

# Conserving Africa's rain forests: problems in protected areas and possible solutions

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## Abstract

Problems and correlates of success in the conservation of Africa's rain forests were evaluated for 16 protected areas in 11 countries, representing approximately half of all protected areas in this biome. Data were obtained from questionnaires, published and unpublished accounts, and direct observations. Despite numerous problems, all protected areas conserved indigenous rain forest biodiversity more effectively than did alternative land uses. More than half the protected areas suffered extensive ecological isolation. Effective management of protected areas was seriously compromised by inadequate funding and government support. Dense human populations, often resulting from immigration, constituted major threats to protected areas. Perceived conservation success was greatest for large protected areas surrounded by similar habitat with strong public support, effective law enforcement, low human population densities, and substantial support from international donors. Contrary to expectations, protected area success was not directly correlated with employment benefits for the neighboring community, conservation education, conservation clubs, or with the presence and extent of integrated conservation and development programs. Studies are needed to better understand what shapes positive public attitude towards protected areas because none of the conventional public outreach programs were correlated with public attitude. We also identify apparent deficiencies in foreign assistance to these protected areas. The single most important short-term strategy was considered to be the improvement of law enforcement effectiveness through greater technical and financial support. Nine medium-term strategies are identified, including provision of adequate and secure long-term funding, establishing research and monitoring programs, and developing more appropriate conservation and development programs. Long-term strategies deal with two ultimate causal factors, mainly attitudes and value systems, and stabilizing human populations. Future success of Africa's protected areas is contingent upon long-term international assistance including contingencies mandating realistic performance standards.

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## 1. Introduction

Conservation of the remnants of Africa's rain forests with their full array of species, viable populations, and ecosystems depends on the effective protection, management, and expansion of its rain forest parks. Although

some still question the utility of national parks as a conservation strategy, those professionals who actually study and manage rain forests in the field unanimously support parks as the best and most effective approach to conserving biodiversity (Kramer et al., 1997; Struhsaker, 1997, 1998; Oates, 1997; Myers et al., 2000; Bruner et al., 2001). Alternative approaches, such as extractive reserves or sustainable harvest, are problematic at best for conserving the full array of biodiversity

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(Wells and Brandon, 1992; Robinson, 1993; Kramer et al., 1997; Rice et al., 1997; Struhsaker, 1997, 1998).

The need to improve management strategies and the conservation effectiveness of Africa's rain forest parks is urgent because most of these forests are threatened and they have among the highest levels of species richness and endemism on the entire continent (e.g., Brooks et al., 2001). Rapidly growing human populations (2–3% increase annually) throughout most of Africa bring increasing demands on forests and their associated natural resources. Large concentrations of humans coincide with some of the most important areas for biodiversity conservation (Balmford et al., 2001). Exacerbating this problem are the aspirations of governments and a growing middle class that seek a higher standard of living modeled after the hyper-consumption of western nations.

The objectives of this study were to identify the problems facing Africa's rain forest protected areas (PAs) and the variables that best correlated with their conservation status. In addition, this study indicates areas where more research is needed and generates testable hypotheses that are relevant to conservation management. Recommendations are made for ways to improve the conservation effectiveness of these PAs and these have broad application to other tropical regions and biomes (Struhsaker, 2001).

The primary weakness of this study is that the conservation status of the PAs was based on the opinions of scientists, managers, and administrators working in them. Consequently, it cannot be equated to studies based on long-term, quantitative data. However, an ideal study of the questions addressed here for a representative sample of PAs would require an enormous budget and many years of research by a multitude of scientists. This is probably why the ideal study has not been done and why such a study is unlikely in the near future. Such an approach is not only impractical, but would greatly delay action in the face of impending crises. A useful and expedient alternative to the ideal study is to seek the opinions of conservationists who have extensive, first-hand knowledge of the problems.

The use of questionnaires that rely on qualitative information from experienced practitioners is widely used in assessing conservation success (e.g., Hockings, 2003; Ervin, 2003; Goodman, 2003). As Hockings (2003, pp. 828–829) stresses "...the subjective responses of protected area managers are likely to be based on years of field-level experience, and these responses may better capture the realities and complexities of the protected area than many monitoring programs." He further emphasizes that "...scoring methodologies may reveal useful insights into management issues and management effectiveness, even though they are based more on perception than on concrete data."

We emphasize that we do not consider ours to be a definitive study, but rather one that provides guidelines for consideration in developing management plans, evaluation studies, and conservation investment strategies. Our premise is that the opinions of highly experienced, professional field biologists and park managers and administrators provide valuable insights into the problems facing Africa's forest parks and reserves, as well as their possible solutions.

## 2. Methods

### 2.1. Sources of data

Information was obtained from three sources: a questionnaire sent to colleagues working in African forest PAs, vegetation maps, satellite imagery, published and unpublished accounts, and direct observations by T. T. Struhsaker (TTS) from 1966 to 2000.

Questionnaire data on 16 parks and wildlife reserves were obtained from 36 respondents (23 scientists and 13 managers/administrators) whose collective experience exceeded 567 person-years ( $\bar{x} = 16$  years). Eleven of the respondents were from 4 African nations, 14 from the United States of America and Canada, 10 from 4 European nations (including the United Kingdom), and one from Japan. TTS conducted research in or made short-term visits to 11 of these 16 PAs over the past 34 years; three were visited in 2000. We selected PAs where data were available, where there were professionals working and willing to assist us, and where one of us (T.T. Struhsaker) had first-hand experience. More details of this study can be found in Struhsaker (2001) and at the following web site <http://www.frame-web.org/>.

### 2.2. Study sites

The 16 study PAs covered a wide geographic area; 11 countries from Cote d'Ivoire to Tanzania. They ranged in size from 306 to 13,600 km<sup>2</sup>, and had been established for 8–66 years. These protected areas, their conservation success score (1 being a failure and 5 very successful; see Section 2.3 for explanation), and number of respondents (roman numerals) are: Tai (3.8) (V) and Marahoue (2) (II), Cote d'Ivoire; Ankasa (2) (II), Bia (2) (II), and Kakum (2.5) (IV), Ghana; Cross River (3) (I), Nigeria; Korup (3) (V) and Dja (3) (I), Cameroun; Dzanga Sangha (3.5) (V), Central African Republic; Odzala (5) (I), Republic of Congo; Lope (3) (III), Gabon; Mt. Alen (5) (I), Equatorial Guinea; Ituri (Okapi Wildlife Refuge) (3.5) (I), Democratic Republic of Congo; Kibale (3.9) (VII), Uganda; and Mahale (4) (II) and Udzungwa Mountains National Park (4) (V), Tanzania. These 16

PAs represent approximately half of all of Africa's rain forest parks and wildlife reserves.

### 2.3. Data analysis

Data and evaluations for 32 variables (listed in Tables 1, 5, 6 and Fig. 1) relevant to PA conservation success were collected. The information ranged from quantitative data, such as human population densities, PA size, and degree of ecological isolation to qualitative impressions (e.g., conservation status of the PA, effectiveness of law enforcement, and public attitude). An overall conservation success score was given to each of the 16 PAs based on a qualitative evaluation by the respondents. All respondents were asked the following question: How would you score this PA in terms of conservation success on a scale of 1–5, with 1 being a failure and 5 being very successful. This qualitative evaluation was used because none of the PAs had comprehensive, PA-wide monitoring programs that might have allowed for a quantitative evaluation. In fact, we do not know of any African forest park or reserve that has such a program. In general, however, it can be said that PAs considered to be very successful were characterized by having relatively large populations of species that are typically hunted for meat, large areas of old-growth forest, and few signs of poaching or other signs of recent human disturbance, e.g., cutting of poles, timber, and agricultural encroachment.

Mean values were used for those variables and PAs with more than one respondent or source of data. These data were scored on a continuous scale of 1.0–5.0 (to the

first decimal point resulting in 41 intervals), permitting comparisons between ordinal and interval data. Pearson product–moment correlation coefficients were used to measure the association among the 32 variables, as well as with the overall success score. Normal probability plots of the 32 variables and the overall success scores demonstrated the validity of the assumption of approximation of normality for these data. Further, Spearman and Kendall rank correlation coefficients for these comparisons were essentially identical to the Pearson correlation coefficients. Unless otherwise noted, probabilities are two-tail at  $n = 16$ ,  $df = 14$ . Bonferroni adjustments were not made because they increase the probability of type II errors (see Perneger, 1998 for other criticisms of Bonferroni adjustments).

## 3. Results

### 3.1. Problems facing PAs

Most of the PAs suffered major deficiencies and were confronted by serious pressures from surrounding human populations (Table 1). None of the PAs had long-term monitoring programs that sampled the entire PA at frequent and regular intervals. Consequently, the conservation success of the PAs and the management strategies used cannot be evaluated with objective scientific data. All evaluations of success are based largely on qualitative impressions (see Section 1 and 2 for rationale). Those PAs with research stations (37.5%) were better able to evaluate success and management, but

Table 1  
Presence or absence of key variables in 16 rainforest protected areas (PA) in Africa

Variable	Percent of protected areas	
	Present	Absent
PA-wide monitoring program	0.00	100.00
Research station	37.50	62.50
Implemented management plan	37.50	62.50
Adequate number of guards	25.00	75.00
Adequate guard salaries	62.50	37.50
Adequate guard bonus system	50.00	50.00
Adequate equipment	25.00	75.00
Effective law enforcement	31.25	68.75
Adequate long-term, secure funding	18.75–25.00	75.00–81.25
Supported in part by foreign donors	93.75	6.25
PA size large enough for viable populations of all species	43.75	56.25
PA size large enough for seasonal movements of all species	31.25	68.75
Exotic species a major problem	81.25	18.75
Poaching a major problem	100.00	0.00
Immigration a major problem near PA	62.50–75.00	25.00–37.50
Political instability and insecurity near PA	50.00	50.00
Integrated conservation and development projects	81.25	18.75
Extension programs and/or conservation education	100.00	0.00
Revenue sharing	25.00	75.00
Traditional respect of wildlife (conservation ethic) including hunting restrictions by communities around PA	0.00–25.00	75.00–100.00
Corruption in or associated with PA a serious problem (no information given for 6 of the 16 PAs)	43.75–56.25	6.25

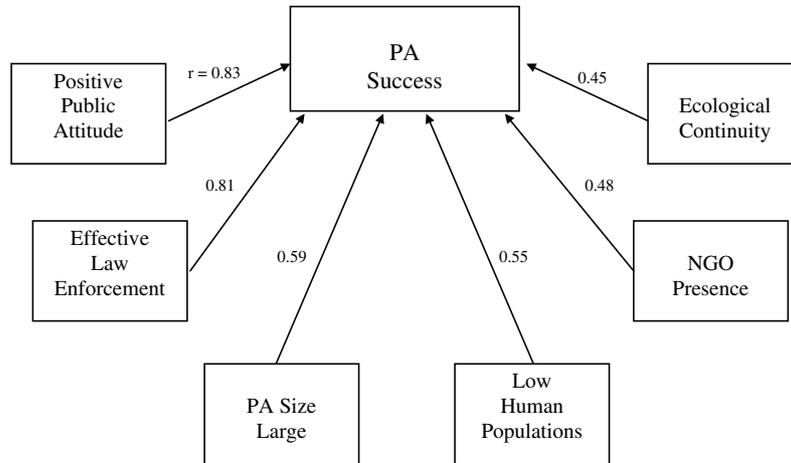


Fig. 1. First-order correlations & hypothesized causal relations ( $p$ -values for Pearson product-moment correlation coefficients: for  $r = 0.426$ ,  $p = 0.10$ ;  $r = 0.497$ ,  $p = 0.05$ ;  $r = 0.575$ ,  $p = 0.02$ ;  $r = 0.623$ ,  $p = 0.01$ ;  $r = 0.742$ ,  $p = 0.001$ ) (see text for details).

even then research activities usually covered no more than 2–3% of the entire PA.

Implemented management plans were present in only 37.5% of the PAs. Law enforcement was considered ineffective in 68.8% of the PAs due in part to insufficient numbers of guards, inadequate bonus systems, salaries, and equipment. Adequate, long-term and secure funding was absent from at least 75% of the PAs, in spite of widespread involvement of international donors in 94% of the PAs. Unsolicited information on corruption was volunteered by respondents for 10 of the 16 PAs sampled. Corruption involving PA personnel or other government officials was reported as a serious problem in 7 of these 10 PAs, a likely problem in at least two more, and not a problem in one. No information on corruption was available for the 6 remaining PAs.

More than half of the PAs were considered too small to support viable populations and seasonal movements of all species, e.g., elephants, leopard, and chimpanzees. Furthermore, more than half of the PAs suffered from extensive ecological isolation and nearly one-third were completely isolated (Table 2). Exotic species were considered a major problem in at least 80% of the PAs and this was probably underestimated because of the absence of PA-wide monitoring programs. *Chromolaena odorata* (an aggressive colonizer from S. America of the Asteraceae) was the most commonly reported problem species. It forms dense thicket that suppress forest regeneration and produces enormous quantities of seeds

that spread rapidly over long distances via wind dispersal and exo-zoochory (Gautier, 1992).

Crude estimates of human population densities in a 5-km wide perimeter surrounding the PAs indicated that densities exceeded 90 persons per km<sup>2</sup> for 47% of the PAs (Table 3). These are high densities for populations dependent on low-technology, subsistence agriculture often supplemented by hunting and fishing. Consequently, human pressures were high on at least half of the PAs studied. These pressures are likely to increase because of high rates of intrinsic growth and high levels of immigration. Immigration was considered to be a major problem in 63–75% of the PAs. One of the most extreme cases of immigration is the Tai Park of Cote d'Ivoire where the neighboring human population increased 16-fold between 1965 and 2000 (a doubling time of 2.2 years) (Boesch, 2000). Much of the immigration problem was the result of political instability and insecurity due to war that affected half of the PAs studied. PAs surrounded by high human population densities also tended to have high levels of immigration ( $r = 0.60$ ,  $p = 0.014$ ) and greater tribal diversity ( $r = 0.42$ ,  $p = 0.105$ ). The number of tribes living around the study PAs ranged from one to 30. High cultural diversity usually includes a wide range of value systems that further complicates the development of community-based activities. This is particularly so where there is a diverse array of recent immigrants into areas of high population density. As populations increase exponentially, resources per capita decrease accordingly. Added to this problem

Table 2  
Percentage of protected area boundary isolated from forest habitat outside the protected area

	Extent of ecological isolation				
	0–20%	21–40%	41–60%	61–80%	81–100%
Percentage of PAs ( $n = 16$ )	31.25	12.50	12.50	12.50	31.25

Table 3  
Human population density estimates for 5-km perimeter around PA

	Number people/km <sup>2</sup>				
	0.4–5.6	9.0–14.0	93–118	170	315–320
Percentage of PAs ( <i>n</i> = 16)	37.50	15.63	15.63	6.25	25.00

is the apparent lack of any traditional respect for wildlife, conservation ethic or tribal laws regulating hunting amongst populations living around 75% of the PAs studied, and only little or minimal respect for wildlife in the remaining 25%.

Integrated conservation and development programs (ICDP) were associated with 81.3% of the PAs, but varied greatly in content and extent. Extension services (e.g., tree planting) and/or conservation education programs were supported by all PAs. Revenue sharing by the PA with the local community was associated with only 25% of the PAs largely because forest PAs do not attract large numbers of tourists and there was little revenue to share. By contrast, all PAs in Tanzania allocated 7.5% of their annual budgets to community projects regardless of revenue generated. Financial benefits from employment associated with PAs affected an average of 4.1% of the neighboring community, but this estimate was only 2.5% or less for more than half the PAs (Table 4). (The percentage of the local community benefiting was estimated as the number employed in PA activities multiplied by 5 to include dependents and divided by the estimated population within a 5-km wide perimeter around the PA). Even though monetary benefits per capita were small, respondents felt that they generated some goodwill among the neighboring community towards the PAs.

### 3.2. Correlates of success

In spite of numerous problems, all respondents were unanimous in their opinion that the indigenous flora and fauna were far better protected inside the PAs than outside (see also Wells and Brandon, 1992). Indeed, this conclusion was supported by the fact that indigenous forests were essentially eliminated and replaced by agriculture from the areas surrounding more than half the PAs (Table 2), i.e. the only indigenous forest remaining was in the PAs.

Of the remaining 32 variables, five were separate indicators of conservation success: low level of threat and violation to PA; status of fauna excellent; status of flora excellent; low degree of disturbance to vegetation; and low impact of exotics. These five variables were used to check for consistency in the responses for an overall conservation success score. They were significantly correlated with overall success score and with one another (Table 5), supporting the conclusion that respondents were consistent in their evaluation of PAs and that the overall success scores were realistic indicators of conservation success for these 16 PAs. PAs with high overall success scores had low levels of threat and violation, good to excellent populations of indigenous flora and fauna, little disturbance to the habitat, and little or no impact by exotics. Given these correlations, overall success score was used as the basis for evaluating the possible role of the remaining 27 variables in shaping the status of the 16 PAs.

The correlation coefficients were used to generate hypotheses about cause and effect relationships between PA success and key managerial, ecological, and sociological variables. First-order relationships describe the strongest correlations between PA success and variables most likely to directly impact the PA. Second-order relationships describe the significant correlations between these first-order parameters and those variables most likely to influence them. In our model, first-order parameters can and, apparently, do sometimes interact with one another.

Six variables were strongly correlated with PA success and are considered to be operating at the first-order level (Fig. 1). This model predicts that PA conservation success is most likely where the PA has strong public support (at least in attitude); effective law enforcement; low human population densities around the PA; the PA is large (>1500 km<sup>2</sup>) and surrounded by very similar, if not identical, habitat (ecological continuity); and the PA receives appreciable technical and financial

Table 4  
Percentage of neighboring community within 5-km perimeter of PA receiving financial benefits through employment associated with PA<sup>a</sup>

	Percentage of population benefiting				
	10.1–17%	7.6–10%	5.1–7.5%	2.6–5%	0–2.5%
Percentage of PAs ( <i>n</i> = 16)	18.75	3.13	9.38	12.50	56.25

<sup>a</sup> The percentage of the local community benefiting was estimated as the number employed in PA activities multiplied by 5 to include dependents and divided by the estimated population within a 5-km wide perimeter around the PA.

Table 5  
Pearson product–moment correlation coefficients for overall PA success score vs score of five biological measures of success<sup>a</sup>

Variable	Overall PA success very high	Low threat and violation to PA	Status of fauna excellent	Status of flora excellent	Vegetation: low degree of disturbance
Low threat and violation to PA	0.77				
Status of fauna excellent	0.78	0.85			
Status of flora excellent	0.51	0.64	0.54		
Vegetation: low degree of disturbance	0.61	0.55	0.57	0.91	
Low impact of exotics	0.58	0.72	0.64	0.78	0.73

<sup>a</sup> *p* values (2-tailed, *N* = 16, *df* = 14) for Pearson product–moment correlation coefficients: for *r* = 0.426, *p* = 0.1; *r* = 0.497, *p* = 0.05; *r* = 0.575, *p* = 0.02; *r* = 0.623, *p* = 0.01; *r* = 0.742, *p* = 0.001. There were five possible scores for each variable (Struhsaker, 2001).

assistance from NGOs (non-governmental organizations). Surprisingly, PA success was not significantly correlated with 4 variables that were expected to have a positive impact: (1) percentage of neighboring community deriving employment benefits from PA (*r* = 0.08; *p* > 0.10); (2) conservation education for neighboring community (*r* = 0.02; *p* > 0.10); (3) presence of conservation clubs (*r* = 0.10; *p* > 0.10); and (4) presence and extent of ICDPs (*r* = 0.01, *p* > 0.10).

Six sets of second-order relationships were apparent. Public attitude towards PAs was correlated with five variables (Table 6). The cause and effect relationship with law enforcement is not clear even though it is the strongest correlate of positive public attitude. However, the remaining four positively correlated parameters suggest that positive public attitude towards PAs develops in relatively inaccessible areas with low human population densities where there is revenue sharing and an NGO presence. Four parameters not correlated (*p* > 0.10) with positive public attitude were: (1) employment benefits (*r* = 0.33), (2) conservation education for neighboring community (*r* = 0.01); (3) extent of ICDPs (*r* = 0.07); and (4) extent of conservation clubs in neigh-

boring community (*r* = 0.19). This was unexpected because these 4 activities represent some of the most direct strategies of outreach to the local community.

Effective law enforcement was significantly correlated with seven variables (Table 6) and is predicted to be most successful in PAs where the protection force has adequate support (bonus system, salaries and equipment), there is a positive public attitude (perhaps influenced by revenue sharing), low human population densities, and in areas that have extensive ecological continuity. Exceptions exist, such as when there is a high market price for wildlife commodities (e.g., ivory and bushmeat) or minerals (e.g., gold and coltan). Under these conditions even large PAs with low human population densities suffer, e.g., Korup, Ituri and Odzala.

PA size was significantly correlated with three variables: (1) low human populations; (2) ecological continuity; and (3) no immigration problem (Table 6). Large PAs usually occur in areas with low human population densities, vast tracts of wildlife habitat (ecological continuity), and where human immigration is not a problem. These conditions allow for the creation of large PAs, but they do not cause their establishment. PA establishment is a

Table 6  
Second-order correlation coefficients<sup>a</sup> and hypothesized causal relations<sup>b</sup>

Variables influencing/interacting with first-order parameters	Six first-order parameters					
	Positive public attitude	Effective law enforcement	PA size	Low human population	Ecological continuity	NGO presence
Effective law enforcement	0.65					
Low human population	0.52	0.45	0.70		0.88	
Revenue sharing	0.50	0.62				
PA inaccessible	0.49			0.55	0.74	
NGO presence	0.43					
Guard bonus		0.78				
Guard salary		0.59				0.47
PA equipment		0.57				
Positive public attitude		0.65				0.43
Ecological continuity		0.43	0.64			
Immigration low			0.44	0.60	0.44	
Number of tribes				0.42		
Monitoring program						0.42

<sup>a</sup> Pearson product–moment correlation coefficients: *r* = 0.426, *p* = 0.10; *r* = 0.497, *p* = 0.05; *r* = 0.575, *p* = 0.02; *r* = 0.623, *p* = 0.01; *r* = 0.742, *p* = 0.001.

<sup>b</sup> See text for details on hypothesized causal and other interactive relationships between these variables. Note that “First-Order Parameters” do sometimes co-vary and apparently influence one another.

political decision. It is easier to create large PAs where there is minimal conflict over land use.

Three parameters were correlated with low human population densities around PAs: (1) low level of immigration; (2) inaccessibility of PA; and (3) low number of tribes (Table 6). Low human population densities are fostered by poor accessibility and low levels of immigration and are associated with low numbers of tribes. The ultimate factors driving intrinsic population growth were not dealt with in this study.

Ecological continuity between the PA and adjacent areas was strongly correlated with: (1) low human population densities; (2) relative inaccessibility of PA; and to a lesser extent with (3) low levels of immigration (Table 6). These variables reflect the relative absence of development and are key causal factors determining ecological continuity.

The extent of NGO involvement with PAs was significantly correlated with three parameters that are almost certainly the consequence of NGO involvement rather than the cause (Table 6). These are the presence of: (1) adequate guard salaries; (2) positive public attitude; and (3) partial monitoring programs. These relationships indicate the importance of NGOs to PA success. Although this study was not designed to determine the factors shaping an NGO's decision to invest in a PA, there was a significant correlation between the extent of NGO involvement and PA size ( $r = 0.54$ ,  $p = 0.03$ ). Large PA size appears to be an important determinant of NGO involvement and this may be because larger PAs have a greater probability of long-term success. What this also means, however, is that many of the smaller and biologically important PAs are not given the support they warrant. Without this support, there will certainly be even more rapid and significant losses of biodiversity.

Eleven variables were not significantly correlated ( $p > 0.10$ ) with the extent of NGO involvement in PAs and suggest deficiencies in NGO programs. These are the presence of: (1) adequate bonus system for guards ( $r = 0.36$ ); (2) long-term funding for PA ( $r = 0.33$ ); (3) research station ( $r = 0.23$ ); (4) PA management plan ( $r = 0.24$ ); (5) adequate equipment ( $r = 0.12$ ); (6) effective law enforcement ( $r = 0.12$ ); (7) proportion of neighboring community deriving employment benefits from PA ( $r = 0.02$ ); (8) extent of conservation education for local community ( $r = -0.25$ ); (9) revenue sharing with local community ( $r = 0.10$ ); (10) extent of ICDPs ( $r = -0.23$ ); and (11) extent of conservation clubs in neighboring community ( $r = 0.15$ ).

### 3.3. Geographical variation in PA success

The overall conservation success of PAs also varied geographically. The five PAs in west Africa (Tai, Marahoué, Ankasa, Bia, and Kakum) had, on average, signif-

icantly lower conservation success scores than did the 11 PAs from central (Cross River, Korup, Dja, Dzanga Sangha, Mt. Alen, Odzala, and Lope) and east Africa (Ituri, Kibale, Mahali, and Udzungwa Mts) ( $U = 49$ ,  $p = 0.014$ , Mann–Whitney  $U$ ). There was no significant difference in scores for the central and east African PAs ( $U = 8.5$ ,  $p = 0.28$ , Mann–Whitney  $U$ ). Gross ecological, demographic, and cultural differences between the three areas help explain these results. The five west African PAs were all ecologically isolated, very accessible, and surrounded by high population densities of people with a meat-eating culture that includes nearly every vertebrate species, as well as many invertebrates. Three of these five PAs are small (306–509 km<sup>2</sup>), one is moderate (1010 km<sup>2</sup>), and only one is large (5100 km<sup>2</sup>). These conditions predicate against conservation success. The one large west African PA (Tai) had a substantially higher success score (equivalent to those of central and east Africa) than did the 4 smaller west African PAs and was exceptional in having had very significant NGO technical and financial assistance for nearly two decades.

Although the same meat-eating culture predominates in central Africa, the seven PAs in this region were generally much larger, relatively inaccessible, had greater ecological continuity, and were surrounded by low human population densities. Except for the meat-eating culture, all of these conditions favor conservation.

East Africa, except for Ituri (Okapi Wildlife Refuge), differs from central and west Africa primarily in traditions of meat eating. Three of the 4 east African PAs had conditions that were not particularly conducive to conservation, such as a relatively high degree of ecological isolation, ready accessibility, and high human population densities surrounding them. They did, nonetheless, have high conservation success scores because the people living around these PAs were much more selective in the wildlife they ate (far fewer species and usually excluded primates from diet) and they consumed much less bushmeat than cultures in west and central Africa. The Ituri differs in being very large (13,500 km<sup>2</sup>) with extensive ecological continuity beyond its boundaries and in having relatively low human population densities and poor accessibility. It more closely fits the pattern of central African PAs.

In addition to the problems outlined above, respondents indicated that there was a relatively poor commitment to conservation in general and PAs in particular by the governments of west and central Africa, a reluctance to enforce their own laws regarding natural resources, and a high incidence of corruption. Indeed, these same problems occurred in east Africa as well, but seemed to be less pronounced. In spite of these problems, the remnant forests of west Africa still have biodiversity attributes worth conserving, particularly the avifauna, invertebrates, and flora (Ghana Wildlife Department,

University of Cape Coast, and Conservation International, 1997; Oates, 2002).

### 3.4. Operating costs

A preliminary cost analysis was performed for 8 of the 16 PAs. Reliable budget figures or estimates were only available for Dja, Dzanga Sangha, Kibale, Mt. Alen, Odzala, Ituri (Okapi), Tai, and Udzungwa Mts. (Table 7). Annual budgets included both recurrent costs and capital development and improvements for each PA. They did not include any costs for the national agency (i.e. parastatal or ministerial headquarters) responsible for country-wide PA administration (see Struhsaker, 2001 for details). There was a highly significant negative correlation between PA size and costs per unit area ( $r = -0.85$ ,  $p = 0.007$ , Fig. 2). PA size accounted for 73% of the variation in costs per km<sup>2</sup> (see also James et al., 1999). Although numerous other variables affect PA costs (Struhsaker, 2001), large PAs are generally more cost effective per unit area than smaller ones. The cost per km<sup>2</sup> of operating an African forest PA varied between \$23 and \$208. Respondents considered most of the PAs to be under funded. Doubling the preceding estimates raises these costs to about \$50 to \$400 per km<sup>2</sup>, which remain 2.7- to 22-fold lower than costs of PAs in developed nations (James et al., 2001). Clearly, investment in African forest PAs is an extremely cost effective way of conserving biodiversity.

## 4. Recommendations

This study identifies many of the problems confronting Africa's forest PAs and suggests ways in which these PAs can become more effective in conservation (see Struhsaker, 2001 and web site given earlier for detailed recommendations). There is a need for more biological monitoring and research programs that cover much greater proportions of the PAs in order to provide the

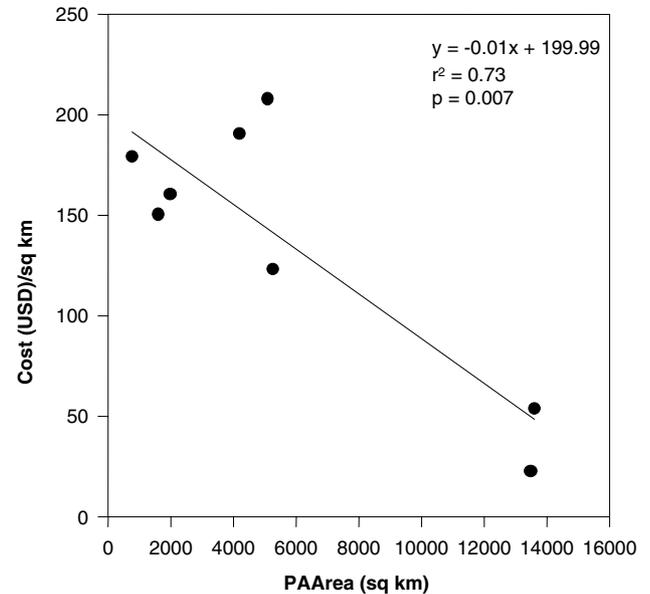


Fig. 2. Recurrent, capital development and improvement costs in US dollars per square km. versus protected area size (see Table 7 for details).

quantitative data needed to evaluate the success of the PAs, the problems they face, and the effectiveness of management strategies being applied. All respondents agreed that law enforcement is critical to PA success and that it must and can be improved in all of these PAs at relatively little cost.

A positive attitude towards the PAs by the neighboring community was the strongest correlate of PA success, but it remains unclear how this attitude is developed. Contrary to expectations, none of the community outreach strategies that are expected to influence public attitude through education and financial benefits were correlated with PA success. This lack of correlation may be due to several variables, including a time-lag effect, inappropriate methods, insufficient investment in the strategy, and a swamping effect of other, more influential factors that affect PA success.

Table 7  
PA operating costs in relation to size

Protected area	Country	Size (km <sup>2</sup> )	Annual budget <sup>a</sup>	Budget year	Cost/km <sup>2a</sup>	Source
Dja	Cameroon	5260	\$646,252	Avg. 1997–1999	\$122.86	Dr. Conrad Aveling
Dzanga Sangha	Central African Republic	4200	\$800,000	1998	\$190.48	Estimate from Blom (1996)
Ituri, Okapi Wildlife Refuge	Democratic Republic of Congo	13500	\$305,600 <sup>b</sup>	2000	\$22.64	Estimate from Dr. Teresa Hart
Kibale	Uganda	766	\$137,130	2000–01	\$179	Kibale N.P. Accountant
Mt. Alen	Equatorial Guinea	1600	\$240,464	Avg. 1997–1999	\$150.29	Dr. Conrad Aveling
Odzala	Republique du Congo	13600	\$729,773	Avg. 1997–1999	\$53.66	Dr. Conrad Aveling
Tai	Cote d'Ivoire	5100 <sup>c</sup>	\$1,060,000	1988–89	\$207.84	WCMC
Udzungwa Mts.	Tanzania	1990	\$319,487	1998–1999	\$160.54	Udzungwa Warden, Ami Seki

<sup>a</sup> Budgets include recurrent costs and capital investment.

<sup>b</sup> Budget is an average over 5 years.

<sup>c</sup> 5100 km<sup>2</sup> includes 4350 in park and 750 in resource reserve.

For example, the lack of correlation between PA success and the presence of conservation education programs may reflect the very long time-lag between the initiation of these programs and the consequent changes in behavior that have positive affects on PAs. Alternatively, the positive effects of conservation education may have been swamped by the negative effects of more influential variables on the PAs, such as human population size. It is also unclear why development (ICDPs) and employment benefits do not seem to enhance public attitude toward PAs. These results are, however, consistent with those of Wells et al. (1999) in Indonesia and others elsewhere (e.g., Kramer et al., 1997) who concluded that ICDPs were ineffective at conserving biodiversity and PAs because of inappropriate methods (design and implementation). Clearly, there is a need for more research that advances our understanding of what strategies most effectively shape positive public attitude towards PAs.

With few exceptions, PAs were under funded. It was equally apparent, however, that money alone would not solve the problems. All respondents agreed that strong commitment to PA protection by the government at all levels and by PA staff was of paramount importance.

There is rarely a single approach that solves the problems of any PA. Instead, it is useful to think of the problems and possible solutions in terms of the temporal scale involved and whether or not they deal with proximate or ultimate issues (Struhsaker, 2002). Proximate issues are usually addressed by short and medium-term strategies. Our results suggest that increasing the effectiveness of law enforcement with greater technical and financial support is the single most important short-term strategy. Medium-term strategies include: improving the morale and quality of PA staff; establishing adequate, secure, long-term funding for the PA through trust funds; developing appropriate NGO involvement; increasing the size of PAs through boundary extensions; generating greater commitment to the PA by all levels of government such as through contingencies on aid; establishing research and monitoring programs; reducing, if not eliminating, immigration to the vicinity of PAs; limiting and regulating access to PAs; and developing more appropriate and effective ICDPs that focus on conservation rather than economic activities that increase pressures on the PA.

Ultimate causal factors are generally much more complex and difficult to resolve, in part because they involve long-term strategies. Our study identifies two ultimate factors that warrant priority attention. These are: (1) attitudes of the neighboring community towards the PAs; and (2) human population growth. As pointed out earlier, there is a need to improve strategies that address these problems. How best can human attitudes, value systems and behavior be influenced to the

benefit of the PAs? What kinds of educational programs, technical and financial assistance, and other incentives (e.g., contingencies on bilateral aid) will help most in reducing human population growth to the benefit of the PAs and human living standards? Unless these ultimate factors are dealt with, the future welfare of Africa's PAs and human population are problematic at best.

Finally, we suggest that improving the status of Africa's forest PAs will depend to a very large extent on long-term international assistance that includes contingencies mandating realistic performance standards.

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