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THE ROLE OF PROTECTED AREAS IN CONSERVING BIODIVERSITY AND SUSTAINING LOCAL LIVELIHOODS

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■ **Abstract** The world's system of protected areas has grown exponentially over the past 25 years, particularly in developing countries where biodiversity is greatest. Concurrently, the mission of protected areas has expanded from biodiversity conservation to improving human welfare. The result is a shift in favor of protected areas allowing local resource use. Given the multiple purposes of many protected areas, measuring effectiveness is difficult. Our review of 49 tropical protected areas shows that parks are generally effective at curtailing deforestation within their boundaries. But deforestation in surrounding areas is isolating protected areas. Many initiatives now aim to link protected areas to local socioeconomic development. Some of these initiatives have been successful, but in general expectations need to be tempered regarding the capacity of protected areas to alleviate poverty. Greater attention must also be paid to the broader policy context of biodiversity loss, poverty, and unsustainable land use in developing countries.

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INTRODUCTION

Over the past 25 years, the area of land under legal protection has increased exponentially. As of today, >100,000 protected areas have been established encompassing 17.1 million km^2, or 11.5% of the planet's terrestrial surface (1). During the same period, biodiversity, a term once solely considered by scientists, has moved to center stage of global environmental debates, most recently at the Seventh Meeting of the Conference of the Parties (COP-7) to the Convention on Biological Diversity (CBD) in Kuala Lumpur in February 2004. The 157 representatives to COP-7 agreed to establish and maintain "comprehensive, effectively managed, and ecologically representative systems of protected areas" that, collectively, will significantly reduce the rate of global biodiversity loss (2).

Most conservationists celebrate the expansion of protected area coverage and greater attention to biodiversity. However, they often disagree regarding how best to manage parks and reserves and, more fundamentally, what the underlying purpose of protected areas should be. Twenty-five years ago, protected areas were largely the domain of ecologists, forestry officials, and the occasional land-use planner. Now, they are included in the international arena as part of the Millennium Development Goals (4), and their mission has broadened substantially: Protected areas are expected to directly contribute to national development and poverty reduction.

In this review, we examine the remarkable physical expansion of protected areas during the past 25 years and draw attention to the equally significant expansion in the mission of parks and reserves. We describe the variation in protected area coverage between regions and habitats, as well as the different categories of protected areas, most notably sustainable-use management areas. We discuss the issue of measuring protected area effectiveness, which is becoming increasingly complex given the ever more ambitious (and fiercely disputed) agenda for parks. To highlight one important measure of effectiveness, we present a compilation of empirical data from 21 studies of deforestation rates in and around 49 protected areas in the tropics during the past ~15 years. We draw out the authors' conclusions regarding threats to forests and go on to draw broad inferences about the capacity of parks to slow deforestation in different contexts.

We then discuss the effectiveness of protected areas in supporting local livelihoods, a far more difficult goal to measure and achieve. To start, we recognize that

creating parks has sometimes undermined local incomes and security, particularly in Africa where they are associated with exploitative colonial regimes. Urgent appeals to human rights concerns and equity have pushed a more people-centered paradigm for parks. We then discuss the modest outcomes thus far of integrated conservation and development projects (ICDPs), the most widespread strategy to link people and parks. We conclude our review by highlighting two major trends in protected area management.

Throughout our review, we focus on protected areas in developing countries because these regions hold the highest levels of biodiversity and they have experienced much of the greatest expansion in parks and reserves over the past 25 years (5). Managing protected areas in developing countries presents profound challenges, given widespread conditions of poverty, rapid population growth, and political instability. Protected areas are buffeted by these local conditions as they are by powerful international forces as well. Although globalization and neoliberal reform have brought greater external funding to developing countries for protected areas, these same reforms have also opened remote areas to logging, oil extraction, and mining (6). Conservationists thus struggle to build alliances with communities neighboring protected areas while simultaneously defending parks from industrial-scale resource extraction and promoting sustainability in national policies.

The campaign to protect biodiverse parks and reserves in developing countries exposes political tensions that surface for other international environmental problems, such as climate change. How can local rights be balanced with global environmental aims? What right do northern countries have in promoting certain environmental strategies for southern countries given the North's disproportionate consumption of the world's resources? Yet, what sets the protected area debate apart and obliges conservationists to work across international boundaries is that biodiversity is not fungible. Biodiversity, by almost any definition, is tied to specific places. Although there have been advances in ex situ conservation of single species, biodiversity maintenance still requires in situ protection. For example, if mountain gorillas are to survive, they must be protected in Africa's Albertine Rift, a desperately impoverished and politically instable region. This reality compels conservationists to focus on place-based interventions, namely, protected areas.

THE EXPANSION OF PROTECTED AREAS, 1980 TO 2005

To understand the forces driving the global expansion of protected areas, it is necessary to trace key events in the development of international environmental policy during the past 25 years. During this period, consensus emerged that protected areas were essential for maintaining biodiversity. There was also agreement that protected areas must address local communities' concerns with development. But considerable debate surfaced regarding the relative weight of social and economic objectives versus biodiversity goals in protected area management.

International Campaigns to Expand the Coverage of Protected Areas

The campaign to expand protected areas began in earnest at the 1982 World Parks Congress in Bali, where delegates recommended that all nations strive to place 10% of their lands under protection (7). A decade later, protected areas were promoted again in the landmark Rio Summit—or 1992 United Nations (UN) Conference on Environment and Development. Delegates came from around the world to discuss the meaning and importance of biodiversity and to formally endorse conservation programs. In the end, 167 countries signed on to the CBD and pledged to create systems of protected areas to conserve in situ biodiversity (29, Article 8a).

These high profile events and international conventions helped spur the expansion of protected areas, as did growing public concern over rain-forest destruction. Further driving the expansion was increased funding for protected area management. For example, several U.S. foundations increased their funding for international biodiversity sevenfold during the late 1980s (8). During the period 1990 to 1997, U.S. government agencies, private foundations, and nongovernmental organizations (NGOs) invested $3.26 billion in biodiversity conservation in Latin America alone, with 35% of the total dedicated to protected area support (9). The number of protected areas and their area of coverage has tripled over the past two decades (Figures 1 and 2), and many countries have met or surpassed the 10% set-aside target [e.g., Venezuela 34.2%, Bhutan 29.6% (10)] (Table 1).

Geographic Variation and Gaps in Protected Area Coverage

The expansion of protected areas has been highly variable among world regions. Zimmerer et al.'s analysis (11) of data from 1985 and 1997 published by the World Conservation Union (IUCN) and the UN Environment Programme's World Conservation Monitoring Centre (WCMC) revealed that the largest areas of land were added to North and South American protected area systems (1,283,914 km^2 and 1,148,567 km^2, respectively), whereas the largest percent increases occurred in Middle America (composed of Mexico, Central America, and the Caribbean) and Western/Mediterranean Europe (i.e., western Europe and the European side of the Mediterranean), 10.38% and 10.28%, respectively (11). Russia, Central and South Asia, and Australia were among the regions lagging behind in protected area coverage (11).

The unevenness of protected area coverage has a number of possible explanations. Some posit that wealthy countries devote more land to parks because many of their citizens hold postmaterialist values about protecting nature (116). Related research by Steinberg (12) highlights the political relationships shaping the geography of biodiversity investments. He suggests that countries more closely aligned with the West (especially the United States) receive more funding for environmental activities and thus set aside more land in protected areas. However, Venezuela and Cuba are conspicuous counterexamples to Steinberg's hypothesis because despite their problemmatic relationships with the United States, they have large areas

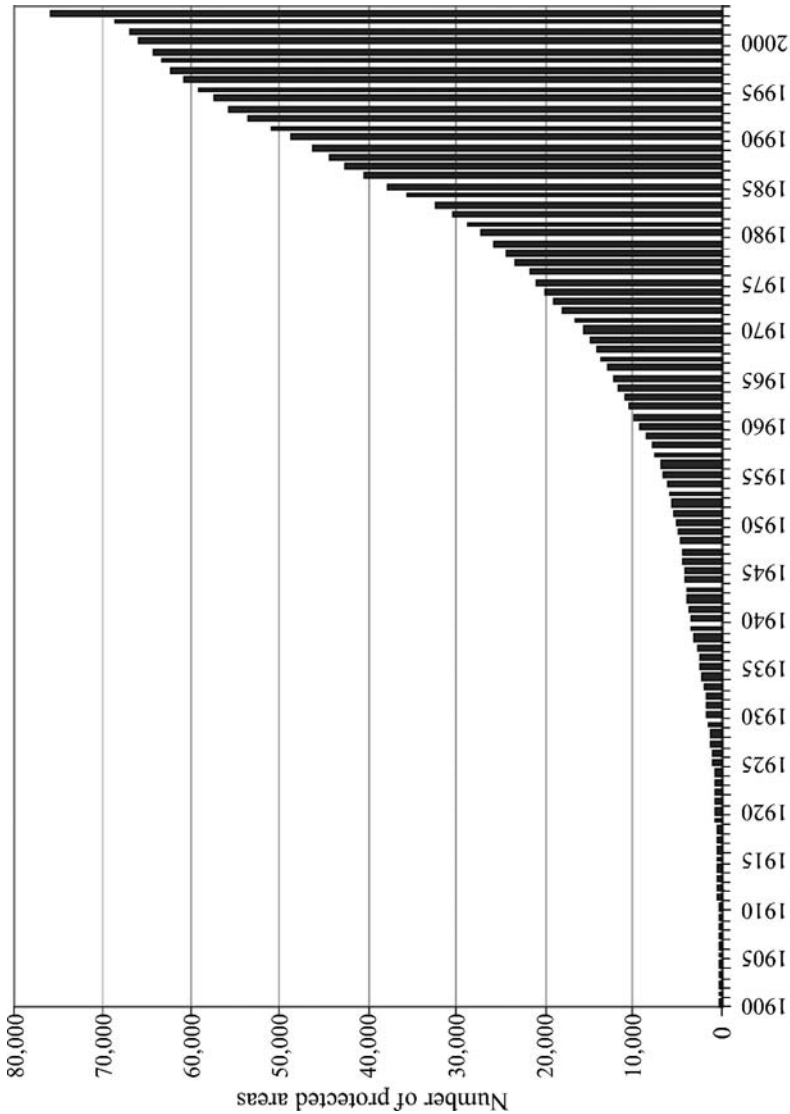

Figure 1 Cumulative growth in the number of protected areas worldwide, 1900–2003. Source: derived from data available at UN Environment Programme's World Conservation Monitoring Centre (UNEP WCMC) (5), 2005.

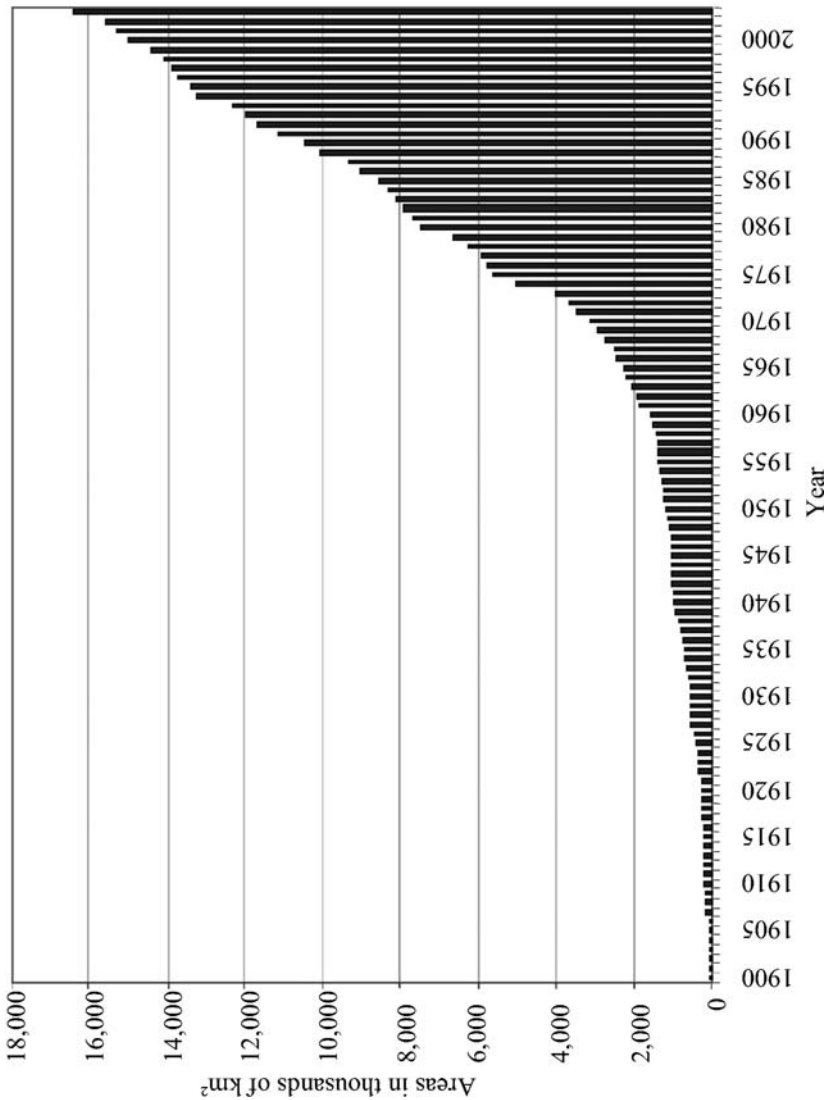

Figure 2 Cumulative growth in area covered by protected areas, 1900–2003. Source: derived from data available at UNEP WCMC (5), 2005.

TABLE 1 Top 20 developing countries by percent territory in protected areas (PAs)[a]

Area in protected area categories I–V[b]	Percent total land area[b]	Categories I–VI and other[c]	Percent total land areas[c]
Venezuela	34.2	Colombia	72.3
Guadeloupe	31.4	Venezuela	70.4
Mauritius	29.8	Brunei Darussalam	56.2
Bhutan	29.6	Saint Pierre and Miquelon	50.9
Brunei Darussalam	23.9	Saudi Arabia	41.8
Tonga	23.7	Zambia	41.4
Dominican Republic	22.9	Tanzania	39.6
Cambodia	20.5	Guadeloupe	31.9
Saint Helena	19.8	Malaysia	30.5
Botswana	18.1	Bhutan	30.2
Equatorial Guinea	16.8	Botswana	30.2
French Guiana	15.4	Mauritius	29.8
Hong Kong	15.4	Ecuador	27
Tanzania	14.6	Sri Lanka	26.5
Congo	14.1	Uganda	26.4
Mongolia	13.5	Dominica	25.6
Dominica	13.3	Dominican Republic	24.5
Suriname	12.7	Hong Kong	24.4
Thailand	12.7	Tonga	23.7
Seychelles	12	Costa Rica	23.5

[a]Source: World Resources Institute (10).

[b]These data are based on protected areas officially designated as IUCN categories Ia, Ib, II, III, IV, and V.

[c]These data include all categories of protected areas, as recognized and listed by the IUCN.

under legal protection. Other observers point out that, for practical reasons, protected areas are more likely to be established where land is inexpensive—often amidst vast expanses of sparsely inhabited frontier land. For example, looking at all parks in Latin America and the Caribbean that were established through 2002, the vast majority by number (85%) were inside the "human footprint"—areas defined as largely impacted by people (13, 14). However, in terms of area, only 24% of the total area of the reserves was in places of high human impact (13, 14). This indicates that many small reserves were established near people, likely in places containing species in decline or with opportunities for tourism or historic monument preservation. But the largest protected areas, and hence those that are most consistent with long-term biodiversity conservation, have been established in places where human impacts are low.

Setting aside international variation in protected area coverage, the coverage of biomes varies widely. Tropical rain forests have received a disproportionate emphasis in conservation campaigns owing to their great species richness, but some analysts worry that other goals may have been neglected in the "tyranny of the rain forest" (Director K. Redford, Wildlife Conservation Society Institute, personal communication).

One prominent conservation strategy, first promoted in the mid-1980s by British ecologist Norman Myers (14a), focuses on "biodiversity hotspots"—regions with exceptionally high concentrations of endemic species (those found nowhere else) and high habitat loss. An updated analysis released in February 2005 identified 34 hotspots worldwide. These 34 regions contain 75% of all threatened mammals, birds, and amphibians within only 2.3% of the Earth's surface (15). Hoekstra et al. (16) argue that if in place of species loss, conservationists were to focus on rates of land conversion (e.g., to agriculture or cities), their concern would shift from tropical rainforests to Mediterranean forests or temperate grasslands. Only a fraction of the original area of these biomes is under protection, and nearly half of the area has been lost (16). Similarly, mangroves and tropical dry forests are underrepresented in protected area networks. The hotspots approach has also been criticized because it excludes areas with lower species richness that nevertheless provide important ecological services (e.g., water capture or carbon sequestration) or scenic beauty (17).

Undoubtedly, the best solution would be to develop a network of parks and reserves sufficient to address all these concerns. But given the limited funding currently available for protected areas, some international conservation organizations are calling attention to current extinction rates to justify making species and habitat protection a priority. Human activities have caused plant and animal extinctions to reach rates $\sim$1000 times greater than background rates, perhaps comparable to those experienced during the great mass extinctions of the past (18, 19). Some conservationists argue that these extinction rates justify an emphasis on protecting species and their habitats, an approach that also implicitly requires resource transfers from developed to tropical countries.

Despite disagreement about geographic priorities, most conservationists agree that more land needs to be protected for several reasons. First, most parks are not large enough to maintain adequate populations of rare or far-ranging species nor to maintain ecosystem-level processes that sustain biodiversity (e.g., natural fire regimes) (20). Most of the world's protected areas are smaller than 10,000 hectare (ha) (approximately 80% of the global protected areas in IUCN categories I–VI) (5). Small parks have significant local importance, but research suggests that only parks $>$10,000 ha have the potential to slow long-term species loss (21). Moreover, many sites of high endemism and/or species richness have no legal protection (22), and pressures to transform land, particularly to agriculture, are increasing. One third of the world's land has already been transformed to agriculture or urban areas, and projections suggest that an additional one third could be converted within the next 100 years (23). Pressure on remaining natural habitats and the

biodiversity within them is likely to intensify from the combined impacts of population growth, increased resource consumption in both rich and poor countries, civil conflict, climate change, expansion of large-scale development activities, and a doubling of food demand in the next 50 years (24). Building on these and other findings, delegates to the 2003 World Parks Congress, entitled "Benefits Beyond Boundaries" in Durban, South Africa, concluded that the global reserve system must be expanded if further extinctions are to be avoided (1). As efforts to conserve biodiversity are scaled up, human welfare and economic issues come to the fore.

A SHIFT TOWARD PEOPLE-CENTERED PROTECTED AREAS

During the 1980s and 1990s, as the number of protected areas multiplied, conventional views on economic development shifted profoundly, with important implications for conservation. Much of the rhetoric on the fringes of mainstream development theory in the late 1970s and early 1980s, such as appropriate and small-scale technologies, local empowerment, popular participation, democratization, and devolution of power, moved to center stage. These perspectives fit well with the need to internalize development concerns into the conservation debate, and their impact was apparent in formal international plans for protecting biodiversity.

International Agreements and Conventions Defining the Social and Economic Agenda for Protected Areas

At the 1982 World Parks Congress in Bali, the consensus emerged that "protected areas in developing countries will survive only insofar as they address human concerns" (25, p. 134). Delegates offered suggestions on how to support communities' neighboring parks, whether via sustainable development projects, education, tourism revenue sharing, or opening park resources to local use. Despite a newfound commitment to human welfare, some delegates expressed doubt that protected areas could deliver substantial economic benefits to the broad citizenry. Everyone agreed that parks and reserves had a fundamental role in protecting species from extinction and supporting natural ecological processes, but some wondered whether they could also provide a multitude of benefits at local, regional and global scales.

The importance of integrating biodiversity conservation with sustainable economic development was underscored again in 1987, in the report issued by the World Commission on Environment and Development (the Brundtland Commission) (26). At the 1992 World Parks Congress, the expectations of what parks could accomplish were ratcheted up even further. Conservationists were called to devise "win-win" scenarios of conservation and development in which both appropriate human use of natural resources and the preservation of the same could

occur simultaneously (27). Congress delegates agreed that "protected areas must be managed so that local communities, the nations involved, and the world community all benefit," and some went on further to say that parks should become "demonstrations of how an entire country must be managed" (28).

A formal, international commitment to these goals was forged in the 1992 UN Conference on Environment and Development—known as the Rio Earth Summit—when countries drafted the CBD (29) to address the loss of biodiversity and develop mechanisms for funding. To date, the CBD has been ratified by 179 governments and has more signatories than most other international environmental agreements, despite the conspicuous absence of the United States as a signatory. The CBD has three primary objectives: (*a*) conservation of biological diversity, (*b*) sustainable use of the components of biological diversity, and (*c*) fair and equitable sharing of the benefits arising out of the utilization of genetic resources (29, Article 1).

The creation of the CBD was not completely smooth, however, and there was considerable debate over the precise meanings of many of the terms being used, e.g., sustainable use, fair and equitable sharing, and even biodiversity, reflecting the competing interests among the wide range of actors, from indigenous peoples' leaders to pharmaceutical company representatives. These contested meanings have profound implications for protected area management (30, 31). If biodiversity is defined to include human cultural diversity (28), park management becomes a much more complex endeavor. Ultimately, the CBD adopted the following, more conventional definition of biological diversity: "the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems" (29).

These treaties, and the attention given to biodiversity amid high threat, signaled the beginning of a campaign to create protected areas where none existed, especially in those countries regarded as having the highest levels of biodiversity that were under the greatest threat. Developed nations, through bilateral and multilateral organizations, restructured some of their development assistance to provide the financing for protected area expansion. However, both developed and developing countries were eager to see this financing support conservation and economic development, whenever possible.

Creation of New Categories of Protected Areas

Conservationists worldwide were thus faced with the challenging task of rapidly assembling a global protected area system where none existed, among disparate sociopolitical conditions and institutional settings from one region to the next. In recognition that different types of protected areas are better suited to different settings and that not all of these areas emphasize biodiversity conservation, the World Commission on Protected Areas developed six different management categories with two subcategories: (*a*) areas managed primarily for biodiversity conservation (categories I and II) and (*b*) areas managed mainly for the sustainable use of

TABLE 2 The six categories of protected area recognized by the World Conservation Union (IUCN)[a]

Category	Description
I (a and b)	Strict nature reserve, wilderness protection area, or wilderness area managed mainly for science or wilderness protection
II	National park, managed mainly for ecosystem protection and recreation
III	National monument, managed mainly for conservation of specific natural features
IV	Habitat/species management area, managed mainly for conservation through management intervention
V	Protected landscape/seascape, managed mainly for landscape/seascape conservation or recreation
VI	Managed resource protected area, managed mainly for sustainable use of natural resources

[a]Source: derived from data available at UN Environment Programme's World Conservation Monitoring Centre (5).

resources (categories III–VI) (Table 2). Within this same report, the IUCN released its official definition of a protected area, a definition that reflects the change in conservation strategies of the time and the expansion and diversification of the original protected area model: "An area of land and/or sea especially dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources, and managed through legal or other effective means" (32). The vast majority of the world's protected areas (84.5% of those with assigned IUCN categories) are open to some form of human use.

It is commonly believed that the global growth of protected areas between 1985 and 1997 was focused within the managed-use categories of protected areas, i.e., those with less strict levels of protection. Zimmerer et al. (11) tested this hypothesis by comparing the IUCN-WCMC protected area listings for both 1985 and 1997, grouping the categories into two divisions—strict protection (categories I–III) versus less strict protection or sustainable use (categories IV–VI), and analyzing changes within the two groups for this same time period. Unexpectedly, they discovered only a weak shift to less strictly protected areas and concluded that over the past two decades the growth in protected areas globally has maintained a stable ratio between the amount of land placed under the stricter protection afforded by IUCN categories I–III, and the emphasis on more sustainably utilized land designated in protected area systems under categories IV–VI. They go on to describe a strong shift toward strict protection in East Asia, and an opposite trend in Latin America and Western/Mediterranean Europe. It is worth noting that since 1997, when this analysis ends, over 2.5 million km^2 of land have been put into approximately 13,800 new protected areas, a change that merits a new analysis of these trends using more current data (Figure 3) (5).

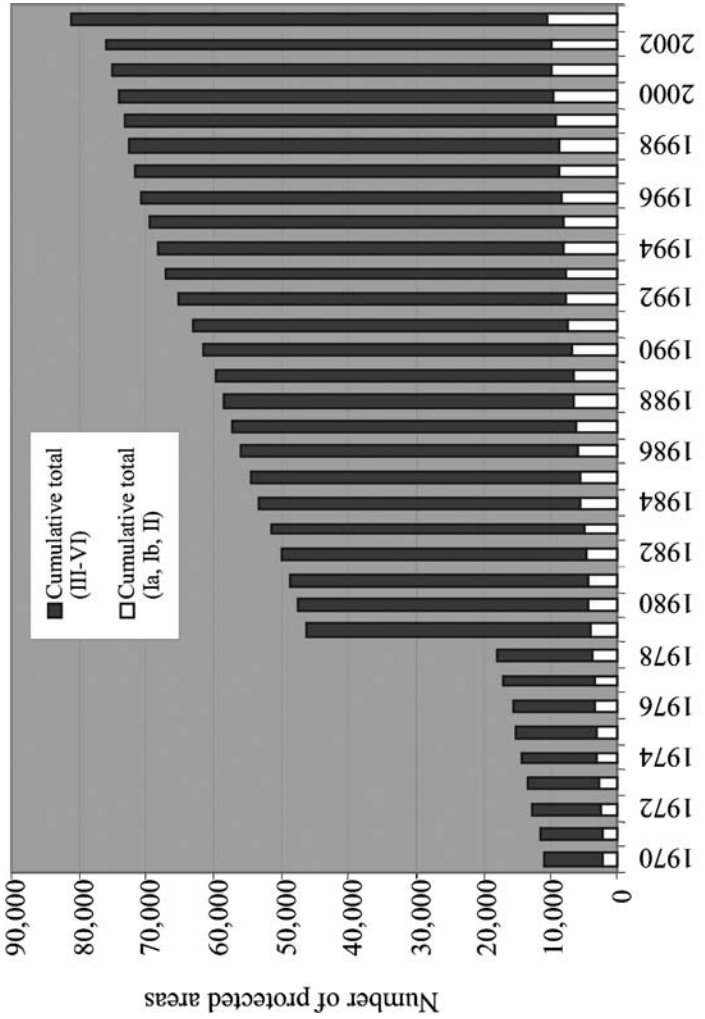

Figure 3 Growth in number of protected areas worldwide by IUCN category, 1970–2003. Source: UNEP WCMC (5).

A similar result emerged from a more detailed analysis of developments in the protected area systems of Ecuador and Peru between 1980 and 2000 (44, 48). These two countries added greater land to their protected area system under categories I and II than under categories III–VI (those emphasizing sustainable use). But two key lessons emerged from a subsequent series of interviews and fieldwork. First, the addition of two large (1million ha each) national parks in the Amazon frontier swamped the analysis. Second, and perhaps more important, protected area managers were largely unconcerned with official IUCN categories; in fact, they all (understandably) struggled to recall the six-part nomenclature.

Categorization of protected areas is a dynamic process. Protected area boundaries are often shifted, and multiple-use zones are frequently created within national parks. Some protected areas zoned for multiple-use areas are upgraded to core areas. In Brazil, a key country for analysis given that it holds half the world's rain forest, over twice as much state and federal protected land is open to sustainable use (III–VI) compared to strictly protected (I and II) lands (34). If one includes lands belonging to indigenous peoples, which are managed for sustainable use, the figure rises to nearly five times the area under strict protection. Globally, using the most recent data available, relatively few protected areas are managed with biodiversity conservation as the primary objective; of the world's 98,400 terrestrial protected areas, only 8800 (8.9%) are listed under IUCN categories I or II (10).

MEASURING PARK EFFECTIVENESS

Evaluating the effectiveness of protected areas is difficult, especially given the poor availability of data on ecological and social conditions and their change over time. Evaluating park effectiveness is also a politically fraught endeavor given the ambitious and disparate agendas imposed on protected areas. For example, a conservation biologist may label a protected area as a conservation success only if the full suite of native wildlife species is present in viable populations, including large and rare carnivores. An anthropologist viewing the same protected area may deem it a failure if local citizens' rights or livelihoods were undermined when the park was established. Thus, public discussions regarding the effectiveness of protected areas sometimes resemble the familiar blind-men-observing-an-elephant parable. For example, recently the Manager of Machalilla National Park in Ecuador publicly promised that this 39,000 ha protected area would serve as a *maquina de dinero* (money machine) for the surrounding province. In the same meeting, indigenous leaders testified that Machalilla was above all else a cultural homeland and "source of life" for the Agua Blanca people. Then an Ecuadorian botanist explained that the park represented the last hope for sustaining endemic species found in coastal dry forests (35).

Recognizing the lack of a unified measure of protected area effectiveness, we offer two different analyses: (*a*) an empirical assessment of the ability of protected areas to prevent forest conversion and (*b*) a broader discussion of the progress

made thus far in integrating local economic development with protected area management.

Analysis of Deforestation Rates in and Around Protected Areas

Despite the "conceptual muddiness" regarding the mission of protected areas (36), persistent concern for species loss in developing countries has yielded several publications evaluating conditions in tropical rain-forest parks. All these publications present a litany of management problems and paint a potentially troubled future for parks. Conversely, many rain-forest parks appear to be slowing land conversion even though they have inadequate political and financial support and face significant threats (37). Avoiding deforestation is not the ultimate litmus test for parks; biodiversity can be significantly compromised by invisible threats, such as hunting (38). But intact forest is an important signal that protected areas are having substantive results on land-use changes.

To investigate the effectiveness of protected areas in slowing land conversion, we compiled results from 20 recently published studies on deforestation rates at 49 protected areas across the tropics (Table 3). To improve conformity between studies and better reflect recent advances in remote-sensing technologies and analysis, we used the following selection criteria: (*a*) published after 1998, (*b*) focused on moist or wet tropical forest, and (*c*) offered analysis of deforestation rates over time. Most of the studies focused on changes over the past two decades and relied primarily on Landsat satellite imagery, supplemented by analyses of aerial photos, SPOT, MODIS, IKONOS, or Corona images. Quality control was typically ensured by field verification and ground truth techniques, with some studies using image-to-image referencing. The 19 teams of authors employed various sample designs. Some focused on assessing deforestation trends only within protected area boundaries, and others compared deforestation within parks to outlying areas, ranging from less than 1 km to 15 km from the park boundary. More sophisticated analyses of forest conditions, including fragmentation and patch size, are becoming more common (39); however, given the criteria of this review, too few were available to yield substantive cross-site comparisons.

In the 36 cases for which authors explicitly compared deforestation rates outside and within protected areas, in 32 the deforestation rates were faster outside protected area boundaries than within (range 0.1% to 14% faster outside), whereas in 4 cases the protected areas were ineffective (i.e., there was no difference in rates, or rates were actually faster inside the protected area) (Table 3). The small sample size (36 sites) and variable methods limit rigorous analysis that might identify correlates of protected area effectiveness, but it appears that among the three tropical regions, Latin American protected areas are fairing best in mitigating deforestation. Curran et al.'s 2004 documentation (57) of forest degradation due to logging in Indonesia's protected areas dominate the sample of Asian parks. Research on deforestation in African protected areas has been generally scarce, at least when compared to Latin America.

TABLE 3 Deforestation studies at individual protected areas

Protected area (PA)	Reference	Country	Year PA established	Size of PA (ha)[a]	IUCN Category[a]	Elevation within PA (m)[a]	Analytical design[a]	Defor in vs out[a]	Is PA reported to mitigate defor?[a]	Reported Threats to PA[a]
Africa										
Aberdares Forest Reserve	40	Kenya	1943	103,316	II	1800–3200	Defor inside PA only	—	—	Log, charc-fuel, ag-subsis, graze, settle
Budongo Forest Reserve	41	Uganda	1932	81,788	unset	700–1270	Defor outside PA only	—	—	Ag, log, war, settle
Bugoma Forest Reserve	41	Uganda	1932	39,973	unset	990–1295	Defor outside PA only	—	—	Ag, log, war, settle
Bwindi Impenetrable Forest National Park	41	Uganda	1991	32,092	II	1190–2607	Defor outside PA only	—	—	Ag, log, war, settle
Kagombe Forest Reserve	41	Uganda	1953	30,063	unset	—	Defor outside PA only	—	—	Ag, log, war, settle
Kalinzu-Maramagambo Forest Reserve	41	Uganda	1932	58,400	unset	—	Defor outside PA only	—	—	Ag, log, war, settle
Kasyoha-Kitomi Forest Reserve	41	Uganda	1932	39,900	unset	975–2136	Defor outside PA only	—	—	Ag, log, war, settle
Kibale National Park	42	Uganda	1932	76,600	II	1110–1590	Defor inside vs. outside PA	+	Yes	Tea plantations Ag
Kibale National Park	43	Uganda	1932	76,600	II	1110–1590	Defor inside vs. outside PA	++	Yes	Charc-fuel
Latin America and the Caribbean										
Alto Mayo Reserve	44	Peru	1979	182,000	VI	500–1500	Defor inside vs. outside PA	+	No	Hunt, log
Bahuaja Sonene National Park	44	Peru	1977	1,091,416	II	100–400	Defor inside vs. outside PA	+	Yes	Hunt, log, mine

(*Continued*)

TABLE 3 (*Continued*)

Protected area (PA)	Reference	Country	Year PA established	Size of PA (ha)[a]	IUCN Category[a]	Elevation within PA (m)[a]	Analytical design[a]	Defor in vs out[a]	Is PA reported to mitigate defor?[a]	Reported Threats to PA[a]
Braulio Carrillo National Park	45	Costa Rica	1978	48,158	II	500–2900	Defor inside vs. outside PA	+	Yes	Ag, log
Caaguazu National Park	46	Paraguay	1976	16,000	II	250–300	Defor inside vs. outside PA	+	Yes	Ag, settle, log
Cabo Blanco Biological Reserve	45	Costa Rica	1963	1,172	Ia	0	Defor inside vs. outside PA	0	Yes	Ag, log
Cahuita National Park	45	Costa Rica	1970	1,070	II	10	Defor inside vs. outside PA	+	Yes	Ag, log
Calakmul Biosphere Reserve	47	Mexico	1993	723,185	UNESCO-MAB	50–380	Defor inside vs. outside PA	+	Yes	Ag-subsis, log
Carara Biological Reserve	45, 48	Costa Rica	1978	5,312	II	100–1000	Defor inside vs. outside PA	++	Yes	Ag, log
Cayambe Coca Reserve	48	Ecuador	1970	403,103	VI	600–5790	Defor inside vs. outside PA	(−)	No	Hunt, log, graze, fire, mine, oil
Celaque National Park	49	Honduras	1987	27,000	II	1800–2827	Defor inside vs. outside PA	+	Yes	Ag-subsis, log, settle
Chirripo National Park	45	Costa Rica	1975	51,641	II	1220–3819	Defor inside vs. outside PA	+	Yes	Ag, log
Corcovado National Park	45	Costa Rica	1975	47,563	II	750	Defor inside vs. outside PA	+	Yes	Ag, log, hunt, mine
Corcovado National Park	50	Costa Rica	1975	47,563	II	750	Defor inside vs. outside PA	+	Yes	Ag, log, hunt, mine
Guanacaste National Park	45	Costa Rica	1991	38,461	II	0	Defor inside vs. outside PA	+	Yes	Ag, log

Hellshire Hills, Portland Bight PA	51	Jamaica	1999	6,475	unset	20–700	Defor inside vs. outside PA	+	Yes	Charc-fuel, settle, ag-subsis
Manuel Antonio National Park	45	Costa Rica	1972	682	II	100	Defor inside vs. outside PA	++	Yes	Ag, log
Maya Biosphere Reserve	52	Guatemala	1990	2,112,940	UNESCO-MAB	50–636	Defor inside PA only	—	—	Ag-subsis, log, NTFP
Maya Biosphere Reserve	53	Guatemala	1990	2,112,940	UNESCO-MAB	50–636	Defor inside vs. outside PA	+	Yes	Log
Mbaracayu Forest Biosphere Reserve	46	Paraguay	2000	280,000	UNESCO-MAB	140–450	Defor inside vs. outside PA	+	Yes	Ag, settle, log
Montes Azules Biosphere Reserve	54	Mexico	1979	331,200	UNESCO-MAB	200–1460	Defor inside vs. outside PA	+	Yes	Ag-subsis, log
Pacaya Samiria Reserve	44	Peru	1940	2,080,000	VI	125–800	Defor inside vs. outside PA	+	Yes	Hunt, log, fire
Podocarpus National Park	48	Ecuador	1982	146,280	II	900–3600	Defor inside vs. outside PA	+	Yes	Hunt, log, graze, fire
San Matia, San Carlos Reserve	44	Peru	1987	145,818	VI	—	Defor inside vs. outside PA	+	No	Hunt, log
San Rafael Managed Resource Reserve	46	Paraguay	2002	70,000	VI	300–830	Defor inside vs. outside PA	+	Yes	Ag, settle, log
Sangay National Park	48	Ecuador	1975	517,725	II	600–5230	Defor inside vs. outside PA	+	Yes	Hunt, log, graze
Tortuguero National Park	45	Costa Rica	1975	18,946	II	299	Defor inside vs. outside PA	+	Yes	Ag, log

(*Continued*)

TABLE 3 (*Continued*)

Protected area (PA)	Reference	Country	Year PA established	Size of PA (ha)[a]	IUCN Category[a]	Elevation within PA (m)[a]	Analytical design[a]	Defor in vs out[a]	Is PA reported to mitigate defor?[a]	Reported Threats to PA[a]
Volcan Arenal National Park	45	Costa Rica	1991	12,010	II	1000–1450	Defor inside vs. outside PA	+	Yes	Ag, log
Volcan Tenorio National Park	45	Costa Rica	1976	5,277	II	—	Defor inside vs. outside PA	+	Yes	Ag, log
Yanachaga-Chemillen National Park	44	Peru	1986	122,000	II	800–3800	Defor inside vs. outside PA	+	No	Hunt, log
Yasuní National Park	48	Ecuador	1979	982,300	II	500–600	Defor inside vs. outside PA	+	No	Hunt, log, oil
Asia										
Bach Ma National Park	55	Vietnam	1991	22,031	II	200–1500	Defor inside vs. outside PA	+	Yes	Ag-subsis, log, settle
Bukit Barisan Selatan National Park	56	Indonesia	1999	365,000	II	0–1964	Defor inside vs. outside PA	(−)	No	Ag-subsis, settle, log, fire
Gunung Palung National Park	57	Indonesia	1990	27,000	II	0–1160	Defor inside vs. outside PA	+	Yes	Log, Ag, ag-subsis
Kerinci Seblat National Park	58	Indonesia	1982	1,368,000	II	200–3805	Defor inside vs. outside PA	0	No	Log, ag-subsis
Wolong Nature Reserve	59	China	1975	200,000	V	1200–6250	Defor inside vs. outside PA	+	No	Settle, ag-subsis, log, charc-fuel

[a]The meaning of abbreviations and symbols are ha, hectare; defor, deforestration; +, deforestation outside PA > inside PA; ++, deforestation outside PA > inside PA (with > deforestration at boundary); (−), deforestation inside PA > outside PA; 0, no difference between deforestration inside and outside PA; Ag, large-scale agriculture; ag-subsis, subsistence agriculture (slash & burn); browse, browsing by large mammals (elephants); charc-fuel, charcoal production and fuelwood; fire, clearing for agriculture and wildfires; graze, livestock grazing; hunt, hunting; log, logging (both for land clearing and large-scale); mine, mining; NTFP, collection of nontimber forest products; oil, oil exploration and extraction; settle, encroachment by human settlements; and war, destruction of habitat due to war/conflict; UNESCO-MAB, Biosphere Reserve officially recognized by the United Nations Environment and Science Man in the Biosphere Programme; unset, IUCN category of protected area is not identified; —, unknown.

The size of the protected area does not appear to correlate with deforestation outcomes. The category of a protected area might be relevant in that type V and VI protected areas appear to be less effective in mitigating deforestation than type II protected areas, but again, firm conclusions are limited by the small sample size and the rudimentary methods of measuring effectiveness. Human population density has a potentially confounding affect on assessments of park effectiveness, especially given the contrast between sites. For example, remote protected areas in sparsely inhabited regions of the Amazon, such as Bahuaja-Sonene National Park in Peru where there are <10 people/km^2, appear to have a minimal affect on slowing deforestation simply because land clearing is negligible around most of their boundaries. Conversely, protected areas in densely settled areas (e.g., Kibale National Park in Uganda where there are $\sim$90 to 240 people/km^2) may appear more effective given that deforestation is much faster in the densely settled land beyond the boundary, yet absolute deforestation rates are slower in Bahuaja-Sonene National Park than in Kibale.

Comparing these studies is difficult given that many focus on only one aspect of forest-cover change or do not offer enough detail so as to allow transferability of methods and results. Because of the typically high cost of images and/or the problems with cloud cover in humid regions, researchers often must design their analysis around the availability of their chosen satellite imagery, and this dictates the length of time period. Of the studies researched for this chapter, only two that focused on inside and outside protected area change examined a time period greater than 20 years, with the average time period of analysis being slightly more than 13 years. This leads us to question whether as researchers, we are allowing the availability of high-quality data to dictate our research design too significantly. As images become more readily available and affordable, constraints on study design will be partially alleviated.

Although all of the studies reviewed reported direct threats to biodiversity conservation within each protected area (e.g., logging or agriculture), few included a discussion of other socioeconomic, demographic, or biophysical factors that might aid in establishing the correlation between forest-cover loss and human activity and influence. Meanwhile, the broader field of research on land use and land-cover change offers a far richer analysis on how direct factors as well as indirect factors (investment patterns, development policies) relate to overall deforestation in tropical countries, (see References 60 and 61 for meta-analyses of forces behind tropical forest loss). Because it is well established that local communities are not the only actors in effecting land-use change within and surrounding protected areas, future studies of forest-cover loss for an individual protected area should consider factors that extend across scales and can draw from the nonprotected area-specific analysis that already exists within the land-use and land-cover change literature.

Despite the spatially localized focus of the studies presented in Table 3 and the challenge of exploring studies from authors of multiple academic disciplines, methodological and intellectual "cross-pollination" does appear to be growing.

The more recent analyses implement an incremental buffer approach to assess forest loss, both within and outside of the protected area (43, 44, 48, 63). This approach reveals more detailed patterns of deforestation, for example the rate of observed deforestation was greater in the buffered areas closer to the boundary of several protected areas, rather than further away. Many interpret this phenomenon as an indication of increasing pressure on the protected area and a warning sign of landscape fragmentation and ecological isolation (63). Mas (54) questions whether the approach of analyzing forest-cover change within a protected area and immediately without produces a biased result that exaggerates park effectiveness in mitigating deforestation. In a recent analysis of Calakmul Biosphere Reserve in Mexico, he introduces a new methodological tool of including "complementary" or "similar" buffers in the analysis. The concept of complementarity in conservation planning is also explored in depth by Margules & Pressey (64). We feel these analyses bring to light two important considerations for expanding the frontier of research into protected area effectiveness and deforestation. The first is the concept of using "similar" areas as a pseudo-control for experimental analysis of the effectiveness of a protected area in mitigating deforestation, as well as other extractive or consumptive activities. The second is the need to study land-use dynamics in areas adjacent to protected areas that are formally designated as buffer zones. Several of the studies listed in Table 3 reveal more intensive use in buffer zones than in areas further away from the protected area, but causal explanations for this pattern of intensive use are weak or absent. Finally, few studies attempt to integrate quantitative satellite image analysis with field mapping of invisible threats to protected areas, such as hunting. Those that do (44, 48) confirm that deforestation patterns offer a conservative view of the extent of human activities in protected areas.

A new trend in assessing protected area effectiveness centers on regional-scale assessments using lower resolution and more regularly available imagery, such as MODIS. These studies offer a first-cut analysis of trends in the relative isolation of protected areas in particular regions. Most recently, DeFries et al. (65) released an analysis of 198 strictly protected areas (IUCN categories I and II) worldwide, using MODIS satellite imagery, over the past two decades. The 50 km buffer surrounding each protected area was significantly larger than any used in the studies listed in Table 3, thus allowing DeFries et al. (65) to draw regional and subregional conclusions about the level of isolation of protected areas. This type of regional study creates a solid base for launching higher resolution and more focused studies regarding the temporal and spatial trends related to forest-cover loss within and outside protected areas.

Ultimately, it is encouraging that the majority of protected areas studied (Table 3) appear to be significantly slowing deforestation within their boundaries, despite inadequate funding and weak institutions. This accords with Bruner et al.'s 2001 (66) conclusions based on surveys with managers of 93 parks in developing countries. But this apparent success could also be interpreted as a warning signal. Many authors indicated that the protected areas were becoming increasingly

isolated as forest clearing pushed right up to their boundaries. To some observers, sharp park boundaries (e.g., Figure 4) serve as a reminder of the dismal fate of forests under conventional development scenarios; in essence, they are a "line drawn in the sand" against habitat conversion (67). By contrast, others view sharp boundaries as a sign that protected areas are failing in their mission of sustainable development. Some critics would even view sharpening boundaries as evidence that protected areas are accelerating deforestation, whether by displacing and intensifying forest extraction elsewhere (68) or by perpetuating neglect among conservationists for environmental quality outside of protected areas (69, 70), but see Waller (71) for a rebuttal. Ultimately, although each assertion contains at least a grain of truth, proving or disproving them would require a much broader analysis. Protected areas remain our best hope for conserving substantial tracts of habitat, but only in recent years have some protected areas begun to foster better environmental stewardship in the surrounding region.

Effectiveness of Protected Areas in Sustaining Local Livelihoods: The Experience of Integrated Conservation and Development Projects

By global mandates, protected areas are now supposed to do far more than conserve biological diversity. These areas are charged with improving social welfare, guarding local security, and providing economic benefits across multiple scales, objectives traditionally relegated to the development sector. These goals are vitally important and are founded on the truth that amidst desperate poverty the long-term prospect for biodiversity conservation is poor. But as expectations for protected areas have multiplied, confusion has ensued about what makes an effective park and how to operationalize the plurality of objectives.

Conservationists, although often accused of being unconcerned with social issues, have significantly altered their approach in an attempt to meet the new mandate for protected areas. In many cases, conservation organizations formed new partnerships with development agencies and institutions, as well as citizens' groups. Together they have pursued an array of strategies linking conservation with development that generally fall into three broad groups: community-based natural resource management, community-based conservation, and integrated conservation and development projects (ICDPs). Unlike community-based conservation or community-based natural resource management, ICDPs focus primarily on protected areas and thus deserve special attention in this review.

The term ICDP was introduced in a study of 23 projects linking development activities to conservation at 18 parks in 14 countries (72). Since then ICDPs have proliferated around parks scattered throughout developing countries, and they have captured a sizeable portion of support for conservation (73). ICDPs vary considerably in form and size between sites, but the underlying model throughout is to establish "core" protected areas in which uses are restricted and, in the surrounding areas (often labeled "buffer zones"), promote socioeconomic development

and income generation compatible with park management objectives. Specific economic activities promoted in ICDPs range from ecotourism to agroforestry to sustainable harvest of biological resources. Some ICDPs have made notable achievements in improving forest management outside parks and raising support for conservation among specific communities (74). However, reviews of ICDPs consistently have found that despite their appeal, it is hard to identify substantial achievements either in improving social welfare or in protecting biodiversity (75). Explanations for the limited success of these projects vary considerably. Political ecologists have harshly criticized these projects on the grounds that ICDPs do not invite true local participation in environmental management, but rather constitute coercive forms of conservation practice, which resemble "ill-fated colonial efforts to convert shifting cultivators into progressive farmers" (76, p. 564). By this view, to succeed, ICDPs need to truly devolve authority to communities over biological resources so that they have a vested interest in protecting them. Political ecologists also call for more open, fair negotiation regarding the placement of less rigid and more "dynamic" protected area boundaries (77, p. 363). By contrast, some conservation biologists argue that development and conservation are ultimately incongruent goals (78). On a more encouraging note, other conservation biologists believe that development and conservation are intertwined goals, but their scale of integration is inappropriate in ICDPs (79). Robinson & Redford (79) explain that the concept of scale involves two dimensions, extent and grain. In the context of ICDPs, extent refers to the total area to be considered for the integration of conservation and development (e.g., a bioregion), whereas grain is a smaller unit of analysis in which certain activities will be implemented. Instead of attempting to promote integrated conservation and development throughout the total area under consideration, success is more likely if smaller units of land are devoted primarily to conservation aims or economic activities, depending on the productive capacity of the soil and ecosystem. For example, in Zambia, commercial trophy hunting appeared to be more sustainable and profitable in community-managed areas that were located adjacent to national parks. These national parks served as "sources" (sensu) (81) that replenished game populations when harvest rates in community areas were not sustainable (82).

Recent reviews of ICDPs have found that although there has been an evolution in the scale of projects and how they are conceptualized, most of the projects are still hampered by implementation problems similar to those associated with rural development projects (27, 83, 84). ICDPs have "become all things to all people" (83), and what is now called an ICDP is often any conservation project that deals with people. A recent book on ICDPs found that both conservation organizations and funding agencies are identifying serious problems with the ICDP approach (73). Some are turning toward more direct strategies, such as conservation concessions, whereby donors pay to have land managed for biodiversity (85). But most conservation agencies remain broadly committed to ICDP approaches, with some attempting to shift both the focus and scale of these efforts, described below.

Biodiversity Conservation and Poverty Alleviation

Beyond small-scale efforts to incorporate local communities in protected area management, biodiversity conservation today is challenged to engage with the most important UN Millenium Goal, which is to eradicate extreme poverty and end hunger. As the development community has increasingly focused on this goal, biodiversity funding has been linked more often, and more directly, to poverty alleviation (86). In entering this arena, conservationists face formidable challenges, given the uneven record of poverty alleviation projects promoted over the past half century by agencies and organizations exclusively devoted to this task (87).

Worldwide, between 1970 and 1990, the rate of poverty alleviation was the most rapid and extensive in recent history—even with significant population growth—showing that advances in poverty alleviation are possible. According to the UN's International Fund for Agricultural Development's Rural Poverty Report from 2001, the majority of areas affected in those two decades of increased poverty alleviation were rural. However, the report also notes that since 1990, the rate of alleviation has slowed considerably, and international aid for agricultural and rural purposes has, in many cases, reached an all-time low (88). Although society as a whole becomes more urban, poverty remains concentrated in rural areas, home to half of the world's poor, and 75% of the people are considered "extremely poor" (89). Despite projected gains in poverty alleviation, in absolute terms, over 60% of the world's absolute poor will live in rural areas by 2025 (89). As we have seen from the impact of the recent Asian tsunami, the numbers of poor can change very quickly owing to natural disasters, war, and economic shocks. The poor who possess assets (e.g., small farmers with shelter and wells) can rapidly become poor with nothing (e.g., refugees). There is also evidence that there may be spatial overlaps of poverty, inequality and biodiversity: "under-nutrition rates in several large countries—including Mexico, Guatemala, Brazil, Peru, Ecuador, China, Indonesia and Vietnam—are much higher in the vicinity of biodiversity hotspots than for the country as a whole" (90). Spatially, rural poverty may be highest in the places where biodiversity is greatest, i.e., the "Rich Forests, Poor People" syndrome (91).

There is considerable debate regarding the causal explanations for the overlap of high biodiversity and poverty, and this leads to very different opinions about how to address rural poverty in areas of high biodiversity. But from the mid-1990s on, the development community has continually pushed poverty alleviation goals into conservation funding and action: "Conservation programmes are only valid and sustainable when they have the dual objective of protecting and improving local livelihoods and ecological conditions" (92). Folded together in this mandate are moral arguments and practical puzzles. This is often the case when win-win scenarios are presented. Seldom do policy analysts acknowledge that the impact of raising incomes on biodiversity is shaped by complex sociopolitical and ecological conditions. One revealing study demonstrated that biodiversity outcomes of increased incomes can vary even within the same Amazonian community, e.g.,

increased income led some households to diminish their extraction of forest products and invest in agroforestry gardens, whereas others bought chain saws and cleared forest even faster (93).

The fact that many parks today retain higher levels of biological resources than surrounding areas has led some prominent development groups to call on these areas to contribute substantially, and directly, to rural poverty alleviation [e.g., the U.K. Department for International Development (94)]. These arguments gain greater significance as the area under protection expands. Yet some conservationists fear this will lead to cashing in on park resources, and they believe there should be more attention toward effective management outside of parks by communities, indigenous peoples, private sector, or other interests. If parks are viewed as part of a broader landscape of initiatives that work with one another, such as corridor, ecoregional, and landscape scales, then they can be viewed as an "intact" area that can provide vital ecosystem services and help contribute to the quality and restoration of surrounding areas. In other words, it is equally urgent to promote the environmental agenda beyond protected area boundaries as it is to promote economic development inside parks (95, 96).

Even conservation actions that may not appear to be directly linked to poverty alleviation may contribute because the poor are most reliant on natural and wild resources. If the ecological base upon which the rural poor depend becomes seriously degraded, then their livelihoods are likely to diminish as well. Only recently have studies emerged showing the tangible economic benefits of protected areas. One study of 41 reserves, covering approximately 1.5 million ha in Madagascar, found that the economic rate of return of the protected area system was 54% (97). The main benefits were from watershed protection, although ecotourism benefits were significant and expected to increase over time, providing greater returns to surrounding communities. The study also confirmed other findings, e.g., there are often winners and losers from conservation, even among groups of poor. In this example, 265,000 poor rice-farming households (average of 1.5 ha per household) benefited, as did the 25,000 urban households receiving potable water. But 50,000 shifting agriculturalists (also known as "slash-and-burn" farmers) were deprived of the land within the parks. Conservationists have also been working to demonstrate tangible economic benefits of conservation outside of protected areas. In South Africa, the Working for Water Program, is enhancing water security and improving ecological integrity by eliminating invasive species, restoring degraded lands, and promoting sustainable use of natural resources (98). It has employed over 42,000 people in less than four years. The landless movement in the Atlantic Forest of Brazil has stopped targeting reserves and remaining forest lands for invasion, recognizing their low value for agriculture and ecological degradation; many formerly landless are supporting restoration activities (99).

Yet there are important semantic differences that relate to what expectations are realistic from parks specifically, and the conservation sector, more generally. The development community asks the conservation sector to alleviate poverty, to essentially buy into their mission. The development community often assumes

that sustainable use of biotic resources can lift people from poverty. Sustainable management of biotic resources, such as nontimber forest products, fish, wildlife and other resources, can support rural lives and livelihoods, but it rarely provides a sufficient surplus to allow the poor to move out of poverty. Broader investments and reforms are needed (100). Local projects in and around protected areas cannot alleviate poverty for a substantial number of people if they are in fact made poor by the workings of a broader economic system that constrains their ability to acquire goods (101). Similarly, improving the security of the rural poor may entail reform in government policies favoring powerful interest groups (e.g., subsidies for industrial soybean farming in the Amazon). Protected areas in Madagascar safeguard the agricultural practices and provide employment from tourism for many people—very successfully. But are they to provide the development interventions that are often most important: education for women, health care, and infrastructure? Conservation cannot solve poverty, but it can significantly help to prevent and reduce poverty by maintaining ecosystem services and supporting livelihoods.

More fundamentally, there is a need to take a look at the serious set of problems that plague the rural sector in most tropical countries (13, 27, 102). The emphasis on the conservation sector has shifted attention away from the large-scale actors and policies that often lead to biodiversity loss and greater poverty. "Without reshaping poverty alleviation strategies, biodiversity will pay the price for development yet again. . ." (103, p. 389). For these reasons, the current trend of having conservation programs and policies shaped and funded primarily through a poverty lens must be reversed. Instead, the development community must make significant and targeted investments to improve environmental sustainability beyond protected area boundaries (102).

The Special Case of Indigenous People

Globally, lands managed by indigenous peoples often have retained high levels of biodiversity. Although these lands are not necessarily officially protected areas, and a treatment of this is well beyond the scope of this paper, it is essential to stress the contributions these areas make to biodiversity conservation. There has been active engagement of indigenous peoples in discussions about protected areas and biodiversity conservation, both at national scales and in international fora. At national scales, there have been numerous examples of protected areas established by indigenous peoples within their territories, and these peoples have then sought to have the areas nationally recognized, integrated into national protected area systems (on the condition that their rights are not affected), and supported by national or international donors. One well known example is that of Kaa-Iya del Gran Chaco National Park in Bolivia. The Capitanía del Alto y Bajo Isoso, representing the Guarani-Izoceño peoples, promoted the creation of Kaa-Iya Park adjacent to their territory and assumed financial responsibility and management authority for the park. This was essential to buffer their own territory from external threats and to manage the park so that it supported sustainable resource use on

their own territory. Combined, the Kaa-Iya National Park and the Guarani-Izoceño territory represent 5% of Bolivian lands.

In other cases, indigenous peoples have maintained control over their territories and have strongly defended them from outside interests. This is the case in Brazil, where indigenous reserves now cover 12% of Brazil's total land area and approximately 21% of the Amazon. A prime example of territorial defense is of the Kayapó Indians, who legally and physically control a continuous block of the Amazonian forest totaling 28.4 million acres (11.5 million ha)—by far the planet's largest block of tropical forest protected by a single indigenous group (104). The related Panará group controls an adjacent 1.2-million-acre (500,000 ha) area. Conservationists agree that the fate of the Amazon may well depend on how indigenous lands are managed.

Although the explicit interest of indigenous peoples is not biodiversity conservation per se, the coincidence of interests between indigenous peoples and conservationists, especially given large-scale external threats, is high, even though critics of such alliances abound (105). Yet the reality is that both sides have far more to gain working jointly, especially recognizing that the greatest threats to both indigenous territories and protected areas are from mineral and energy exploration and large-scale infrastructure development. As a result, indigenous peoples have taken an important role in recent international conservation meetings, such as the fifth World Parks Congress in 2003 and the World Conservation Congress in 2004 (2). Strengthened alliances between indigenous peoples and conservation organizations are likely in the future, as both sides better understand and respect mutual positions, and as a common set of external threats increases in scope and scale.

CHALLENGES AND OPPORTUNITIES FOR FUTURE PROTECTED AREA MANAGEMENT

The remarkable physical expansion of protected areas during the past 25 years is a notable success for conservation, and it signals an international commitment to protecting biological diversity. Similarly, the group of advocates for protected areas has grown far beyond ecologists, foresters, and recreational land-use planners to include development agencies, indigenous people's leaders, rural union leaders, water managers, and advocates for the poor. This groundswell of support has lead to an ever more ambitious agenda for protected areas. By global mandate, in addition to conserving biological diversity, protected areas are to provide economic benefits at multiple scales, alleviate poverty, protect threatened cultures, and promote peace. The challenge for protected area management over the next 25 years will be to implement these multiple and often ambiguous aims as conservation strategies in the face of population growth, ever increasing resource demands by northern and southern countries, and political instability.

The expansion of the protected area system has outpaced institutional and financial capacity for actual management (106), and even if there were a tremendous infusion of financial resources toward protected areas, managing protected areas would still be profoundly difficult, given the multiple and at times ambiguous mandates for parks and reserves. Fortunately, there are energetic and committed scholars and activists working to improve protected area management, not only by appealing for more funds, but also by experimenting with new forms of protected areas and institutional arrangements for governing protected areas. It is also encouraging to note that international discussions and deliberations regarding protected areas are moving beyond divisive pro- or antipark debates. Rather, there is an active exploration of how to design protected areas and park governance regimes to better reflect the local context. To conclude, we highlight two key efforts in this regard.

Land-Use Zoning and the Creation of Ecological Corridors Around Protected Areas

Faced with an overwhelming challenge to promote environmental protection while improving local lives and livelihoods across large or newly expanded protected areas, managers and agencies are increasingly turning to land-use zoning. Ideally, these zoning projects provide a means to balance conservation aims with economic development goals across large areas and among diverse stakeholders. Many of these projects center on creating buffer or multiple-use zones to soften the line between nature preservation and resource extraction (77). Others seek to establish ecological corridors or no-take zones amidst areas of resource extraction, so that biodiversity can be sustained in these zones and can replenish surrounding areas (107). These landscape-level initiatives represent a more appropriate scale for reconciling biodiversity conservation and rural development.

Zoning represents an advance for high-conflict situations or cases where actual land use differs significantly from legal conservation mandates. But the bland terms used in project documents (e.g., buffer zones and stakeholder analysis) belie the intensely political nature of demarcating territories for conservation and/or resource exploitation. Not surprisingly, zoning projects have stirred criticisms from various perspectives.

Some conservation biologists fear that land-use zoning projects will compromise ecosystem integrity if parkland is rezoned for multiple use. Accordingly, because many parks are already small and poorly protected, conservation biologists call on park managers to "draw a line in the sand" and "hold ground" against powerful economic interests (21, 108, 109). Meanwhile, political ecologists generally view many rezoning efforts as but a new incarnation of coercive conservation in which the state expands its authority and further displaces local people from vital resources (76, 77). These critics doubt project leaders' claims of community participation, and assert that as long as state agencies or externally funded conservation NGOs direct rezoning projects, local citizens will lose out. Aside from

political dilemmas, zoning exercises have suffered from problems of implementation. Considerable time and money have been invested in overly elaborate plans (e.g., laying out 20 or more categories of land use) that are far beyond the local managerial capacity. Other times, zoning only perpetuates ambiguity in protected area objectives. For example, a Peruvian manager explained that she was unsure how to enforce a large zone designated in her protected area for "economic development harmonious with biodiversity conservation." Such vague designations reflect the political advantages of avoiding difficult decisions about priority land uses; public consensus on zoning plans is more feasible when the management objectives for contested zones remain vague.

Zoning efforts are most likely to be effective if they are scaled to managerial capacity and are viewed as legitimate by local citizens and key stakeholder groups (note that not all stakeholders will be winners). Research in Latin America has shown that the very notion of park zoning and management can be co-opted by local elites or outside interest groups, who can wrap themselves in the cloak of conservation and maneuver both zoning and enforcement to limit access to other groups, especially when the actions of other groups may restrict or diminish their livelihood resources (110). Given the expansion of biosphere reserves and other categories that allow for complex zoning, it is likely that what is contested will shift from "people versus parks" to "park insiders versus outsiders" (95). In many places, both participatory legislation and participatory zoning allow needed flexibility in drawing boundaries that are more realistic given the current sociopolitical and ecological landscape surrounding each protected area.

Protected Area Governance and the Importance of Strengthening Institutions

An important trend in protected area policy circles is greater attention to environmental governance (111). Beyond elaborating what type of protected area is appropriate for a given place (e.g., type Ia, III, or VI), conservationists are addressing who should have responsibility for management of individual protected areas. Barrett et al. (112) noted that local communities have become the "default locus of most tropical conservation activity," owing in large part to recognized failures with the "fences and fines" approach to conservation management from centralized institutions, as well as pressure to integrate community development and poverty reduction with conservation action (112). The difficulty here is that, in this shift to community-based management of the area and natural resources, the bulk of the economic burden and responsibility of management has fallen to the community itself, and other institutions and stakeholder groups have either disappeared or maintained minimal roles. Although this may offer validation to the local community of the importance of its direct and present relationship with the protected area, the management arrangement as such fails to recognize the complex web of relationships that connect other groups with the protected landscape and resources.

This web of connections to the area and the resources can be mapped across spatial and temporal scales. These scales can include not only local communities that directly depend on the area for sustaining household livelihoods, but these can also aid regional and national constituencies, such as, for example, effectively managing resources to provide clean water to larger portions of the population. The connection then extends even further to international institutions and treaties, including those focused on mitigating the effects of global warming to provide a better outlook for future generations.

When considering the web of institutional and group connections to a protected area, it becomes imperative to look through an economic lens and define the costs and benefits, both direct and passive, that each group maintains with the landscape and resources of the area (113). This type of analysis is challenging, but many argue that the exercise is a necessary step in the development of a more complex and integrated management order. In failing to do so, either local communities or weakened state institutions will continue to bear the brunt of the economic burden of maintaining these areas when international institutions and donors in particular could do much to alleviate it.

Finally, recent publications have illustrated that too little is known about national and regional institutional landscapes and that this research is imperative before conservation managers can effectively create a management "menu," which assigns responsibility to an array of stakeholder groups at varying levels (112). Furthermore, practitioners must not impose uniform conservation strategies across the developing world. Rather, they must recognize the substantial and complex differences in institutional roles and power between Latin America, Africa, and Asia or their subregions.

Environmentalists now face a time of "tragic choices and creative compromises" (W. Cronon, personal communication). Protected areas on their own are unlikely to lift millions of people out of poverty in developing countries. And biodiversity will likely continue to be compromised in many protected areas that remain vulnerable to local, national, and international economic forces. Just as is the case for sustainable development (a mission with "broad appeal and plurality of purpose" (114), greater clarity is needed on the mission of parks, with corresponding support to manage them so that they can effectively meet their assigned mission. At broad scales, it is possible for protected areas to maintain both biological diversity and to set the stage for better environmental stewardship in surrounding lands, a necessity if lasting poverty-reduction is to be achieved.

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Figure 4 Aerial view of the eastern boundary of Aberdares National Park, Kenya, 2004 (photo by Peter Witucki).

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