; 10, plantations of sugar cane, rubber, and oil palm; 11, military camps and/or insurgents indicating availability of firearms; 12, permanent cultivation; 13, tourism; 14, breeding centers for ducks, fish, and other animals; 15, extraction of timber species such as teak.

^eNatural and human-caused fires.

staff and frequently by local guides and hunters who assisted in the data-collection process. We identified 15 different types of incompatibilities (Table 1) and scored these for presence or absence in each protected area. All incompatibilities except for natural and human-caused fires were further classified into one of two categories. The first was small-scale incompatibilities often driven by economic necessity and lack of alternatives for rural peoples living adjacent to and within protected areas. The seven small-scale incompatibilities recorded were hunting, fuelwood collection, extraction of nontimber forest products such as honey or bamboo, grazing, fishing, shifting cultivation, and mining. The second category was large-scale incompatibilities arising from official projects with institutional support and driven by larger commercial interests. The eight large-scale incompatibilities recorded were permanent human settlements, roads and railroads, plantations, military camps,

permanent cultivation, selective tourism activities resulting in degradation, fish and duck breeding centers, and commercial timber extraction (Table 1). Except for tourism involving pilgrimages to religious shrines within protected areas, all other incompatibilities as defined here are in theory illegal in protected areas.

The distinction between the two categories of incompatibility—small- and large-scale—is useful for designing effective solutions. Most small-scale incompatibilities could be partially addressed locally at the site level, whereas large-scale incompatibilities caused by larger economic interests and backed by official support are generated by external forces and consequently require action at the national or international policy levels (Brandon et al. 1998; van Shaik et al. 1997).

In addition, every park was surveyed for information on five factors related to park-management activities: (1) physical infrastructure, (2) number of on-site personnel,

(3) training, (4) site-based management plans, and (5) environmental education programs. The first three of these factors were scored on a scale of 1 to 5, and the last two were scored on a scale of 1 to 3. Descriptions of the scoring categories are given in the Appendix and are adapted from Brandon et al. (1998).

Results

The 20 protected areas (total area of 11,380 km²) included in the sample represented 75.6% of the existing protected-area network. The sampled areas were representative of the network in terms of size distribution as well as protected-area categories. The average size (569.04 ± 950.4 km²) of the sampled population of protected areas ($n = 20$) did not significantly differ from the average size (486 ± 821.8 km²) of all existing protected areas ($n = 31$) ($p > 0.05$) (Table 1). The sampled areas consisted of all national parks ($n = 3$) and protected areas ($n = 2$), 9 out of 18 wildlife sanctuaries, four out of five bird sanctuaries, and two out of three wildlife parks.

The size of a protected area was not correlated significantly with either number or type of incompatibilities (Spearman's rank correlation $p > 0.05$ for both cases), but older protected areas were affected by a greater number of incompatibilities than recently established protected areas (Spearman's rank correlation, $p < 0.05$).

Small-scale incompatibilities arising from the activities of local populations occurred in more protected areas than large-scale incompatibilities caused by official projects (t test, $p < 0.001$; Table 1). A chi-square test did not reject the null hypothesis of similarity in the proportion of small- versus large-scale incompatibilities across sampled protected areas ($\chi^2 = 19.25$, $df = 19$, $p > 0.25$). Extraction of nontimber forest products was reported in 85% of protected areas and ranked highest among all identified incompatibilities. Grazing, hunting, fuelwood extraction, and permanent settlements occurred in more than 50% of the parks surveyed. The average frequency of incompatibilities was 8 out of 15 identified incompatibilities, with a maximum of 10 recorded for Pidaung and Shwese-taw wildlife sanctuaries.

Forty percent of the parks surveyed had some infrastructure for reserve management (with significant gaps) but insufficient on-site personnel to adequately perform management activities. Thirty-five percent had approximately half their staff trained in basic field techniques (Fig. 1). Staff training had been only formally conducted since 1995. None of the protected areas surveyed had the necessary infrastructure for effective reserve management or sufficient on-site personnel to perform park management activities adequately. Sixty percent of protected areas surveyed had a planning document (not a comprehensive management plan) yet to be implemented. The three protected areas with no

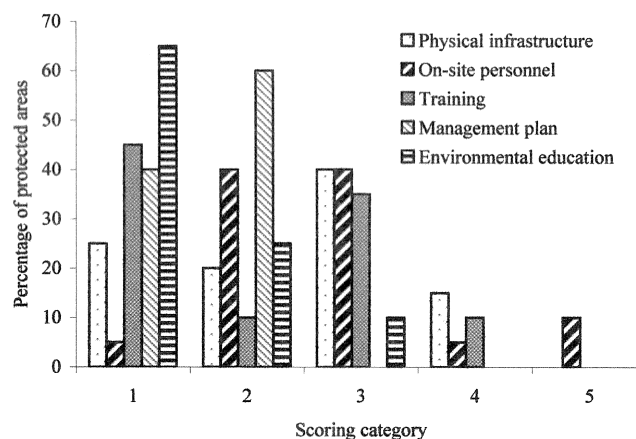


Figure 1. Park-management status based on physical infrastructure, on-site personnel, training, management plan, and environmental education activities in 20 protected areas. Scoring categories are described in Appendix. (Physical infrastructure, on-site personnel, and training were scored on a scale of 1–5, and management plan and environmental education were scored on a scale of 1–3).

management plan were Hkakaborazi national park, Pidaung wildlife sanctuary, and Shwe-U-daung wildlife sanctuary. Environmental education programs were being conducted in two protected areas and were being developed in five areas. Sixty-five percent of the protected areas had no environmental education programs under development (Fig. 1).

Discussion

The size of protected areas within the existing network varied widely, with parks ranging from as small as 0.5 km² (Lawkananda Park) to as large as 3812 km² (Hkakaborazi National Park). The lack of significant correlation between the size of a protected area and the number or type of incompatibilities requires careful interpretation. Although park size was not correlated with frequency of incompatibility, smaller parks were generally more vulnerable to activities incompatible with protected-area status than were larger parks. Therefore, the inclusion of larger areas is recommended as expansion of the protected area system proceeds.

Older protected areas appear to be subject to a greater number of incompatible activities than recently created protected areas. This is perhaps attributable to the earlier Wildlife Act (1936), which afforded protection to wildlife but not their habitat (the 1994 Wildlife Act provides protection to both wildlife and their habitat). Following is a brief description of three protected areas and their current status as determined by the study.

The Pidaung Wildlife Sanctuary in northern Myanmar was set aside in 1918 to protect a unique mix of evergreen forest and savanna-like ecosystems with a rich array of wildlife, including elephants (*Elephas maximus*), gaurs (*Bos gaurus*), tigers (*Panthera tigris*), leopards (*Panthera pardus*), and bears (*Ursus* sp.). The sanctuary had 10 out of the 15 identified incompatibilities, equally distributed between the two categories of small- and large-scale. The presence of permanent human settlements, roads and railway lines, plantations of sugar cane, military camps, and permanent cultivation have completely altered large portions of the sanctuary, and an insignificant area of the original ecosystem remains. Earlier studies have shown that, between 1939 and 1957, populations of elephants declined more than 75% and tigers, leopards, and bears by 83–90% (Milton & Kimlai 1964). The current status of wildlife in the sanctuary remains unknown.

The Tamanthi Wildlife Sanctuary was established in 1974 along the upper Chindwin River in northwest Myanmar, primarily for the protection of the Sumatran rhinoceros (*Dicerorhinus sumatrensis*) and other species of large wildlife (Hundley 1952). The vegetation consists mainly of tropical evergreen forest, with some mixed deciduous and hill-forest types. The sanctuary had four small-scale incompatibilities related to hunting for subsistence and wildlife trade, extraction of nontimber forest products, fishing, and mining. Of these, hunting appeared to be primarily responsible for reduced wildlife densities. In 1994 there was no evidence of rhinos surviving in the sanctuary, and other species of large mammals such as tigers and gaurs occurred at critically low densities (Rabinowitz et al. 1995). Although poaching has decimated wildlife populations, the habitat has not been exploited heavily and remains relatively intact with high potential for conservation. A planned hydroelectric project could destroy a significant portion of this sanctuary, however.

The Meinmahla Kyun Wildlife Sanctuary, established in 1994, is comprised of Meinmahla Island, a low-lying, deltaic island of approximately 13,600 ha lying near the mouth of the Bogalay River, one of the main branches of the Ayeyarwaddy Delta in southern Myanmar. The sanctuary was established to protect the largest single block of remaining mangrove forest in Myanmar and the only remaining stronghold in the region of the estuarine crocodile (*Crocodylus porosus*). Other significant mammals present in the sanctuary include the Ayeyarwaddy dolphin (*Orcaella brevirostris*), leopards, leopard cats (*Felis bengalensis*), jungle cats (*F. chaus*), fishing cats (*F. viverrina*), sambar (*Cervus unicolor*), hog deer (*C. porcinus*), and wild pig (*Sus scrofa*). The sanctuary had four small-scale incompatibilities related to hunting, fuelwood collection, extraction of nontimber forest products, and fishing. With no permanent settlements within the sanctuary and two areas of adjacent reserved forest

available to meet the subsistence needs of local people, the status of the sanctuary could potentially be improved to protect the last remaining mangrove forests and estuarine crocodile populations in the region.

Although the purpose for establishing different types of protected areas is mentioned in the law (Section 14), the lack of clear direction on prohibitions and allowed activities in the various categories constitutes a significant weakness in the protected-area system (Pant 1998). Clarification of the various categories to more closely match World Conservation Union protected-area categories would be an important step toward effective planning.

Our study does not attempt to quantify levels of incompatibilities, so observed variation in the frequency of the two incompatibility categories does not reflect variation in the actual consequences for biodiversity. A higher frequency of small-scale incompatibilities attributable to local populations may not necessarily translate to higher levels of habitat alteration. For example, although livestock grazing occurs more frequently than timber extraction, alteration caused by the latter on a unit-area basis may far exceed the alteration caused by livestock grazing (Whitmore & Sayer 1992). Furthermore, the distinction between the two categories is admittedly blurred in the case of hunting, which, although perpetrated by local populations, occurs primarily because of external demand for wildlife products and is often a highly organized activity. Although it is difficult to determine the degree of sustainability of small-scale incompatibilities related to the extraction of nontimber forest products, there is some evidence to suggest that hunting for the wildlife trade occurs at extremely high levels, resulting in the local extinction of species such as the rhino (Rabinowitz et al. 1995). Among the large-scale incompatibilities, activities associated with cultural tourism often result in altered habitat, as in Inlay Wetland Bird Sanctuary and Alaungdaw Kathapa National Park. While the former is renowned for its cultural heritage, the latter contains a religious shrine of national significance that attracts a large number of pilgrims annually.

It is often difficult to distinguish between resource use by local versus nonlocal populations and between subsistence versus commercial use, although it is clearly important to do so in formulating effective site-based solutions. In Tamanthi Wildlife Sanctuary, local villagers meet their needs from the unclassified forests in the buffer zone between the village and the sanctuary, but poachers, gold panners, and commercial collectors of nontimber forest products travel from as far as 150 miles downstream of the Chindwin River, where lucrative markets for forest products exist.

The extraction of nontimber forest products such as honey, bamboo, rattan, medicinal plants, and orchids occurred in 85% of the protected areas surveyed and ranked highest among all the recorded activities. In the

absence of alternatives, local people are economically dependent on these natural resources, and the lack of clearly defined and well-managed buffer zones exacerbates the pressures on core protected areas. The few existing buffer zones are generally modified and neither protect core areas nor meet the requirements of the surrounding human communities. Two out of the six protected areas with buffer zones included in the survey (Popa Mountain Park and Shweseztaw Wildlife Sanctuary) were each associated with the highest incompatibility levels (8 and 10 incompatibilities, respectively).

The Forest Department, in consultation with local communities, has established community plantations (fuelwood and agroforestry) near villages to help generate income and meet local resource needs. Some of these plantations are still in use, but many of them have been encroached on by agriculture and other development activities. In areas of low human population density and stable land use, activities such as the extraction of nontimber forest products and fuelwood collection associated with subsistence use by local people could perhaps be addressed through the creation of carefully designed buffer zones. Providing resource alternatives directly linked to the objective of reducing unsustainable resource use within core protected areas could be an effective means of addressing the subsistence needs of local people. With appropriate incentives in place, monitoring by protected-area staff and local stakeholders may help regulate levels of resource extraction in buffer zones. In promoting development adjacent to or near protected areas, however, it is important to specify a coherent strategy linking conservation and development objectives and to recognize that the sustainability of participatory management of natural resource use is subject to specific conditions (Brandon & Wells 1992).

Hunting for subsistence and the wildlife trade has a significant effect on wildlife populations, leading to depletion and local extinctions through a number of mechanisms (Robinson & Bennett 1999). Hunting is evidently the most serious threat to the long-term persistence of wildlife in Myanmar's protected areas. In addition to subsistence use, wildlife and their products are sold for their medicinal value, as trophies, for use in making coats (deer skins), or as food. The largely illegal trade occurs mainly with neighboring countries such as China and Thailand and is responsible for the depletion of wildlife populations both within and outside existing protected areas (Rabinowitz et al. 1995; Martin 1997; Martin & Redford 2000). Myanmar's recent (1997) accession to CITES requires the country to take the steps necessary to control local and international trade in wildlife products. Furthermore, because wildlife depletion within Myanmar is driven largely by external demand for wildlife products in neighboring countries, there is a critical need for effective transboundary cooperation in implementing CITES regulations in addition to

clarifying the rules for enforcement of existing wildlife laws.

Our analysis of park-management activities revealed potential causes of widespread incompatibilities within protected areas. Gaps in reserve-management capabilities, measured in terms of physical infrastructure, on-site personnel, technical knowledge, and site-based management plans, are attributable largely to inadequate financial resources for park management. The lack of basic physical infrastructure and sufficient on-site personnel in most of the surveyed protected areas is a significant constraint on effective park management. Government policy decrees that park headquarters be located outside the park and generally close to a village or large town. In remote areas, park headquarters are often extremely far from the park itself and therefore not effective in implementing management activities. Protected-area staff stationed at remote outposts need to be appropriately compensated to help reinforce their commitment to conservation. But, the remoteness and inaccessibility of some areas have been key factors in ensuring protection of some areas against logging, commercial plantations, and other large-scale incompatibilities.

The implementation of a comprehensive land-use strategy is an integral requirement for an effective protected-area network (Terborgh & van Schaik 1997). The Myanmar Forest Policy (1994), recognizing the irreversibility of changes in land use, decrees the development of a national land-use plan, not only as imperative for the protection of important watersheds but also for the long-term conservation of biological diversity. An effective strategy focused on the stabilization of land use outside protected areas will help alleviate some of the large-scale incompatibilities related to land conversion and timber extraction, will benefit local communities, and will allow for an expansion of the protected-area network.

The following recommendations summarize the requirements for an effective protected-area network in Myanmar:

- build the technical capacity of protected-area staff to manage protected areas, community forests, and buffer zones;
- involve local populations in the management of protected areas, community forests, and buffer zones;
- clarify use restrictions in various protected-area categories;
- make amendments to the Protection of Wildlife and Protected Areas Law to incorporate the provisions of the Convention on Biological Diversity and CITES;
- address the issue of hunting for trade in wild flora and fauna that is largely responsible for their depletion in the wild;
- implement a comprehensive land-use plan at the national level that includes the protected area network and focuses on the stabilization of land-use;

- address the fundamental economic and policy incentives that drive unsustainable land use outside protected areas; and
- carry out a systematic, survey-based selection of biologically significant sites for the expansion of the existing protected-area network to ensure that reserves serve to protect biodiversity (Food and Agriculture Organization 1983, 1985; Pressey et al. 1993).

Myanmar's conservation challenges are not unique and tend to reflect similar patterns in the Asia-Pacific region (MacKinnon et al. 1986; MacKinnon 1996; Dudley & Stolton 1999). Although there are few broad solutions to the incompatibilities faced by the protected-area system, identifying common incompatibilities and potential solutions is a first step toward developing realistic, site-based conservation strategies.

Acknowledgments

This project was funded by the Wildlife Conservation Society and was conducted in collaboration with the Myanmar Forest Department. We thank the Ministry of Forestry and the Director-General of the Forestry Department for their interest and support. U Than Myint, Daw Bibiana Chit, U Than Nyo, and U Kyi Shwin provided invaluable logistical support for the surveys. We also thank J. Robinson, J. Thorbjarnarson, J. Ginsberg, K. Redford, C. Meine, and two anonymous reviewers for constructive comments on the manuscript.

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Appendix

Scoring of factors related to park management activities.

Physical infrastructure, office building, visitor's facility, training facility, communications, electricity, transport

- 5 = all physical infrastructure necessary for reserve management (as defined below) in place
- 4 = most physical infrastructure for reserve management in place; one or more components listed as necessary missing or inadequate
- 3 = some physical infrastructure for reserve management in place, but significant gaps exist
- 2 = little physical infrastructure for reserve management in place
- 1 = no physical infrastructure for reserve management in place

On-site personnel

- 5 = number of on-site personnel sufficient to perform all management activities
- 4 = number of on-site personnel adequate to perform most planned management activities
- 3 = on-site personnel able to perform some management activities

- 2 = some on-site personnel, not enough to adequately perform management activities
- 1 = no on-site personnel

Training

- 5 = 100% of on-site personnel have undergone training
- 4 = 75% of on-site personnel have undergone training
- 3 = 50% of on-site personnel have undergone training
- 2 = 25% of on-site personnel have undergone training
- 1 = 25% of staff have undergone training

Site-based management plans (1–5 years)

- 3 = management plan completed and implemented successfully
- 2 = management plan completed but not yet implemented
- 1 = management plan not yet begun

Environmental education programs

- 3 = environmental education programs being conducted
- 2 = environmental education programs being developed
- 1 = no environmental education programs under development

