Financial Costs and Shortfalls of Managing and Expanding Protected-Area Systems in Developing Countries

AARON G. BRUNER, RAYMOND E. GULLISON, AND ANDREW BALMFORD

Underfunding jeopardizes the ability of protected areas to safeguard biodiversity and the benefits that intact nature provides to society. In this article, we evaluate the cost of effectively managing all existing protected areas in developing countries, as well as the cost of expansion into high-priority new areas. We find that recent studies converge on a funding shortfall of $1 billion to $1.7 billion per year to manage all existing areas. The costs of establishing and managing an expanded protected-area system would total at least $4 billion per year over the next decade, an amount that far exceeds current spending but is well within the reach of the international community. These findings indicate the need for rapid action to mobilize significant new resources for the developing world's protected areas. In particular, this will require (a) the use of a range of tools to generate funds and improve efficiency of management; (b) greater precision and better communication of the costs and benefits of protected areas, both locally and globally; and (c) increased, stable support from developed countries for on-the-ground management of protected-area systems in developing countries.

Keywords: protected area, developing countries, financing, effectiveness, funding shortfall

The creation and effective management of a comprehensive protected-area system, covering the world's highest-priority conservation areas, is vital for the protection of biodiversity and the numerous market and nonmarket benefits that intact nature provides (Pimm et al. 1995, Balmford et al. 2002, Rodrigues et al. 2004). Establishing such a protected-area system requires long-term political and financial commitments that go far beyond simply declaring new parks (Hockings et al. 2000).

These commitments are frequently unmet. Thousands of protected areas in the developing world currently suffer an extreme funding deficit (James et al. 1999, 2001, Wilkie et al. 2001), and many areas have no budget at all (IUCN 1999). Insufficient funding means that many protected-area systems have inadequate staff, equipment, and other management necessities. Funding for necessary protected-area expansions is also limited.

While funding is only one of several basic needs for creating functional protected-area systems, inadequate financial support plays a central role in the loss and degradation of important natural resources, as it limits both the management effectiveness of established protected areas and the coverage of protected-area systems. Examples of the former include Ghana's "empty forest" parks (Oates 1999), oil spills in protected areas of Ecuador (van Schaik et al. 1997), and widespread logging and clearing of parks in Indonesia (EIA/Telepak Indonesia 1999, Curran et al. 2004). The other articles in this special section of *BioScience,* as well as important published work (e.g., Margules and Pressey 2000, Groves et al. 2002), address the issue of protected-area system coverage, providing evidence of key gaps in global protected-area systems as well as methodologies for strategic establishment of new protected areas.

Accurately estimating the financial needs of protected areas is an important first step to securing adequate funding.

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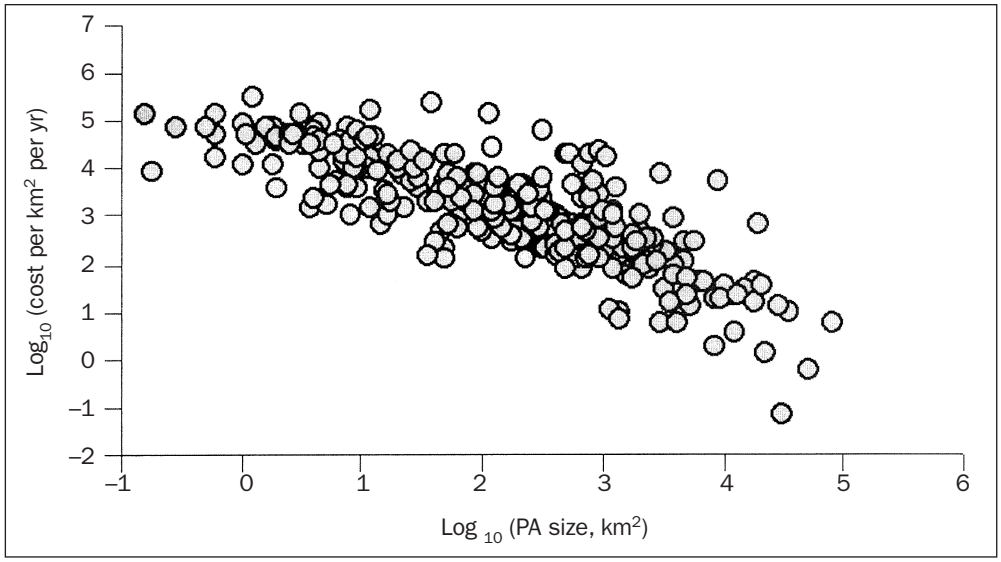

Figure 1. The importance of size for protected-area costs, shown as the relationship between the base-10 logarithms (log_{10}) of protected-area size (in square kilometers) and cost (in dollars per square kilometer per year). At a global level, protected-area (PA) size accounts for more than 65% of the variation in management costs per square kilometer, despite differences in national cost structures (n = 290). Rapid improvements in management and expansion of the world's protected-area systems can take advantage of this favorable cost structure while opportunities still exist to protect larger areas in simpler social contexts.

In this article, we draw on published cost studies, working sessions on protected-area costs from the Fifth World Parks Congress (WPC) in 2003, and post-WPC analyses to quantify the funding shortfall for terrestrial protected areas across developing countries and to assess necessary actions to close the gap. We begin by describing the major components of protected-area system costs and how these vary. We then discuss methodological differences in accounting for this variation and summarize the major findings of several previous studies of financial needs. Finally, we present new analyses of both the shortfall for existing protected areas and the potential costs of expansion. These analyses reinforce the existence of a major funding shortfall and, we argue, converge on a clear target for urgently needed action. We conclude by presenting a series of recommendations aimed at moving toward well-funded protected areas.

Components of protected-area system cost

The costs of a protected-area system can be usefully divided into three categories: (1) recurrent management costs for existing areas, (2) systemwide expenses needed to support a network of protected areas, and (3) costs of bringing new areas into the system.

Recurrent management costs. Recurrent management costs include operations (e.g., staff salaries and training, fuel, maintenance, community engagement, and monitoring and evaluation), site-level administration, and development projects or recurrent compensation costs that are a direct responsibility of the protected area. Factors that influence these costs include the following:

Management objectives. The objectives for managing protected areas vary widely, including wilderness protection (IUCN category I), active ecosystem management and restoration (IUCN category IV), and the promotion of sustainable use (IUCN category VI; IUCN 1994). Different management objectives require widely different activities and expenditures.

Accessibility. In many instances, accessibility determines the level of pressure faced by a protected area, with more threat generally requiring more investment (Sader 1995, Chomitz and Gray 1996, Wilkie et al. 2001). Indeed, many poorly funded "paper parks" in remote regions remain largely intact, while more accessible protected areas with small budgets have suffered serious degradation. Vegetation type may also affect access and cost (Hanks and Attwell 2002, Frazee et al. 2003).

Size. Management costs per hectare (ha) generally decrease rapidly as the size of a protected area increases (ART 1998, Balmford et al. 2003, Frazee et al. 2003), perhaps because of economies of scale in management, a greater area protected by inaccessibility, fewer impacts from edge effects, and a greater likelihood of larger areas being ecologically self-sustaining (figure 1; Nepstad et al. 1999, Gascon et al. 2000). However, because larger protected areas may also be more likely to be located in less complicated social contexts (i.e., in areas with lower population densities and more secure land tenure), simply expanding protected areas without regard for context may in fact result in more complicated and expensive management (Harcourt et al. 2001).

Systemwide expenses. The systemwide costs of a national protected-area network include national and regional administration, new site selection, budgeting, securing financial allocation within the political system, and other activities necessary to support the network. Primary determinants of costs across national systems include countrywide cost levels (Wilkie et al. 2001, Balmford et al. 2003) and the size of the protected-area network.

Establishment costs. The costs of establishing new protected areas may include both designation costs (e.g., stakeholder consultations, biological inventories, boundary demarcation,

Table 1. Studies of protected-area costs.

Country or region	Focus of study	Reference
Broadscale studies		
Global	Management costs and costs of creating of new protected areas (survey based)	James and colleagues (1999, 2001)
Africa	Review of 10 countries	Hanks and Attwell (2002)
European Union countries	Natura 2000 protected-area goals (survey based)	Working Group (2002)
Detailed studies		
Bolivia	SWOT (strengths, weaknesses, opportunities, and threats) analysis	Cammarata (2001), Molina and colleagues (2003)
Ghana	Both core budget and full-implementation budget using management plans	Volta-Tineh (1998); Ankudey and colleagues (2003)[a]
Cameroon	Visits to each protected area and discussion of all major cost components with protected-area staff	Culverwell (1997)
Madagascar	Development of standards based on priority and threat	ANGAP/FTHM Finance (2003), Rajaobelina and Ramangason (2003)[a]
South Africa (Western Cape)	Self-assessment of costs, including alien plant removal	Daitz (2003)[a]
Angola	Preliminary estimate using extrapolation from areas where cost is known	Huongo (2003)[a]
Models of protected-area costs[b]		
Global	Based on protected-area size, with adjustments for national income and purchasing power	Balmford and colleagues (2003)
South Africa (Cape Floristic region)	Based on protected-area size and vegetation type	Frazee and colleagues (2003)
Congo basin countries	Based on protected-area size (from ART [1998])	Wilkie and colleagues (2001)
Africa	Application of a modified version of Balmford and colleagues' (2003) global model to Africa	Moore and colleagues (2004)
Southern Africa	Based on protected-area size	ART (1998)
All developing countries	Based on protected-area size and fixed ratios to other management components	Vreugdenhil (2003), Vreugdenhil and colleagues (2003)

a. Presentations given at the Fifth World Parks Congress.

b. The first three models listed in this category were either calibrated from or later compared with detailed expert estimates of need for the same areas and were able to predict need accurately.

land purchase, and compensation) and up-front purchases, construction, and planning. These costs vary according to many of the factors described above, perhaps especially those relating to social context.

Protected-area costs in developing countries

In the following sections, we summarize the major findings of several previous studies of financial needs of terrestrial protected-area systems in the developing world. Some of the most important existing studies are listed in table 1. We then present the results of two new analyses. The studies we include use a range of methodologies to estimate financial needs, including (a) providing questionnaires to allow protected-area managers to identify their own needs, (b) consulting independent experts, and (c) building on participatory processes such as management plans, and defining general rules for deciding when given expenditures are appropriate. Studies also differ in terms of which components of protected-area system costs they include, although the majority focus on management costs for existing protected areas. Despite these varied approaches, results can be assembled to present a reasonably bounded estimate of financial needs for protected-area systems in developing countries.

Management costs for existing terrestrial protected areas. Although protected-area management spending varies greatly from country to country, it is consistently less than what studies estimate to be adequate. For example, the current protected-area budget as a percentage of necessary annual spending is estimated to be approximately 20% in Cameroon (Culverwell 1997) and across the Congo Basin (Wilkie et al. 2001), 35%–45% in Ghana (Hanks and Attwell 2002, Ankudey et al. 2003), and 70% in Bolivia (Molina et al. 2003). The average current spending reported by these studies ranges from \$0.05 to \$3.00 per ha, while actual needs range from \$0.90 to \$9.00 per ha.

At a broader scale, three independent studies have produced similar estimates of the cost of effective management for all existing protected areas in developing countries (figure 2). Developing countries were defined in these studies as those that are not members of the Organisation for Economic Co-operation and Development (OECD), with the exceptions that James and colleagues (1999) did not include non-OECD European nations, and Vreugdenhil (2003) did not include Caribbean countries. While these differences are important, the total area they represent is relatively small and does

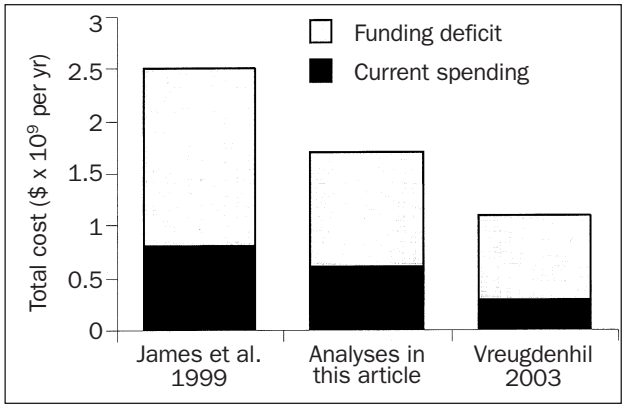

Figure 2. Concordance between the estimate in this study and two other estimates of the total annual costs of managing existing protected areas in developing countries (James et al. 1999, Vreugdenhil 2003), indicating current spending (in billions of dollars per year), necessary spending, and the shortfall between the two. Lower estimates include fewer cost components. The totals for current spending on the cost components included in estimates by Vreugdenhil (2003), and on those presented in this article, are unknown and were estimated using the ratio of current to necessary spending reported by James and colleagues (1999).

not affect the general finding of convergence among these studies.

James and colleagues (1999, 2001) estimate that the total annual cost of effectively managing all existing protected areas in developing countries is approximately $2.3 billion (updated to $2.5 billion to account for inflation [A. B.]); there has been growth in the global protected-area system since these calculations were made, so total costs are now probably somewhat higher. This estimate was based on assessments by more than 600 protected-area agencies of their own needs and on extrapolation of regional averages to nonreporting countries.

Vreugdenhil and colleagues (2003) have developed a model of protected-area management that estimates the cost of 50 management components according to national prices and protected-area size. The model works by predicting staffing needs from protected-area size, with additional parameters (e.g., number of vehicles or technical staff per park guard) set as fixed ratios. The model does not consider noncore management activities such as development projects. An application of this model to all protected areas in developing countries suggests total costs of $1.1 billion per year to cover basic management and administration (Vreugdenhil 2003).

Balmford and colleagues (2003) derived a model of how management costs vary, based on expert estimates of the cost of effective management for 139 individual sites worldwide. Their model explains more than 80% of the $\log_{10}$ variation in costs per square kilometer (km^2) on the basis of (a) protected-area or project size, (b) gross national product (GNP) standardized by country area, and (c) purchasing power parity (PPP), or the local purchasing power of a US dollar. We tested this model by applying it to a new data set of 194 protected areas, which was based on work presented at the WPC (92 areas) and three published sources (102 areas; Culverwell 1997, Frazee et al. 2003, Molina et al. 2003). This new data set, which included 126 protected areas from four African countries, 36 protected areas from Europe, and 32 from Latin America, was significantly different in composition from the original data. Nonetheless, tests of the model resulted in a nearly identical r^2 (0.78), suggesting broad applicability.

To update the model (table 2), we combined the two data sets, removing 33 nonprotected areas from Balmford and colleagues' (2003) data, as well as duplicates of three protected areas common to both data sets. Following Balmford and colleagues (2003), we used forward and backward stepwise regression, with the alpha-to-enter and alpha-to-exit value set at 0.05, to test the explanatory power of (a) protected-area size; (b) gross domestic product (which differs from GNP in that it includes only the goods and services produced within the borders of a nation or territory), standardized by country area; (c) PPP; and (d) human development index (HDI) rank (a measure of wealth that includes data on life expectancy, literacy, school enrollment, and per capita GNP; UNDP 2004). All variables except HDI were natural logarithm–transformed ($\ln[x + 1]$ for each variable x) to approximate normality. This analysis resulted in some change in functional form (the addition of the HDI term and a sign change on the PPP term) and a slight improvement of the r^2 to 0.82. Seven protected areas were excluded from the analysis because PPP information was not available, resulting in a final sample size of 290.

When the sample was broken down by region, even better models were found using the same methodology. Most notably, for Latin America, a final model included only protected-area size and PPP, but resulted in an r^2 of 0.94 ($n = 37$). Such regional models may be especially useful in future efforts to model site-specific management costs with greater accuracy.

Finally, we generated new potential explanatory variables for the global sample by overlaying protected-area boundary files from the recently updated World Database on Protected Areas (WDPA Consortium 2003) on global coverages of roads, rivers, and human population (NIMA 1997, CIESEN et al. 2000). This overlay produced information about road and river access, and about human population density in the surroundings, for each protected area. Reliable data could be generated for only 191 protected areas, because boundary files for many protected areas were still either missing or inaccurately described as circles. The regression methodology described above resulted in an improved model ($r^2 = 0.85$, after the elimination of one outlier) that included new terms for percentage of protected-area border within 10 km of a road and a dummy variable for whether the protected area permitted multiple use (IUCN categories III through VI). The former variable was transformed to approximate normality,

Table 2. Three multiple-regression models of variation in annual protected-area management cost.

Dependent variable[a] cost per km² per year	Independent variables (coefficient, *P*)							
	Intercept, *P*	Protected-area size[a]	Annual GDP per km²[a]	HDI category	Purchasing power parity[a]	Multiple use	Percentage of protected-area border within 10 km of road[b]	Adjusted overall r^2, *P*
Global (general) (*n* = 290)	8.750, < 0.001	–0.650, < 0.001	0.233, < 0.001	–0.777, < 0.001	0.398, < 0.05	NT	NT	0.820, < 0.001
Global (context specific) (*n* = 191)	9.259, < 0.001	–0.669, < 0.001	0.268, < 0.001	–0.899, < 0.001	NS	–0.386, < 0.05	0.007, < 0.05	0.850, < 0.001
Latin America (*n* = 37)	16.351, 0.001	–0.878, < 0.001	NS	NS	–3.857, < 0.001	NS	NS	0.940, < 0.001

GDP, gross domestic product; HDI, Human Development Index; NS, not significant; NT, not tested.

Note: All models were generated using forward and backward stepwise regression; the threshold to add or remove variables from the regression was alpha = 0.05.

a. Natural logarithm–transformed (ln [*x* + 1]).

using a standard transformation for percentage data (arcsine of the square root of *x*, multiplied by 57.2957).

This same limitation in protected-area boundary files prohibits an accurate application of this final model to the entire developing world. Instead, we applied the first model described above to all protected areas greater than 10 km² in non-OECD countries. Data on PPP were unavailable for 5% of the total protected area, so to approximate total costs, we assumed average developing countrywide costs for these areas and added this amount to the total. The results suggest total management costs of approximately $1.8 billion annually.

These three studies set the lower and upper bounds of recurrent management costs, respectively, for all existing protected areas in developing countries at $1.1 billion and $2.5 billion. The range between the estimates is smaller than it appears, because the higher estimates include more cost components: The low estimate focuses exclusively on direct management (operations and administration), the middle estimate covers all management costs at the site level (but not regional or national systemwide support costs), and the high estimate covers all management costs necessary across entire national protected-area systems. Development projects and compensation payments beyond those that are considered the direct responsibility of protected-area management are not included in any of these estimates. These may nonetheless be necessary to support sustainable development more broadly, and they may require significant additional investment.

Current spending and the funding deficit for existing protected areas. James and colleagues (2001) estimate that approximately $0.695 billion per year ($0.8 billion when adjusted for inflation) is spent on protected areas in developing countries, significantly less than even the lowest estimate of financial needs. However, comparing total current spending with the $1.1 billion minimum estimate of financial needs would be inaccurate, as the latter covers only direct operations and administrative costs, while much of current protected-area expenditure does not fund these management components, instead supporting sustainable use and economic development in local communities. This may be especially true for funding from bilateral and multilateral aid agencies, many of which increasingly use social and economic objectives to drive biodiversity funding priorities (Lapham and Livermore 2003). Countries with significant biodiversity funding may therefore still have little basic protected-area management.

A comparison of total current spending with the two higher estimates to which it is more directly comparable suggests that the total shortfall in annual funding in developing countries is between $1 billion and $1.7 billion. Given that the lower estimate comes from a cost analysis that does not include systemwide costs, we conclude that the funding shortfall is greater than $1 billion, and perhaps best estimated at the midpoint, $1.3 billion.

Costs of protected-area system expansion. In addition to ensuring adequate management of existing protected areas, funding is needed to expand the world's protected-area systems to include species and ecosystems that are not adequately represented. The expansion of protected areas to some of the highest-priority terrestrial sites in developing countries might require consideration of an area of approximately 3.5 million km² (a 30% increase), estimated at a scale of half-degree grid cells (Rodrigues et al. 2004). Although protected-area creation over this entire area may not be necessary to cover all of the priority species analyzed (Rodrigues et al. 2004), we decided to use the entire area covered by the grid cells because the methodology used to prioritize sites was conservative. Further, since it is not possible to predict the shape and size of potential new protected areas, we estimated

the cost of management using average countrywide costs, rather than accounting for differences caused by factors such as accessibility and size. We used, in order of preference, data from (a) published national or regional estimates (13 countries; Howard 1995, Volta-Tineh 1998, Wilkie et al. 2001, Hanks and Atwell 2002, Molina et al. 2003), (b) James and colleagues (2001; 32 countries), (c) Vreugdenhil (2003; 34 countries), (d) regional averages where new regional data were available (8 countries), and (e) regional averages from James and colleagues (2001; 8 countries).

The combination of these data suggests that expanding protected-area systems to include the highest-priority sites might raise annual management needs by an estimated $1.8 billion per year, bringing total management costs to perhaps $4 billion per year. Average per-ha management costs for new protected areas are likely to be greater than those for existing protected areas, because high-priority areas for expansion are largely in more fragmented and developed regions, where costs are higher.

The establishment costs of new protected areas will also be significant, potentially requiring land purchases or compensation payments, and almost always requiring construction of infrastructure and purchase of equipment. Designation costs are difficult to estimate because they are highly variable, ranging from zero (when governments allocate uninhabited public lands) to the full cost of land purchase (when public protected areas are established on private lands). If all areas require either purchase or compensation equivalent to purchase value, the application of a formula developed by James and colleagues (1999) suggests that creating new protected areas in non-OECD countries could cost as much as $9 billion per year for the next 10 years. The costs of expansion and management could therefore total as much as $13 billion per year over the next decade, although it is important to note that the protected areas created to date have generally not required land purchase or compensation. For the purpose of this analysis, given the level of uncertainty in predicting establishment costs, they are best treated as a range between zero (no compensation) and $9 billion (full compensation).

Putting protected-area financial needs in context

Even if creating and managing an expanded protected-area system costs a full $13 billion per year, this amount is not excessive when compared with other global expenditures. Using a comparison first made by James and colleagues (1999), $13 billion is equivalent to 1% of what governments spend globally each year on environmentally harmful subsidies (Myers 1998, van Beers and de Moor 1999). Simply meeting the approximate $1.3 billion annual shortfall for managing all existing protected areas in developing countries, in itself a critically valuable step, would require global support on the order of 2% of what Americans spend each year on soft drinks (Jacobson 2003). Finally, the total cost of managing an expanded protected-area system in developing countries is perhaps 50% of total current spending on protected areas in developed regions (James et al. 2001). Perhaps two-thirds of the world's species are located in the developing countries (Raven 1988), suggesting that investment in these countries' protected areas is highly cost-effective.

The analyses presented here focus exclusively on the costs of protected areas; they do not consider the benefits that these areas provide. In many cases, protecting biologically important areas may provide economic benefits greater than the costs of protected-area establishment and management. For example, Carret and Loyer (2003) showed that effective management of the protected-area network in Madagascar would cost approximately $18 million annually in management and in lost agricultural biomass and nontimber forest production, but would generate more than $20 million annually in net local benefits from ecotourism (nonconsumptive direct use value), watershed protection (indirect use value), and direct payments for biodiversity conservation (nonuse value). Other studies have also demonstrated significant local benefits from conservation, such as clean water from intact cloud forests (Becker 1999) and storm protection and other services from coral reefs (White et al. 2000). If these benefits are accounted for, it appears that adequately funding protected-area systems in developing countries would generate considerable net benefits to society (Balmford et al. 2002).

Closing the funding gap

In recognition of the importance of protected areas, the Convention on Biological Diversity program of work on protected areas contains a worthy target to address the funding gap: "By 2008, sufficient financial, technical and other resources to meet the costs to effectively implement and manage national and regional systems of protected areas are secured, including both from national and international sources, particularly to support the needs of developing countries and countries with economies in transition and small island developing States" (CBD 2004). The short time frame for implementing this goal is critical; inadequate management results in environmental degradation and in situations that are ever more complicated and expensive to manage (Balmford et al. 2003). Similarly, rapid action on protected-area expansion will permit new protected areas to be larger and to be created in less complicated social contexts in which management and establishment costs will be lower.

Detailed study of management costs, as well as broader, systematic demonstration of protected-area benefits, will be basic to achieving this goal in many countries. However, these studies should not delay rapid action in increasing funding. Enough is now known about the magnitude of funding needs to demonstrate that the international community must immediately begin mobilizing new resources.

Given both the scope and urgency of meeting the funding deficit, all appropriate mechanisms must be employed. At local and national levels, mechanisms such as ecotourism, payment for ecosystem services, and environmental exit taxes on visitors all have the potential to raise significant revenues (CFA 2002). Funding shortfalls can also be reduced by decreasing costs through improved efficiency and through

innovative partnerships with groups including indigenous communities, private landowners, and tourism companies. New tools such as certification and independent audits of effectiveness have the potential to drive improvements in management and improve donor confidence (WWF 2004). Similarly, innovative strategies such as direct payments for conservation performance can facilitate effective management and permit protected-area expansion in complicated social contexts, as well as make investment in protected areas more transparent and fundable (Ferraro and Kiss 2002, Hardner and Rice 2002). Finally, national governments must also seek to increase their direct support for protected areas.

Unfortunately, experience to date with the suite of local and national mechanisms suggests that these approaches will not be able to meet the entire financial need of protected areas in developing countries. Similarly, national government contributions are often constrained by limited budgets and numerous competing priorities. Given the scale and urgency of the need, greatly increased direct financial support from developed countries will be central to the success of protected areas worldwide (Wilkie et al. 2001, Lele 2002, Nasi et al. 2002, Balmford and Whitten 2003). Developed countries benefit substantially from protected areas in developing countries, and thus they have practical as well as moral reasons to support these areas financially. Furthermore, such support is well within the means of the developed world. Official development assistance from the OECD countries in 2002, for example, was nearly $60 billion (OECD 2004).

Maximizing the contribution of increased funding will require prioritizing investments until financial needs can be completely met. Potential criteria for prioritization include focusing on the protected areas and protected-area systems with the highest conservation value; providing greater support to the most threatened protected areas; prioritizing the funding of core management activities; and supporting protected areas in countries where the likelihood of success is greatest, as evidenced by factors such as strong political support for protected areas, supportive legislation and enforcement, low corruption, and matching funding at appropriate levels. The efficient use of increased funding can be promoted by monitoring management results and using this information to drive improvements in performance through adaptive management.

Finally, it is critical to ensure that increased funding, by whatever means, actually reaches protected areas to be used for on-the-ground management activities, and that funding flows are stable enough to permit these activities to be consistent. Rapid action in providing necessary protected-area financing will minimize biodiversity loss and promote a future in which healthy, natural areas are an integral part of sustainable development.

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