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An estimate of the costs of an effective system of protected areas in the Niger Delta – Congo Basin Forest Region

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Abstract. This paper presents an analysis of the costs of implementing a biodiversity conservation vision for the Niger Delta – Congo Basin Forest Region, a region covering the forests from Nigeria across Cameroon, Equatorial Guinea (EG), Gabon, Central African Republic (CAR), Congo and the Democratic Republic of Congo (DRC), based on an effectively managed and representative protected area network. The Niger Delta – Congo Basin Forest Region has an existing protected area system of about 135,000 km^2. A system of effectively managed protected areas that would maintain a substantial part of the biodiversity would require an additional 76,000 km^2 to be gazetted and an investment for the total system of over \$1 billion (10^9). After this initial 10-year investment an estimated \$87 million a year would be sufficient to maintain this system. Overall, current donor expenditure in the present network is probably less than \$15 million per year, so over \$800 million dollars will have to be found elsewhere. If the international community values the biodiversity of the Niger Delta – Congo Basin Forest Region, it is going to have to cover the cost of maintaining this biodiversity.

Introduction

In April of 2000 an expert workshop took place in Libreville, Gabon, to assess the biological priorities for conservation in the Niger Delta – Congo Basin Forest Region (WWF 2001; Kamdem-Toham et al. 2003). This workshop resulted in a biodiversity conservation vision for the Niger Delta – Congo Basin Forest Region, a region covering the forests from Nigeria across Cameroon, Equatorial Guinea (EG), Gabon, Central African Republic (CAR), Congo and the Democratic Republic of Congo (DRC) to the bottom of the Ruwenzorie and Virunga mountains in DRC. This area encompasses the entire forest of the Congo Basin, as well as several smaller river drainage systems. To assess proper representation the workshop used the ecoregion concept. Ecoregions are relatively large areas delineated by biotic and environmental factors that regulate the structure and function of ecosystems within them. The justifications for ecoregion-based conservation are (WWF 2001):

1. Conservation planning at scales higher than specific sites will more effectively conserve the full range of biodiversity and promote persistence.
2. Many threats to biodiversity operate at the scale of ecoregions or even larger areas.

3. Coordinated regional efforts can facilitate the creation of new partnerships and alliances and can help avoid redundancy among groups working independently.
4. This approach can more accurately define an area for conservation, redemption, restoration or other management regimes compared to those primarily based on connecting sites or tailoring plans to political boundaries or agendas.
5. Ecoregion-based strategies will have greater leverage, creating more political impact and donor interest and support than initiatives focused solely on sites.

The participants, experts in the fields of taxonomy, biogeography, conservation and socioeconomy, and aware that the planet is, as Wilson (2000) put it, going through a bottleneck of species extinction, concluded that a cornerstone of biodiversity conservation is a well-managed system of protected areas (WWF 2001). This could be accomplished most efficiently by protection of priority areas identified by the experts (WWF 2001; Kamdem-Toham et al. 2003). Fortunately, in many cases these priority areas already contain gazetted protected sites. However, in reality many gazetted areas are ineffectively managed, not managed at all or managed largely by foreign assistance. A case study of the Central African Republic clearly demonstrates this problem (Blom 2001; Blom et al. 2004a). Several underlying causes, such as lack of institutional capacity, civil war and poverty, can be mentioned to account for this failure of the governments of the region to effectively manage their protected area network.

Nevertheless the fundamental problem in the management of protected areas, particularly in the developing countries of the Niger Delta – Congo Basin Forest Region, is the lack of long-term economic sustainability (Blom 2001; Wilkie et al. 2001, in preparation). Although these countries spend only a slightly smaller percentage (0.05%) of their national budgets on protected areas compared to wealthy European and North American nations (0.09%) (data from Wilkie et al. 2001), this sum is clearly insufficient to manage their national protected area systems (Blom 2001). Recently, Leakey (2000) once again called upon the world's richest nations to provide funding to the poorest nations to help conserve the world's biodiversity. However, there seems to be little willingness to pay (Wilkie et al. 2001) and the failure of the recent The Hague meeting on climate change emphasizes this even further. The under-funding of the management has seriously affected the integrity of many protected areas in the Niger Delta – Congo Basin Forest Region (Blom 2001; Wilkie et al. 2001).

Protected areas are a net cost to local and national economies (Wilkie et al. 2001), as they do not generate significant revenue, in contrast to landscapes with for example agriculture and logging (Ruitenbeek 1992; Wilkie et al., in preparation). The countries in the region already carry this economic burden and are unlikely to be able to generate substantial additional funding for protected area management from their limited national budgets (Wilkie et al. 2001).

To develop the necessary long-term economic sustainability of the protected area systems, it is essential to have a rough idea of the total cost of maintaining such a system. This paper presents some estimates based on an analysis of recurrent costs of protected area management. At the end of this paper, I also give a brief overview

Table 1. The ecoregions of the Niger Delta – Congo Basin Forest Region.

Ecoregion	Approximate size of area (in km^2; rounded off to the nearest thousand)	Approximate total size of area under protection (in km^2; rounded off to the nearest hundred with in parentheses the percentage of the ecoregion under protection)
Nigerian Lowland Forest	67000	1500 (2.3)
Niger Delta Swamp Forest	14000	0 (0)
Cross-Niger Transition Forest	20000	0 (0)
Cross-Sanaga-Bioko Coastal Forest	52000	6400 (12.3)
Atlantic Equatorial Coastal Forest	190000	26800 (14.1)
Mount Cameroon and Bioko Montane Forest	1000	0 (0)
Cameroonian Highlands Forest	38000	1500 (3.9)
Sao Tome and Principe Moist Lowland Forest	1000	0 (0)
Northwestern Congolian Lowland Forest	434000	30800 (7.1)
Western Congolian Swamp Forest	129000	0 (0)*
Eastern Congolian Swamp Forest	93000	0 (0)
Central Congolian Lowland Forest	415000	36600 (8.8)
Northeastern Congolian Lowland Forest	533000	31300 (5.9)
Central African Mangroves	30000	0 (0)
Total	*2018000*	134800 (6.7)

* Lac Tele and Likouala-aux-Herbes have been designated as a Ramsar site (4389.6 km^2), but their IUCN status is unclear; protected areas include areas in categories I–VI of IUCN (Data on size of ecoregion from Blom 2001; WWF 2001; data on protected areas modified from IUCN 1998; UN 1993; Doumenge et al. 2001; Blom 2001). This table does not take into consideration the 13 national parks currently being created in Gabon.

of additional cost estimates such as inventories, surveys, investment costs, technical assistance, national institutional capacity, training, monitoring and evaluation.

The Niger Delta – Congo Basin Forest Region

The Niger Delta – Congo Basin Forest Region is a vast area of over 2 million km^2 consisting of 14 different ecoregions and does not include the Congo side of the Rift valley (WWF 2001; Kamdem-Toham et al. 2003). Table 1 gives an overview of the ecoregions contained within the Niger Delta – Congo Basin Forest Region.

The region is globally outstanding for containing large intact blocks of lowland and swamp forest (WWF 2001). It is one of the last great wilderness areas remaining on the planet, where large mammals still dwell under natural regimes of population fluctuations and migrations. The area of forest remaining per capita is the highest in Africa (data in Wilks 1990). Species richness and endemism is high, with for example an estimated 6000 vascular plants for Gabon alone (Wilks 1990) and over 10,000 species of plants known from DRC (Sayer 1992). A sample of plant taxa studied in Gabon show that these forests are richer in plant species than those of West Africa (Wilks 1990). DRC has at least 409 species of mammals, 1086 species of birds, 80 of amphibians and 400 species of fish (Sayer 1992). Approximately 400 species of birds have been identified for the forest of CAR (Carroll 1987). Cameroon has 29 species of primates in its forests (Gartlan 1992) and Gabon 19 (Blom et al. 1992).

Overall the potential for biodiversity conservation is exceptionally good. However, this situation is changing rapidly, mostly under influence of the logging industry. Although selective logging usually does not contribute to significant habitat conversion in central Africa, it is the main driving force behind habitat degradation and fragmentation in the region. The infrastructure, which logging and other industries develop, seriously fragments the forest and provides markets, transport and access for bushmeat hunters (Wilkie et al. 1992; Wilkie and Carpenter 1999a; Auzel and Wilkie 2000). The depletion of fauna as a result of the bushmeat trade is considered the number one threat to biodiversity conservation in this part of Africa (Blom 2001; WWF 2001).

The total area under official protection represents only about 6.7% of the total area of the Niger Delta – Congo Basin Forest Region (Table 1). Even more troublesome is that only half of the ecoregions contain any protected area at all. In fact, only two ecoregions reach the suggested level of 10% gazetted (WWF 2001).

An estimate of the recurrent expenditure of an effective protected area network

I define an effective protected area network for the Niger Delta – Congo Basin Forest Region as follows:

1. A network based on protected areas, defined by IUCN (1994) as areas 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 (IUCN Categories I–VI).
2. A network that is based on representation. At least 10% of each ecoregion is gazetted as a protected area.
3. A network based on well-managed protected areas.

I consider an area ‘well-managed’ if it is effectively managed so that the area at least maintains its species assemblages and at such densities as to allow them to fulfill their ecological function, except for natural fluctuations, extinctions or additions. This defines the lower limit of effective management and by definition this means that any intervention by the manager or others must assure that viable minimum populations are maintained at densities that allow them to fulfill their ecological role. This is especially critical in multiple-use reserves, where extraction occurs. In practice it is impossible to monitor all species. Monitoring human presence as well as large mammals might, for now, be a good enough indicator for the overall ‘health’ of a particular protected area in this region (Blom 2001). However, few protected areas at present carry out any form of monitoring.

The level of threat and ease of access play an important role in maintaining biodiversity. Even simply creating roads within a protected area is likely to have negative impacts on wildlife populations (Blom et al. 2004b). Although it is clear that the level of threat and ease of access are important factors in assessing the level of funding needed for a protected area to be effectively managed, insufficient data are available at present to analyze the role any such factors play in estimating the costs of management.

Furthermore, the size of a protected area might by itself play a role. A larger protected area might need less funding than a smaller area, due to an economy of scale (Culverwell 1998; Wilkie et al. 2001). In any case, the fact remains that protected areas in central Africa that have been neglected for some time suffer important losses of their large fauna, in some cases even leading to national extinction of species (Mokombo, in Oglethorpe and Ham 1999).

Although the ecoregion is a more appropriate scale for priority setting based on biological data, it is not a practical one for the purpose of cost estimates. Conservation investments are normally directed towards countries and implemented by national institutes (Balmford et al. 2000). Furthermore, staff salary levels and overall costs of protected area management vary considerably between countries (Culverwell 1998; Blom 2000, 2001). I used the Purchasing Power Parity or PPP (Table 2) as an indicator of the relative cost of carrying out protected area management in each country. PPP values are probably the most accurate way to estimate the country correction factor needed to make comparisons between countries (Gulde and Schulze-Ghattas 1993; Heston and Summers 1995a, b, 1997; Kohler 1998). By multiplying the country correction factor (with Cameroon as the base value) with the cost in each other country, I was able to compare the results from Cameroon with the other countries.

To compare reported costs of protected area management I used the following assumption. Although the US dollar fluctuates considerably in comparison to the Central African Franc (CFA), which is used in most countries of the region, I used an average exchange rate of 600 CFA to the US dollar for the period being analyzed (Federal Reserve 2000). Unfortunately no data on PPP values are available for Equatorial Guinea. As the GDP per capita is similar between Cameroon and Equatorial Guinea (Table 2) and based on my own observations, I assumed that costs were more or less equal in the two countries. In any event, as Equatorial Guinea is a rather small country, differences in the country-correction factor used here will have little effect on the overall result for the region.

In Dzanga-Sangha, a protected area in southern CAR, approximately 46% (or 78 country-corrected \$ per km^2) of the recurrent budget is used on local salaries (data from Blom 2000). This is higher than the percentage of 35% (or 16 country-

Table 2. Purchasing Power Parity (PPP) values for the countries of the Niger Delta – Congo Basin Forest Region.

Country	GDP per capita (in US$, 1999 estimates)	PPP values (1995 estimates)	Country-correction factor
Cameroon	2000	2.25	1
Central African Republic (CAR)	1700	3.36	1.49
Congo	1530	1.24	0.55
Democratic Republic of Congo (DRC)	710	7.36	3.27
Equatorial Guinea (EG)	2000	n/a	1
Gabon	6500	1.4	0.62
Nigeria	970	1.03	0.46
Sao Tome and Principe (STP)	1100	4.48	2

GDP per capita data from CIA, 2000a–h; PPP values calculated from data from Penn World Table 1995; World Bank 2000.

corrected $ per km^2) in the Ituri, in eastern DRC (Hart, personal communication). Nouabale-Ndoki, in northern Congo, reports only 16% (or 9 country-corrected $/km^2) (Curran, personal communication), but it must be noted that this project has a heavy research component and has a relatively low level of threat due to low human population densities around the park. Lac Tele and Conkouati-Douli, both in Congo, report 61% (or 15 country-corrected $ per km^2) and 55% (or 13 country-corrected $ per km^2), respectively (Curran, personal communication), but this includes expatriate salaries inflating the percentages. Expatriate salaries are usually paid in dollars or euros and like imported goods and services are probably not much affected by varying cost in the different countries, in contrast to the local salaries. Based on the above-mentioned percentages I assumed that imported goods and services, including expatriate salaries, made up about half of the recurrent costs and as such were excluded from the price differential correction. Therefore, I applied the country correction factor (Table 2) to 50% of the proposed recurrent expenditure to estimate proposed country-corrected recurrent expenditure per year.

Table 3 provides data on running costs for those protected areas for which information on the costs of management were available. These values represent estimated actual running costs, with the exception of protected areas in Cameroon where budget proposals were used instead. Interesting is the fact that Nouabale-Ndoki and Dzanga-Sangha, which together with Lac Lobeke form the Sangha trinational, have both recurrent expenditures for management that are higher than Culverwell's (1998) estimates for Lac Lobeke. Surprising also is his very low estimate for Dja, an area suffering heavy poaching pressure. Boumba-Bek and Nki have similar estimated costs per km^2, but they do not suffer high hunting pressures and are relatively isolated. Overall Culverwell's estimates seem to be low for effective management, but rather present a minimum management option. Two other estimates carried out by Wilkie and colleagues were typically 2–4 times higher than Culverwell's (Wilkie et al. 2001). Given the fact that in Dzanga-Sangha the amount mentioned is considered too low for effective management, the average amount of about 58 $ per km^2 based on the Cameroon cost base should be con-

Table 3. Proposed recurrent expenditure (estimated actual running costs, with the exception of protected areas in Cameroon where budget proposals were used) and country-corrected recurrent expenditure (with Cameroon as a basis) for a selection of protected areas in the Niger Delta – Congo Basin Forest Region (in US$).

Name	Area (in km^2)	Proposed recurrent expenditure per year and km^2	Proposed country-corrected recurrent expenditure per year and km^2
Korup[1]	1259	82	82
Campo[1]	3000	85	85
Dja[1]	5260	19	19
Douala-Edea[1]	1600	53	53
Banyang Mbo[1]	640	93	93
Boumba Bek[1]	2330	19	19
Nki[1]	1950	23	23
Lac Lobeke[1]	3764	44	44
Dzanga-Sangha[2]	4579	114	160
Lac Tele[3]	4396	38	29
Nouabale Ndoki[3]	3866	102	79
Conkouati-Douli[3]	5050	44	34
Ituri[4]	13730	14	30
Average		45	58

Data sources: [1]Cameroon: Culverwell 1998; [2]CAR: Blom 2000; [3]Congo: Curran, personal communication; [4]DRC: Hart, personal communication.

Table 4. Proposed country-corrected recurrent expenditures for a selected group of protected areas based on effective management (in US$).

Name	Area (in km^2)	Proposed recurrent expenditure per year and km^2	Proposed country-corrected recurrent expenditure per year and km^2
Korup[1]	1259	263	263
Campo[1]	3000	170	170
Dja[1]	5260	134	134
Bayang Mbo[1]	640	332	332
Monte Alen[2]	800	175	175
Lope[3]	5300	189	154
Dzanga-Sangha*[4]	4579	200	249
Dzanga-Sangha[4]	4579	175	218
Average		182	212

[1]Cameroon; [2]EG; [3]Gabon; [4]CAR; data from: Wilkie et al. (2001), except *Blom (1996).

sidered an absolute minimum management option, that would allow for a permanent presence and possibly protection of core areas.

Some estimates are also available on what would be considered appropriate levels of funding for effective management. Using the same approach in cost calculations as the previous table we present those data in Table 4.

The variation in the data in this table seems a little less extreme than in the previous one. An average of about 212 $ per km^2 could be used as a ballpark figure

Table 5. Recurrent expenditure per year and km^2 estimates for the different countries in the Niger Delta – Congo Basin Forest Region (in US$).

Country	For minimum management	For effective management
Cameroon	58	212
Central African Republic	48	177
Congo	82	299
Democratic Republic of Congo	38	138
Equatorial Guinea	58	212
Gabon	76	277
Nigeria	92	336
Sao Tome and Principe	44	159

Table 6. Estimated recurrent expenditure (in US$; rounded off to the nearest thousand) for the two options of management of the existing protected area system in the Niger Delta – Congo Basin Forest Region.

Country	Area gazetted (in km^2; rounded off to the nearest hundred)	Estimated recurrent expenditure for minimum management	Estimated recurrent expenditure for effective management
Cameroon	19500	1130000	4130000
Central African Republic	4700	227000	836000
Congo	9200	751000	2738000
Democratic Republic of Congo	67800	2577000	9359000
Equatorial Guinea	800	47000	170000
Gabon	25800	1964000	7159000
Nigeria	7000	643000	2348000
Sao Tome and Principe	0	0	0
Total	134800	7338000	26739000

for effective management. I applied these figures based on the Cameroon situation to the other countries using the same equation (Table 5).

At present only 93 $ per km^2 is spent a year in tropical countries on protected area management, but it is estimated that this should be in the order of 277 $ per km^2 (James et al. 1999). African nations, excluding South Africa, spend about 65 $ per km^2 on protected areas (Wilkie et al. 2001). Thus, estimates in this study of between 38 and 92 $ per km^2 for minimum and between 138 and 336 $ per km^2 for effective management seem on the appropriate level of scale.

When I applied these figures to the present situation of protected areas, I calculated a total cost of about $7.3 million per year to cover the recurrent expenditure for minimum management of the entire Niger Delta – Congo Basin Forest Region protected area system (Table 6). However, to manage the system effectively would cost more than three times as much, or around $26.7 million per year (Table 6).

However, these figures would just cover the recurrent expenditure of the presently existing protected area network. As previously noted the existing protected area network is not representative (i.e., $\geq$10% of each ecoregion gazetted as protected area). To extend the protected area system to have at least 10% under an

Table 7. Estimated additional area needed (in km^2; rounded off to the nearest hundred) and total recurrent expenditure (in US$; rounded off to the nearest thousand) for the two options of management of the proposed vision of a representative protected area network in the Niger Delta – Congo Basin Forest Region.

Country	Additional area to be gazetted	Total area needed	Total needed for the minimum management option	Total needed for the effective management option
Cameroon	3500	23000	1332000	4867000
Central African Republic	2400	7100	340000	1255000
Congo	13400	22600	1849000	6742000
Democratic Republic of Congo	40300	108100	4109000	14923000
Equatorial Guinea	0	800	47000	172000
Gabon	6600	32400	2464000	8981000
Nigeria	9800	16800	1541000	5628000
Sao Tome and Principe	100	100	4000	16000
Total	76100	210800	11687000	42584000

IUCN recognized category of protection would require the gazetting of an additional estimated 76,100 km^2 (Table 7). As some ecoregions expand across borders, alternative scenarios are possible by increasing the area to be gazetted in one country and diminishing it in another (WWF 2001). Furthermore, it might no longer be possible, in for example Nigeria, to attain the needed extension due to high human pressure (Oates, personal communication). Nevertheless the scenario presented gives a rough estimate associated with expanding the protected area network. This would bring the total amount of recurrent costs per year for the minimum management option to about $11.7 million and for effective management to roughly $42.6 million (Table 7).

An estimate of additional costs of an effective protected area network

Although covering the recurrent expenditure of management is vital for the survival of any protected area network, there are additional costs to be considered in the implementation of an effective protected area network in the Niger Delta – Congo Basin Forest Region. These costs can largely be summarized in the following categories, which I will discuss briefly:

Start-up costs

I refer here to the costs associated with the gazetting of new protected areas and in many cases existing protected areas. Almost every protected area needs a certain amount of infrastructure and equipment. Most prominent infrastructure investments include offices, housing, garages, bridges and roads. Equipment includes vehicles, boats, communication networks, etc. needed for initial start-up. Wilkie and colleagues (Wilkie et al. 2001) estimated that these start-up costs would be about $200 million for the existing protected area network for the Congo Basin. The proposed extension of the network by 56% would add a similar percentage or another $112 million to the initial start-up costs. This amount could presumably be spread over a 10-year period.

Replacement costs

Unfortunately the Niger Delta – Congo Basin Forest Region is one of the most war-prone regions in the world. Several protected areas have seen their infrastructure and capital equipment destroyed due to civil war (Hart and Hart 1997; Oglethorpe and Ham 1999). In some cases this has happened several times since independence. For example, some protected areas in DRC have lost all their equipment and infrastructure at least twice since independence. Even in relatively stable countries like Cameroon and Gabon, serious damage due to civil unrest has occurred. It is prudent to take these factors in consideration and budget for an additional $15.6 million every year for replacing lost capital investment, based on an average loss of half the start-up costs every 10 years (50% of the annualized start-up costs).

Technical assistance costs

The protected areas need professional managers and with a few exceptions these are not available at present within the national context. On-the-job training is essential and will take an average of 5–10 years. Meanwhile, and to assure appropriate on-the-job training, the professional managers will have to be imported. This technical assistance, which is not included in the above-calculated recurrent expenditure, will cost at least $100,000 per expert per year. Based on experience in both actual managing as well as knowledge transfer I argue for one expert for about every 2000 km^2 of protected area. This would come down to around 67 experts to run the existing protected area network with an additional 38 needed for the extension of the network. This technical assistance would cost $10.5 million for the entire network and calculating this over a 10-year period would total an additional investment of $105 million.

National institutes overhead

A protected area network needs to be coordinated and supervised at the national level. This institute in most countries of the region is one or in some cases several Ministries. The notable exception is DRC and more recently EG, where specialized institutes are in charge of most protected areas. In DRC, this institute (ICCN) has been remarkably successful given the overall state of disorder in that country. It has been one of the few organizations capable of remaining operational during the civil war in the entire country, even though opposing armies controlled large parts of the country. ICCN continued to fulfill its function as manager of the protected area network, even though an important number of its staff was killed during the recent conflicts (Hart and Hart 1997). Based on this experience, I recommend the creation of similar private or semi-private organizations to manage the protected area network in the other countries as well. Several governments in the region are considering this solution and, as mentioned above, EG has recently created such an organization to manage its protected areas. This would promote a sense of business attitude needed to improve efficiency in the management of these areas. It would also resolve the internal rivalry between Ministries with conflicting portfolios, as is the case for example in Cameroon and Gabon. Having to deal with only one institute per country would also facilitate regional collaboration and cross-boundary management. There are no estimates for the overhead cost of these national institutes. I roughly estimate the overhead at around 20% of the recurrent expenditure. At this level, technical assistance will also be needed for national and regional coordination, supervision and monitoring and evaluation. I suggest a total of 15 experts, with two for Cameroon, Congo and Gabon. For the countries with less forest I suggest one expert for both Central African Republic and Nigeria and one expert for Equatorial Guinea and Sao Tome and Principe combined. DRC, due to its immense size, may need some experts posted regionally, but a total of six seems appropriate. These experts would also help identify priority areas for gazetting following pre-defined guidelines (WWF 2001). The national institutional overhead would cost an estimated $1.5 million a year for the existing protected area network if managed at minimum levels, and $5.3 million a year if managed effectively. This would increase to $2.3 million a year for minimum and $8.5 million for effective management if the network were to be extended as proposed. The proposed technical assistance at the institutional level would cost $ 1.5 million a year for 10 years for a total of a $15 million investment.

Survey costs

If indeed the decision is made to pursue the necessary extension of the protected area to reach sufficient representation, it makes economic sense to invest first in biodiversity surveys (Balmford and Gaston 1999). Based on the results of the expert workshop, the larger areas of particular interest have already been identified, but still within these areas biodiversity surveys are needed (WWF 2001; Kamdem-Toham et al. 2003). These surveys should identify priority sites. Once identified, detailed biodiversity and socio-economic surveys need to be carried out before these data are combined with political and financial feasibility assessments leading to a final choice of areas to propose as protected areas. The possibility of using indicator groups for overall biodiversity should be developed further (Howard et al. 1998), as this would reduce overall costs. Detailed five-taxa surveys in Uganda were estimated to cost about $58 per km^2 (Balmford and Gaston 1999). Such detailed surveys might not be necessary (Howard et al. 1998), in which case surveys in the Niger Delta – Congo Basin Forest Region would cost around \$13 per km^2 based on the cost estimate for the survey for the creation of a protected area network of Gabon (White, personal communication). This recent survey carried out by Wildlife Conservation Society and World Wildlife Fund cost about \$750,000 for an area of roughly 60,000 km^2 surveyed (White, personal communication). Although labor costs in for example DRC might be substantially lower, I did not apply any country corrections here, as areas in DRC to be surveyed are isolated and the additional cost of reaching these areas will probably offset lower labor costs.

About 76,000 km^2 needs to be added to reach the goal of representation. I assume, based on the fact that the area surveyed in Gabon resulted in proposals for an area to be gazetted of about half the size (White, personal communication) that an area twice as large needs to be surveyed to make appropriate decisions on prioritizing the sites. This assumption would result in an area of 152,000 km^2 to be surveyed at an estimated cost of \$2.0 million.

Monitoring and evaluation costs

Monitoring the results of the management of the protected areas and a subsequent evaluation of those activities and making adjustments as needed has been seriously lacking in the region. Few protected areas at present have an institutionalized monitoring and evaluation system, although some progress has been made in this respect (Blom 2001; White, personal communication; Blom et al. 2004b). Culverwell (1998) estimated that in the case of Cameroon, monitoring and evaluation would cost roughly 10% of the recurrent operating costs of the protected areas. I use the same approximation here. Minimum management would result in about \$0.7 million a year to monitor and evaluate the existing protected area network and \$1.2 million if the extensions are included. Monitoring and evaluation under the improved effective management would cost \$2.7 million for the existing protected area network and \$4.2 million per year for the extended system.

Opportunity costs

Opportunity costs are defined as foregone potential revenue that could be generated by converting protected areas to alternative land-uses such as logging, mining or agriculture. Mining is only locally of importance and agriculture is considered only marginal in economic terms. However, most of the protected areas in the Niger Delta – Congo Basin Forest Region contain commercially valuable tree species and logging is likely to be the most important economic alternative for protected areas on the regional scale. Ruitenbeek (1992) used a rainforest supply price in an attempt to estimate the costs for compensating a country for conserving its rainforest. In his case study of the Korup National Park he estimated this rainforest supply price to be 1060 ECU per km^2 or about \$1155 per km^2 at the present (first half of 2003) average exchange rate of 1.09 dollar to the Euro (Infoeuro 2003). Wilkie and colleagues (Wilkie et al. 2001) estimated that for Cameroon the opportunity cost of maintaining protected areas that contain commercially valuable trees at a roughly similar amount of \$1500 km^2 per year. Even though there are serious questions about the sustainability of this industry to maintain this revenue level, I use it here as an approximation to illustrate the importance of these opportunity costs that so far have been carried entirely by national governments (Wilkie et al. 2001). As these opportunity costs are largely determined by the value of the trees and transport costs, I did not apply any country-associated corrections but applied the \$1500 per km^2 to the whole of the Niger Delta – Congo Basin Forest Region. Important variation will exist across this region, mainly based on cost of transport. Even taking only the existing protected area system into account, the nations of the region are together foregoing an estimated \$200 million per year. The extension of the system would bring this to a total of \$316 million per year. Although I am not suggesting that the national governments should be compensated for this loss in revenue, it is important to acknowledge their opportunity costs as an important contribution to biodiversity conservation.

On the other hand, a part of these opportunity costs have been and continue to be carried by local communities. Given the fact that still a large part of the rural population in this part of the world maintains a subsistence level of economy (which in some areas is largely based on barter) it is difficult to estimate the opportunity costs for the rural communities in and around protected areas. To give an indication of the scale of the opportunity costs for rural communities, I assume here that 5% of the opportunity costs are carried locally. This seems a reasonable assumption against the background of an area like Dzanga-Sangha. The annual local opportunity cost for this area would be in the order of \$315,000. The area has about 4500 inhabitants, so this would result in a per capita opportunity cost of \$70. Officially the annual minimum wage is about \$480. As a comparison, at the time of closure, September 1995, the local logging company employed 251 permanent staff with an annual payroll of just over \$200,000 (Blom 2000). The popular approach of the Integrated Conservation and Development Program (ICDP), by which rural development aid is linked to conservation objectives, addresses some of the issues related to the compensation of local opportunity costs. However, this approach might not be the most appropriate response (e.g., Oates 1995). Direct conditioned compensation might be more appropriate and cost effective (Ferraro 2000). Direct compensation can in this way be linked to verifiable conservation objectives for each community involved, such as for example the absence of illegal logging in their community. This link is often much more difficult to achieve in ICDPs. Whatever the form of ‘compensation’, the local opportunity costs need to be taken in consideration and should be an integral part of the regular running cost of any protected area.

Conclusions

In summary, for the Niger Delta – Congo Basin Forest Region to be able to maintain a minimum presence in the existing protected areas, as to assure at least some protection will require a total budget of about \$7.3 million a year. Of course this option would result in increasing conflicts with local communities, as no

Table 8. Summary of all cost estimates (in million US$) associated with implementation of the biodiversity conservation vision of an effective protected area network for the Niger Delta – Congo Basin Forest Region for the next 10 years.

Cost category	Cost/year	Total for 10 years
Recurrent expenditure	42.6	426
Start-up	31.2	312
Replacement	15.6	156
Technical assistance	10.5	105
National institutes overhead	10	100
Survey		2
Monitoring and evaluation	4.2	42
Local opportunity costs	15.8	158
Total undiscounted		1311
Total discounted*		1012

* The total discounted is the present value of the cost given by $131.1 \times 7.72 = 1012$, assuming a 5% discount rate. Thus $1.012 billion is needed now to finance $1.315 billion of expenditure.

compensation occurs. Effectiveness would deteriorate over time as no new investments are made and no technical assistance is provided. The result would be a degradation of the protected area network and would result in serious loss of biodiversity in the Niger Delta – Congo Basin Forest Region.

On the other hand, the vision for biodiversity conservation through a system of effectively managed protected areas in the Niger Delta – Congo Basin Forest Region would require over $ 1.3 billion (10^9) in the next 10 years or just over $1.0 billion ($10^9$) at present value given a discount rate of 5% (Table 8). After these initial 10 years, I assume that national capacity will be reached or close to sufficient levels. Furthermore I assume that by then all the surveys are completed and that all initial start-up investments have been made. This leaves recurrent expenditure, replacement, national institute overhead (without technical assistance), monitoring and evaluation and local opportunity costs for a total annual estimate of $87 million.

The total government spending on protected area projects in the Congo Basin (not including the nations of Nigeria and Sao Tome and Principe) in the 1990s was in the order of half a million dollars a year (data from Wilkie et al. 2001). Taking this in consideration, the total spending by the Governments of the region is unlikely to reach even a tenth of what is needed to maintain a minimum presence in the existing protected areas. Furthermore, overall donor expenditure in the present protected area network is currently less than $8 million per year (Wilkie et al. 2001, in preparation). This estimate does not include Sao Tome and Principe and Nigeria and is probably too low, but the level does not reach $15 million per year. This funding is used both for recurrent expenditure as well as most of the above-mentioned additional expenditures.

If we assume that national governments will carry the national opportunity costs and that both the national governments as well as the donor community will maintain their present level of funding, it means that still more than $800 million needed will have to be found elsewhere.

Tourism is often seen as a substantial source of revenue. Based on a case study in Dzanga-Sangha it is clear that tourism can play an important role in the local economy and could offset some of the local opportunity costs, but is unlikely to contribute sufficient revenue to offset some of the other expenses (Blom 2000). Even adding potential great earners like habituated gorillas, the revenue is unlikely to offset the initial investments and risks (Blom 2000). This led Wilkie and Carpenter (1999b) to conclude that it is unlikely that nature tourism will generate significant benefits to protected areas in the Congo Basin. On the other hand, these authors (Wilkie and Carpenter 1999c) suggest that safari hunting could offer a significant and substantial source of financing to offset some of the costs of maintaining protected areas. Even so, the conclusion is that tourism and safari hunting together are unlikely in the next 5–10 years, if ever, to generate enough revenue to finance the protected area network (Wilkie et al., in preparation). Overall user fees have the potential to generate substantial revenue for protected areas, but these fees will be far from sufficient to manage even the existing protected area system (Wilkie et al., in preparation). Thus, the simple fact remains that if the international community values the biodiversity of the Niger Delta – Congo Basin Forest Region it is going to have to pay the costs. Although an amount of about $1 billion over 10 years is a large sum, it dwarfs in comparison to the annual spending of about $260 billion on defense by the United States of America alone (World Bank 2000).

Donors might be unwilling to invest such amounts in countries that are assumed to have a relatively low or medium capacity to respond to threats to their biodiversity (Cracraft 1999) and are war-torn and politically unstable (e.g., Hart and Hart 1997; Oglethorpe and Ham 1999). I recommend that establishing environmental trust funds for individual areas, possibly in a larger national or regional framework, can help mitigate against some of these problems (see also Wilkie et al. 2001). The major advantage of environmental trust funds is that they provide a stable source of revenue and provide opportunities for greater accountability than present funding mechanisms. Furthermore, they can continue to provide funding in times of instability, while other sources of funding might not be available.

The source of capital is most likely to come from multilateral donors, especially under pressure of a potential clean development mechanism (CDM) within the Kyoto protocol, bilateral donors or private organizations (Wilkie et al. 2001, in preparation). However, the potential of private sector corporation taxation, contribution or corporate sponsoring, such as from pharmaceutical, mining, oil and forestry companies as well as airport taxes, should be further investigated.

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