Program on African Protected Areas & Conservation (PAPACO)

Wildlife monitoring practices and use in Central Africa

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Executive Summary

Monitoring is an essential part of adaptive management, and is necessary for evaluating the outcomes of conservation action. Ecological monitoring plays other roles in conservation, serving as an important communication tool for illustrating the plight of a species, demonstrating the outcomes of payment for ecosystem services schemes, and testing the success of different types of protected areas. Conversely monitoring is not a panacea; good ecological data in itself does not ensure the protection of a species.

Central Africa harbours an amazing diversity in both forest and savanna ecosystems. Over 153 protected areas have been created, covering more than 423,000 km^2, with ecological monitoring an increasingly important theme at the regional level. In the context of the increasing recognition of the value and plight of Central Africa's protected areas and the role of ecological monitoring, this project conducted a comprehensive collation of wildlife monitoring reports from Central Africa's protected areas; the goal was to evaluate the status and uses of wildlife monitoring, and identify the challenges and opportunities for improving this. A database of protected areas and their ecological monitoring information has been completed, with preliminary analyses presented in this report.

Our final sample included 121 protected areas (PAs) in six countries in Central Africa, with 205 reports on 255 individual surveys meeting the monitoring criteria we had set. We did not receive any response ("no information") from 33 PAs, with most of these in the Democratic Republic of Congo. 74 (66%) PAs had some form of monitoring and 14 confirmed "no monitoring". Equatorial Guinea boasts the most complete ecological survey coverage, followed by Gabon and the Republic of Congo, in terms of the percentage of PAs that have been surveyed.

The most frequent monitoring techniques are foot transects, followed by aerial surveys, and then reconnaissance walks. The former two usually provide density data, while the latter provides relative abundance data. By far the most frequently surveyed species is the African elephant, followed by great apes (western lowland gorilla and central chimpanzee), red duiker (species group), and red-fronted gazelle. All of these species have a wide distribution, although the gazelle appears in just one park in the scope of this survey. All apart from the gazelle are often collectively surveyed by foot transect and recces in multi-species surveys, while elephants are also the usual target species for aerial surveys. Species with more narrow ranges, including many endemic species, are far less frequently surveyed. Some wide-ranging species, notably the giant pangolin, have rarely been surveyed.

Based on the process of collating biological monitoring information and early analyses, this report offers a number of recommendations for improving the utility of biological monitoring.

This report has been accompanied by a series of factsheets on a variety monitoring techniques, providing methodological detail and an entry into specialized literature. The final database can be used as a growing tool for more data as it becomes available.

Table of contents

1. Introduction: ecological monitoring and protected area management

1.1. Ecological monitoring

Monitoring can be defined as “intermittent recording of the condition of a feature of interest to detect or measure compliance with a predetermined standard” (Hellawell (1991) cited by Legg and Nagy (2006)). In the field of conservation, the features of interest are ecological: generally habitats and populations of species or groups of species.

Uses of ecological monitoring

Management Tool

In principle at least, appropriate and timely ecological data allows protected area managers to allocate resources and choose between different types or intensities of management intervention in order to make best use of scarce conservation resources. Ecological monitoring is an essential part of adaptive management—“learning by doing”, or “the integration of design, management, and monitoring to systematically test assumptions in order to adapt and learn” (Salafsky et al., 2001). Ecological monitoring is necessary for evaluating the outcomes of conservation action and thereby “closing the adaptive management circle” (Figure 1).

Figure 1 : The adaptive management cycle, as presented by the Conservation Measures Partnership (CMP, 2013).

This role of ecological monitoring in adaptive management has meant that it has become a standard part of almost all protected area planning and management "best practices" (Thomas and Middleton, 2003; CMP, 2013) and is enshrined in the strategies of governments, donors and conservation NGOs (Stem et al., 2005). The monitoring objectives and application of the results are explicit to park management decisions.

Strategic Tool

Apart from adaptive management, ecological monitoring of protected areas has other roles to play in conservation at particular sites:

The results of monitoring may be used as a communication tool to demonstrate success of conservation actions or conversely to illustrate the plight of species or habitats in order to raise funds or to build public or political will for conservation actions. Ecological monitoring is necessary and required for demonstrating outcomes in payments for ecosystem services (PES) programmes where payments for conservation are conditioned on results (Wunder, 2007), be that under biodiversity offset schemes (BBOP, 2012), Reducing Emissions from Deforestation and Degradation (REDD) programmes or otherwise. Conversely, ecological monitoring can help prove (and perhaps quantify) liability for damage in the case of environmental impacts, for example due to pollution. Lastly, by providing objective reference points about the state of conservation targets, ecological monitoring can help guard against the shifting baseline syndrome that is as prevalent on land as in the seas (Papworth et al., 2009).

At a broader scale, as the number of protected areas and investment in conservation increases, there has been a growing call for conservationists to justify the effectiveness of their actions through robust empirical comparisons of the success of different types of protected area with that of other management approaches (Ferraro and Pattanayak, 2006; Miteva et al., 2012). Such evaluations are increasingly required by donors to justify investment in protected areas. Reliable ecological monitoring data is the necessary basis for such evaluations of conservation effectiveness.

Since protected area networks are frequently designed to be the "strongholds" for threatened species, ecological monitoring data from protected areas frequently has a high weighting in evaluations of extinction risk under the IUCN red list criteria. For example in Central Africa, data showing population declines within protected areas formed a core part of the argument for listing western lowland gorillas as Critically Endangered (Walsh et al., 2008). Since IUCN red list classifications are increasingly used to evaluate the level of environmental mitigation required by industrial and other development, for example by the International Finance Corportation (IFC) and the Equator Banks, the quality of protected area ecological monitoring data can have practical impacts well beyond the borders of individual protected areas.

1.1. Protected area ecological monitoring in Central Africa

Central Africa harbours an amazing diversity of wildlife in both forest and savanna ecosystems. Flagship species include both species of gorilla, three sub-species of chimpanzee, the bonobo, forest elephants and the okapi.

In response to the threats to these species and the rest of the region's diversity, a network of more than 153 protected areas covering more than 423,000 km2 has been created in Central Africa. While a few are among the oldest protected areas in Africa, many of these protected areas have been created in the past 20 years.

The institutional context

Ecological monitoring for protected areas is increasingly being adopted, in principle at least, across Central Africa. At a regional level, monitoring (in the sense of "understanding the state of the resource") is a key theme of the Congo Basin Forest Partnership (CBFP) and of the COMIFAC Plan de Convergence. This has been put into practice by CBFP partners in different ways. For example, "Institutionalising Natural Resource Monitoring" has been an a key "Intermediate Result" for the Central African Regional Programme for the Environment (CARPE) programme and whose Regional Development Cooperation Strategy includes as an indicator "Number of biodiversity surveys meeting international standards for "best practices", implemented by local institutions, used for adaptive management of macrozone(s) or landscape(s)".

Institutionally, this focus has been operationalised by the creation of the Observatoire des Forêts d'Afrique Centrale (OFAC) and its sister organisation Observatoire Satellitaire des Forêts d'Afrique Centrale (OSFAC) both organs of COMIFAC which are mandated to collate and disseminate data on the condition of forests, including protected areas. Both have received significant and long-lasting institutional support for collecting, collating and disseminating ecological and socio-economic data from many different international donors.

More recently, the desire to understand the effectiveness of investments in protected areas has recently led to several regional initiatives aiming to collate data from protected area monitoring (and other sources) and make it available to decision makers. This includes the "Decision Support System" proposed by the Réseau des Aires Protégées d'Afrique Centrale (RAPAC), the "Protected Areas Observatory" planned by the Biodiversity and Protected Areas Management Programme (BIOPAMA) consortium.

1.2. Critiques of ecological monitoring

Despite the widespread acceptance that adaptive management is a best practice for conservation, the extent to which ecological monitoring should really be a priority for protected area management remains controversial, for three main reasons:

1. Expense:

implementing ecological monitoring that is statistically reliable frequently requires considerable personnel, logistics and time. Deciding how much to spend on monitoring is therefore always a trade off: money could be better spent on more intensive protection, on other management interventions, on surveys of as-yet non-protected areas, or on something completely different. Given the pressing nature of many threats, and levels of funding that have remained inadequate despite major donor contributions, the trade-off between monitoring and protection is the most controversial.

2. Data quality:

much ecological monitoring may not in fact be able to reliably detect ecological changes over time-scales useful for management. This frequently occurs due to poorly-planned or executed data collection (Lindenmayer and Likens, 2010; Legg and Nagy, 2006), but even where statistical rigour is applied, data quality may be low as a result of the real-world challenges of detecting elusive species in variable and usually difficult field conditions.

3. Effective links with management:

monitoring is clearly not a panacea for effective management and examples where species have been lost or have suffered major declines despite intensive monitoring abound: intensive monitoring of the northern white rhino in Garamba National Park in Democratic Republic of Congo (DRC) was unable to prevent their elimination and the near extinction in the wild[1] of this subspecies in the face of war and insecurity (Emslie, 2012), while repeated surveys of western black rhino in Cameroon failed to help over come the political apathy responsible for its demise (Lagrot et al., 2007).

The choice about whether or not to invest in ecological monitoring is complex and depends on many different factors. Many different authors have tried to codify the different decisions about monitoring that protected area managers need to make and the factors that should influence them either in general (see for example Field et al., 2005; Field et al., 2007; McDonald-Madden et al., 2010; Nichols and Williams, 2006; Nichols, 2012; Tucker et al., 2005) or for particular species or species groups (for example Hedges, 2012; Kühl et al., 2008). In is unclear however, to what extent 1) these academic discussions really influence monitoring practice on the ground in protected areas and 2) whether monitoring results are indeed used to influence management. This project aims take the first step to answering these questions by compiling all records of ecological monitoring and documenting how ecological monitoring is conducted in practice in Central Africa.

1.3. Objectives of this project

In this context of increasing recognition of the value and plight of Central African protected areas, along with considerable institutional and financial investment in monitoring, this project aims to conduct an initial evaluation to:

1. describe the current state of ecological monitoring practices for Central African protected areas, in terms of methods, frequency and species targeted, focusing on wildlife;
2. identify where and how protected area ecological monitoring is used to inform management practice;
3. identify the major challenges and opportunities for improving ecological monitoring and the use of ecological monitoring data in Central Africa.

Although some discussion of methodological issues is necessary to set the existing practice into context, this report does not aim to be a detailed methodological guide or critique for any specific method: these exist in specialised method-specific or species-specific literature2. This project includes:

- a set of seven factsheets that describe the most commonly-used monitoring techniques for several high-priority conservation targets in Central Africa. These factsheets provide more methodological detail and provide an entry into the specialised literature.
- a database of biological monitoring in Central Africa
- this report with preliminary analysis on where, how and what has been monitored in Central Africa, which will be followed by a more in-depth report that will also consider use of monitoring as a park management tool and recommendations.

2. Methods

2.1. Survey Scope

See supplementary document on methods with greater detail on definitions and data collection methods. We attempted a systematic compilation of wildlife surveys conducted in Central African protected areas based on the following criteria:

- wildlife surveys that aimed to measure abundance, relative abundance, density or distribution of predetermined species, that specifically aim to detect population changes over time or that have subsequently been used for that purpose. Baseline surveys with no repeat were included if an only if they were clearly designed to serve as a basis for a monitoring programme;
- surveys from Cameroon, Central African Republic, Democratic Republic of Congo, the continental portion of Equatorial Guinea, Gabon and Republic of Congo;
- surveys of terrestrial and arboreal large- and medium-sized vertebrate species only (i.e. not marine or freshwater species), as protecting these species is a major objective for most protected areas in central Africa and there is sufficiently widespread monitoring that an evaluation is feasible and relevant.;
- surveys from within protected areas in IUCN categories I–VI, that are recognized in either national forest atlases, or in the World Database of Protected Areas ;

- surveys conducted prior to protected area creation were included only if the protected area was in fact created and the survey was subsequently used as a basis for monitoring;
- surveys conducted at a park-wide scale. Localised studies, focusing on less than 10% of a protected area were not included, except where they were either 1) a stratum of a wider survey, 2) specifically designed to provide information at the scale of the protected area or 3) where the area surveyed represents the majority of the occurrence of a target species.
- forest-cover monitoring was not included as this is a fast-moving field that is increasingly being conducted at the scale of entire countries, regions or biomes rather than at the scale of individual protected areas (for example see Hansen et al. 2013).

2.2. Data collection methods

Protected area details

We established a list of protected areas in IUCN categories I–VI using the World Database on Protected Areas (WDPA) (IUCN and UNEP, 2013) and the most recent versions of each country's interactive forest atlas (WRI, 2010a; WRI, 2010b; WRI, 2011a; WRI, 2011b)[2], supplemented with local knowledge for recently created protected areas. We obtained shapefiles and compiled information on dates of protected area establishment and surface area from the same sources.

The final list of protected areas included in this study is presented in Appendix I

Obtaining monitoring reports

We obtained documents through: 1) direct contacts with known monitoring specialists in the region, 2) direct contacts and emails sent to protected area managers (with telephone follow-up where possible), 3) an online search, both with a generic search engine and on specific sites known to hold such reports, notably the CARPE Information Management Tool[3] and the African elephant database[4] and 4) combing the reference lists of available protected area management plans, monitoring reports and species-specific reviews and action plans. We made use of several regional training courses organised at Wildlife Conservation Society (WCS)' regional training centre in Lopé National Park to increase the number of direct contacts with protected area managers.

The complete list of reports used is presented in the bibliography to this report. We welcome any corrections, updates and additions.

Categorisation

We categorised surveys according to the following variables:

Date: we recorded the year of the survey. For surveys lasting more than a year, we report the last year of the survey.

Spatial scope: park-wide or stratum.

Target species: species that were explicitly stated as survey targets and around which the survey was designed. Most surveys report observations of many different species, but were in fact only designed for a small subset.

Survey method: we categorized both by physical method (ground transects, aerial survey etc), by type of observation (direct or indirect) and by data collection method (distance sampling, fixed-with transects/recces, sample vs complete counts).

Funder: we recorded the principal and secondary funders of surveys and categorised them by type: national government, bilateral aid, multilateral aid, private sector, private funds.

Data output: the type of data produced (density, encounter rate, total count) and the level of uncertainty in the estimate.

We did not systematically record information on the costs of surveys; few reports provide such information and non-standard accounting practices mean that even when costs are reported it is difficult to systematically compare one organisation or site with another.

We tabulated our findings in a database linked to a shapefile of protected areas.

As mentioned above, a detailed evaluation of methods and data quality is far beyond the scope of this report, and we did not attempt to do so. However, when reading the reports, we evaluated them according to a number of criteria based on monitoring (and more generally basic scientific) best practice that are important for judging the utility and efficiency of monitoring:

Power analysis: was survey design based on an evaluation of the required precision or amount of change to be detected?

Treatment of uncertainties: did the report clearly present statistical uncertainties in the results in a standard format (eg standard error, coefficient of variation)?

Causality: were the monitoring activities designed to identify the causes of any changes identified?

Justification of conclusions: were conclusions that were drawn (notably regards changes, or lack of changes) clearly linked to and justified by the results presented?

Whilst reading reports, we also made general notes about report clarity and quality.

3. Results

3.1. Number and distribution of surveys

Our final sample included 121 protected areas in six countries (Appendix I). We obtained 205 technical reports and articles (see Bibliography) reporting results from 255 individual surveys meeting our criteria in protected areas across Central Africa.

For 33 protected areas we were unable to confirm whether or not any ecological monitoring has taken place (Table 1). We believe it is most likely there has been no monitoring in the majority of these 34 protected areas, but cannot confirm this. For the 88 protected areas where we were able to confirm whether or not monitoring took place, 74 had at least a baseline survey completed and 14 protected areas had no monitoring at all.

Overall, two-thirds (66%) of the combined area of the 121 protected areas had at least some monitoring (Table 2). The proportion is much higher in Gabon, Republic of Congo and Equatorial Guinea where the vast majority (99-100%) of the protected area estate has been surveyed at least once. However, in Democratic Republic of Congo only about half (49%) of its large protected area estate has been surveyed at least once; this heavily influences the overall average.

Table 1 : Number of protected areas with and without monitoring.

Country	Number of protected areas with:			
	Some monitoring	No monitoring	No information	Total
Cameroun	18	5	4	**27**
Central African Rep	8	0	4	**12**
Dem Republic of Congo	15	4	23	**42**
Equatorial Guinea	8	0	0	**8**
Gabon	15	3	0	**18**
Rep of Congo	10	2	2	**14**
Total	**74**	**14**	**33**	**121**

Table 2 : Area of protected areas with and without monitoring or with no information.

Country	Approx area (km^2) of protected area with:			
	Some monitoring	No monitoring	No information	Total
Cameroun	34,808	1,921	2,188	**38,916**
Central African Rep	39,910	0	16,146	**56,056**
Dem Republic of Congo	120,412	58,665	66,717	**245,793**
Equatorial Guinea	4,258	0	0	**4,258**
Gabon	39,755	382	0	**40,137**
Rep of Congo	41,885	299	518	**42,702**
Total	**281,028**	**61,266**	**85,569**	**427,863**

A few of the 74 protected areas that have been surveyed have been surveyed on many occasions, but almost half have been surveyed only once (Figure 2). However, many of the protected areas that have been surveyed repeatedly are large; despite there being many more protected areas that have been surveyed just once (=32 PAs), this cover a similar surface area to protected areas surveyed several times that are, however, fewer in number. protected areas that have been surveyed once (=32 PAs), cover a similar total surface area to those that have been surveyed three (=9 PAs) or four (=7 PAs) times (Figure 2).

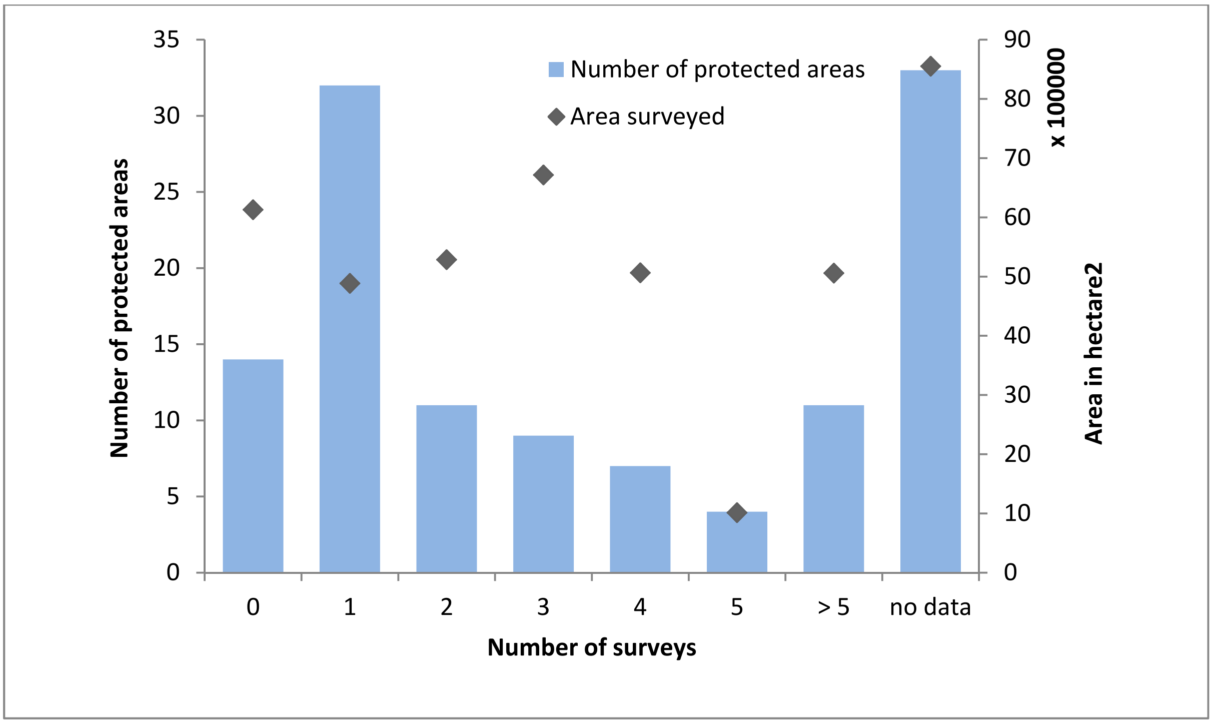

Figure 2 : Number of surveys per protected area and by area surveyed (n=255 surveys across 121 protected areas)

3.2. Monitoring technique

Ground-based transect surveying[1] is the most frequently used survey technique, which in the most part has provided density information (Figure 3). This is followed by aerial surveys, which also typically provides density information. Recces (ground-based reconnaissance walks) in their nature are restricted to providing relative abundance data, but have also been used for presence-absence information. The category "Other" is composed of questionnaires, complete foot counts, and calling stations.

[1] composed of three categories based on the survey design; whether DISTANCE program was used to design the transect location and for analysis, and whether perpendicular distance of a sign is measured from the transect to calculate sign density.

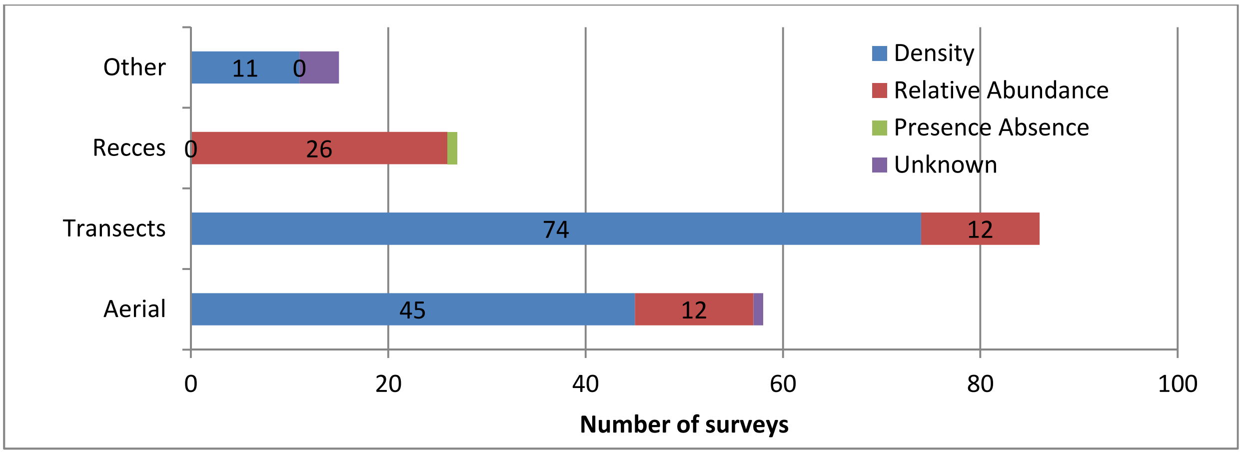

Figure 3 : Number of surveys by grouped survey techniques and the data output

3.3. What has been monitored

By far the most frequently surveyed species is the African Elephant (*Loxodonta africana*). This is followed by the wide-spread great ape sub-species (*Gorilla gorilla gorilla* and *Pan troglodytes troglodytes*), red duiker (a group of medium-sized duiker species), and red-fronted gazelle (*Eudorcas rufifrons*). All of these apart from the red-fronted gazelle, are frequently surveyed together in ground-based transect surveys and recces. They are also wide-ranging within our survey scope, and found in all six of the six countries included in this study. The red-fronted gazelle distribution range is a broad thin band from west Africa, reaching to the north-western limits of Cameroon where it has been surveyed almost annually in Waza National Park since 1960 (Scholte et al, 2007). See Annex II for full list of species with number of survey data.

The general trend then is that species with a broad distribution have been more frequently surveyed as they are included in multi-species surveys repeated in a large number of protected areas, while those with restricted range (including endemic species and sub-species) have been less often surveyed as they are found in a small number of protected areas. Some wide-ranging species have been rarely surveyed simply due to difficulty of surveying these species. The giant pangolin (*Smutsia gigantean*) is rare and highly cryptic, while some duiker species can only be distinguished from genetic analysis of the dung if this is the observational sign.

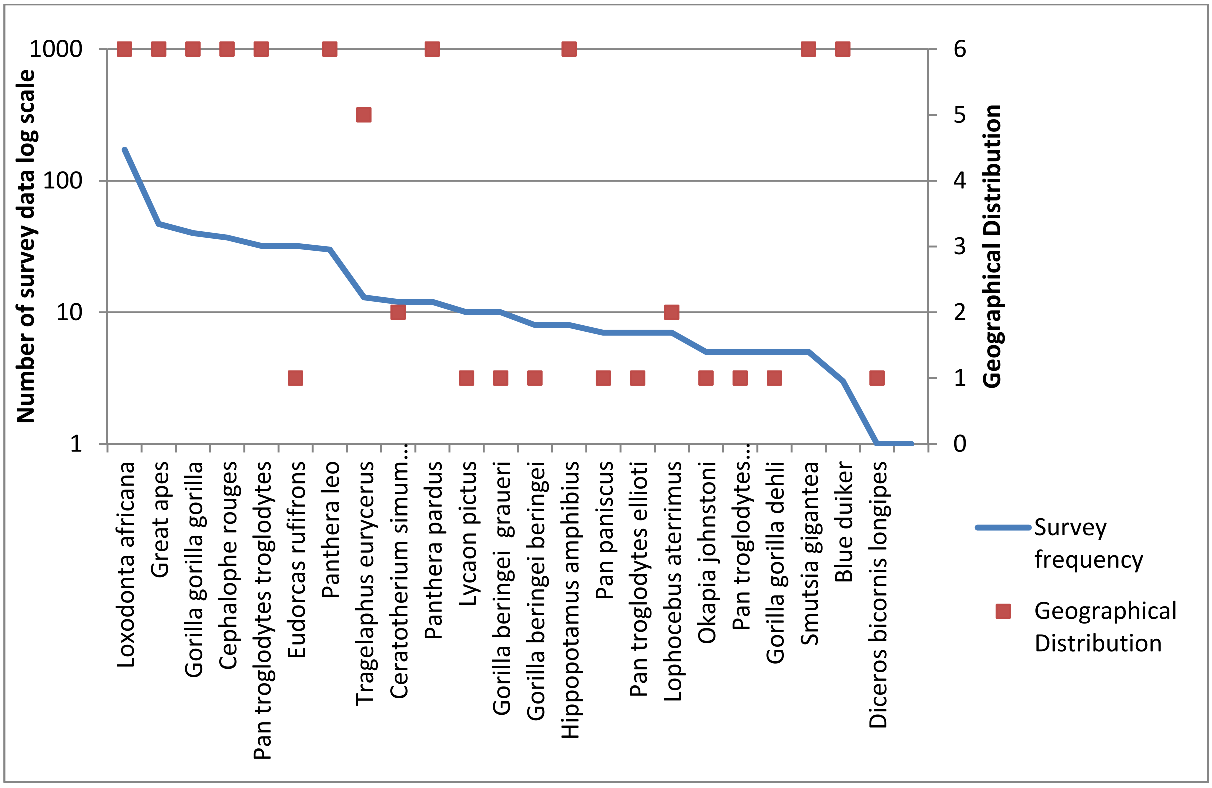

Figure 4 : number of survey data by species, sub-species or species groups, and number of countries in survey scope where they are found

3.4. Uses of monitoring data for management

There are few examples of monitoring for decisions at a site level, with examples presented in the accompanying set of factsheets.

We were, however, able to find several examples where explicit and scientifically strongly-supported monitoring results were not used for management. For example, in Cameroon surveys by Croes et al. (2011) showed that the lion population in the Benoué complex was greatly below the potential level given prey abundance (itself significantly depleted) and that existing quotas for trophy hunting greatly exceeded levels shown to be sustainable. Despite high-quality data, no change in hunting quota (either in number or in age) has yet been implemented.

4. Conclusions and recommendations

The results presented in this preliminary report here show that:

- Some form of monitoring takes place in the majority (66%) of central African protected areas (PAs). The proportion of surface area that has been surveyed once, twice, three or four times is roughly similar (between 11-16%). The one-fifth of PA surface area in the Democratic Republic of Congo (DRC) with “no monitoring” (does not include PAs with “no information”) is composed of two huge PAs, Bili-Uere Hunting Reserve and Sankuru Natural Reserve, and two smaller sized PAs. Most of the unknown monitoring status can be attributed to the DRC, followed by Central African Republic.

- Most monitoring is focused on wide-ranging species that are also collectively surveyed, such as elephants, apes and some red duikers. This has provides valuable data on the regional population status and trends of these species, as seen in the recent meta-analysis of forest elephants that showed a 63% population loss and 30% range loss from 2002-2011[2].

Based on the process of collating biological monitoring information and early analyses, here we offer a number of recommendations for improving the utility of biological monitoring.

Recommendation 1 : Experiment with new methods, but ensure that future surveys remain compatible with existing data.

New methods such as genetics, camera-trapping and acoustic surveys all have potential to greatly increase the effectiveness and efficiency of protected area ecological monitoring in central Africa. However, there is a risk that new techniques, especially those that produce marketable images, are adopted rapidly to the exclusion of more traditional (and perhaps less “sexy”) techniques.

Where new methods are adopted, they should either be used to enhance existing datasets (for example by providing data on the ratio of gorilla to chimpanzee nests) or should be carefully calibrated against existing methods to ensure comparability with older data sets.

Recommendation 2 : Recognise the importance of good management of surveys

For good reasons, donors tend to want to reduce what are seen as unnecessary “overhead” costs, especially salaries for non-field staff. However, as this study has shown, logistical delays can be a major factor increasing the cost of surveys. In such situations, money spent on effective managers may in the end result in net cost savings.

Donors and managers could help survey organisers improve performance (and justify management costs) by requiring that survey implementors set targets for effort during surveys according to standardised categories and then report actual effort applied. While recognising that every protected area has different logistical challenges, and that unforeseeable and unavoidable logisitcal issues will occur, standardised reporting of survey efficiency could be used to benchmark the performance of different organisations or of different survey teams within organisations (Sutherland and Peel, 2010). An example set of categories for standardised survey effort reporting is presented in Table 3. Tracking use of human resources is a management best practice and good managers will already be using a system like this, so requiring it would not be a major additional administrative burden.

Table 3 : Possible categories for planning and reporting on effort. Reporting units would be person-days or team-days as appropriate.

Category	Definition

[2] Maisels et al. (2013) Devastating decline of the forest elephants in Central Africa. PLOS ONE. Vol 8, Issue 3

Primary data collection	Days spent implementing the principal data collection method of the survey. For example days collecting transect data.
Secondary data collection	Days collecting supporting data. Example could include days spent conducting a local decay-rate survey or recces conducted between transects.
Field logistics	Planned days spent conducting or preparing for missions but where no data is collected.
Data analysis and reporting	Days spent on data entry, data analysis and on reporting.
Planned downtime	Planned rest and recuperation time, time-in-lieu, holidays.
Unplanned downtime	Days where no data collection, planned logistics or data analysis is conducted but which are attributed to the survey. For example, days waiting due to lack of material, transport issues, personnel issues etc where staff cannot be assigned to other duties or budgets.

Recommendation 3: Ensure that pilot surveys are cost-effective

In the best case, pilot surveys can provide estimates of encounter rates and of variation in encounter rates that can help significantly improve survey precision and cost-effectiveness by identifying required sampling effort and stratification possibilities. However, in some cases, especially large remote areas the cost of pilot surveys can approach that of a complete survey. Where pilot surveys are proposed, they must be clearly justified; this should include an assessment of cost-effectiveness.

Recommendation 4 : Create incentives for increasing the quality and dissemination of ecological monitoring results.

Although several Central African nationals have produced journal articles based on ecological monitoring surveys (e.g. Omari et al., 2009; Inogwabini et al., 2000; Forboseh et al., 2007; Inogwabini et al., 2007), it is unrealistic to expect every survey to be of a uniqueness sufficient to warrant publication in a high quality international peer-reviewed journal. Unfortunately there are an increasing number of “predatory” online journals with limited or no peer-review that will publish poor quality and even plagiarised work. This is not a theoretical issue: we came across a number of instances of potential plagiarism based on wildlife surveys of protected areas during the course of this review.

Establishing a regional peer-reviewed, open access (and probably online-only) journal could help bridge the gap between the major international journals and the “predatory” ones. This could perhaps be similar to Pachyderm, the journal of the African Elephant Specialist Group or Koedoe, the journal of the South Africa National Parks Service or some of the specialist ornithological journals like Malimbe. An outlet such as this would have the benefits of 1) provide an incentive for surveys to be written up to a quality above the “bare-minimum” required for donors, 2) provide much needed feedback to monitoring specialists and 3) improve the transparency and dissemination of monitoring results.

Managing production of such a journal would be an obvious service that an organisation like RAPAC could provide to the protected area community. It would only be credible if peer-review of a sufficiently high standard was established and maintained. A partnership with an existing high-quality conservation-oriented journal would be one way of ensuring that quality is maintained.

5. Acknowledgements

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Malcolm Starkey oversaw and contributed to all components of the project and the report.

Collation of the reports into a bibliography and construction of the monitoring data-base was mostly carried out by Gemma Taylor.

Fiona Maisels provided comments on the monitoring factsheets and completeness of the bibliography.

Ashley Vosper, Rostand Abaa and Olivia Scholtz contributed to the database and development of monitoring factsheets.

6. References cited

ANCRENAZ, M., A. J. HEARN, J. ROSS, R. SOLLMANN and A. WILTING (2012). Handbook for wildlife monitoring using camera-traps. BBEC II Secretariat, Kota Kinabalu, Malaysia.

BBOP (2012). Standard on Biodiversity Offsets. Business and Biodiversity Offset Program, Washington DC, USA.

BUCKLAND, S. T., A. J. PLUMPTRE, L. THOMAS and E. A. REXSTAD (2010). Design and Analysis of Line Transect Surveys for Primates. International Journal of Primatology 31:5, 833–847.

CMP (2013). Open Standards for the Practice of Conservation: Version 3.0. The Conservation Measures Partnership, http://www.conservationmeasures.org/.

CROES, B., P. FUNSTON, G. RASMUSSEN, R. BUIJ, A. SALEH, P. TUMENTA and H. DE IONGH (2011). The impact of trophy hunting on lions (Panthera leo) and other large carnivores in the Bénoué Complex, northern Cameroon. Biological Conservation 144:12, 3064–3072.

EMSLIE, R. (2012). Ceratotherium simum ssp. cottoni (Northern White Rhino, Northern White Rhinoceros). URL: http://www.iucnredlist.org/details/4183/0.

FERRARO, P. J. and S. K. PATTANAYAK (2006). Money for nothing? A call for empirical evaluation of biodiversity conservation investments. PLoS biology 4:4, e105.

FIELD, S., A. TYRE and H. POSSINGHAM (2005). Optimizing allocation of monitoring effort under economic and observational constraints. Journal of Wildlife Management 69:2, 473–482.

FIELD, S. A., P. J. O'CONNOR, A. J. TYRE and H. P. POSSINGHAM (2007). Making monitoring meaningful. Austral Ecology 32:5, 485–491.

FORBOSEH, P. F., T. C. H. SUNDERLAND and M. ENO-NKU (2007). Priority setting for conservation in south-west Cameroon based on large mammal surveys. Oryx 41:02, 255.

HANSEN, M. C., P. V. POTAPOV, R. MOORE, M. HANCHER, S. A. TURUBANOVA, A. TYUKAVINA, D. THAU, S. V. STEHMAN, S. J. GOETZ, T. R. LOVELAND, A. KOMMAREDDY, A. EGOROV, L. CHINI, C. O. JUSTICE and J. R. G. TOWNSHEND (2013). High-resolution global maps of 21st-century forest cover change. Science 342: 850–853.

HEDGES, S., ed. (2012). Monitoring Elephant Populations and Assessing Threats: a manual for researchers, managers and conservationists. WCS, New York, USA.

HEGERL, G., O. HOEGH-GULDBERG, G. CASASSA, M. HOERLING, R. KOVATS, C. PARMESAN, D. PIERCE and P. STOTT (2010). 'Good practice guidance paper on detection and attribution related to anthropogenic climate change'. In: Meeting Report of the Intergovernmental Panel on Climate Change Expert Meeting on Detection and Attribution of Anthropogenic Climate Change. Ed. by T. STOCKER, C. FIELD, D. QIN, V. BARROS, G. PLATTNER, M. TIGNOR, P. MIDGLEY and K. EBI. IPCC Working Group I Technical Support Unit, University of Bern, Bern, Switzerland.

HELLAWELL, J. (1991). 'Development of a rationale for monitoring'. In: Monitoring for Conservation and Ecology. Ed. by F. GOLDSMITH. Chapman and Hall, London, UK, 1–14.

INOGWABINI, B., J. S. HALL, A. VEDDER, B. CURRAN, J. YAMAGIWA and K. BASABOSE (2000). Status of large mammals in the mountain sector of Kahuzi-Biega National Park, Democratic Republic of Congo, in 1996. African Journal of Ecology 38:4, 269–276.

INOGWABINI, B.-I., B. MATUNGILA, L. MBENDE, M. ABOKOME and T. W. TSHIMANGA (2007). Great apes in the Lake Tumba landscape, Democratic Republic of Congo: newly described populations. Oryx 41:04, 532–538.

IUCN (2013). IUCN Red List of threatened species. Version 2013.1. URL: http://iucnredlist.org.

IUCN and UNEP (2013). The World Database on Protected Areas (WDPA). URL: www.protectedplanet.net.

KüHL, H., F. MAISELS, M. ANCRENAZ and E. A. WILLIAMSON (2008). Best Practice Guidelines for Surveys and Monitoring of Great Ape Populations. 36. IUCN-SSC Primate Specialist Group, Gland, Switzerland.

LAGROT, I., J.-F. LAGROT and P. BOUR (2007). Probable extinction of the western black rhino, Diceros bicornis longipes: 2006 survey in northern Cameroon. Pachyderm 43, 19–28.

LEGG, C. J. and L. NAGY (2006). Why most conservation monitoring is, but need not be, a waste of time. Journal of environmental management 78:2, 194–9.

LINDENMAYER, D. B. and G. E. LIKENS (2010). The science and application of ecological monitoring. Biological Conservation 143:6, 1317–1328.

LINDER, J. M. and J. F. OATES (2011). Differential impact of bushmeat hunting on monkey species and implications for primate conservation in Korup National Park, Cameroon. Biological Conservation 144:2, 738–745.

MASTRANDREA, M. D., C. B. FIELD, T. F. STOCKER, O. EDENHOFER, K. L. EBI, D. J. FRAME, H. HELD, E. KRIEGLER, K. J. MACH, P. R. MATSCHOSS, G.-K. PLATTNER, G. W. YOHE and F. W. ZWIERS (2010). Guidance Note for Lead Authors of the IPCC Fifth Assessment Report on Consistent Treatment of Uncertainties. Intergovernmental Panel on Climate Change (IPCC).

MCDONALD-MADDEN, E., P. W. J. BAXTER, R. A. FULLER, T. G. MARTIN, E. T. GAME, J. MONTAMBAULT and H. P. POSSINGHAM (2010). Monitoring does not always count. Trends in ecology & evolution 25:10, 547–50.

MITEVA, D. A., S. K. PATTANAYAK and P. J. FERRARO (2012). Evaluation of biodiversity policy instruments: what works and what doesn’t? Oxford Review of Economic Policy 28:1, 69–92.

NICHOLS, J. D. (2012). Evidence, models, conservation programs and limits to management. Animal Conservation 15:4, 331–333.

NICHOLS, J. D. and B. K. WILLIAMS (2006). Monitoring for conservation. Trends in ecology & evolution 21:12, 668–73.

O’CONNELL, A. F., J. D. NICHOLS and U. K. KARANTH (2011). Camera Traps in Animal Ecology. Ed. by A. F. O’CONNELL, J. D. NICHOLS and K. U. KARANTH. Springer Japan, Tokyo, Japan.

OMARI, I., J. A. HART, T. M. BUTYNSKI, N. R. BIRHASHIRWA, A. UPOKI, Y. M’KEYO, F. BENGANA, M. BASHONGA and N. BAGURUBUMWE (2009). The Itombwe Massif, Democratic Republic of Congo: biological surveys and conservation, with an emphasis on Grauer’s gorilla and birds endemic to the Albertine Rift. Oryx 33:04, 301.

PAPWORTH, S., J. RIST, L. COAD and E. MILNER-GULLAND (2009). Evidence for shifting baseline syndrome in conservation. Conservation Letters 2: 93–100.

SALAFSKY, N., R. MARGOLUIS and K. REDFORD (2001). Adaptive Management: a tool for conservation practioners. Biodiversity Support Programme.

SCHOLTE, P. (2013). Population trends of antelopes in Waza National Park (Cameroon) show escalating effects of poaching and livestock intrusion. African Journal of Ecology, in press.

SCHOLTE, P., S. ADAM and B. K. SERGE (2007). Population trends of antelopes in Waza National Park (Cameroon) from 1960 to 2001: the interacting effects of rainfall, flooding and human interventions. African Journal of Ecology 45:3, 431–439.

STEM, C., R. MARGOLUIS, N. SALAFSKY and M. BROWN (2005). Monitoring and Evaluation in Conservation: a Review of Trends and Approaches. Conservation Biology 19:2, 295–309.

SUTHERLAND, W. J. and M. J. S. PEEL (2010). Benchmarking as a means to improve conservation practice. Oryx 45:01, 56–59.

THOMAS, L. and J. MIDDLETON (2003). 'Guidelines for Management Planning of Protected Areas'. Gland, Switzerland.

TUCKER, G., P. BUBB, M. DE HEER, L. MILES, A. LAWRENCE, J. VAN RIJSOORT, S. BAJRACHARYA, R. C. NEPAL, R. SHERCHAN and N. CHAPAGAIN (2005). Guidelines for Biodiversity Assessment and Monitoring for Protected Areas. Kathamandu, Nepal and Cambridge, UK, 123.

WALSH, P., C. TUTIN, J. OATES, J. BAILLIE, F. MAISELS, E. STOKES, S. GATTI, R. BERGL, J. SUNDERLAND-GROVES and A. DUNN (2008). Gorilla gorilla (Lowland Gorilla, Western Gorilla). URL: http://www.iucnredlist.org/details/9404/0.

WALSH, P. D. (2009a). Evaluating Management Effectiveness: a wildlife monitoring system for the Dzanga-Sangha Protected Areas. WWF, Yaounde, Cameroon.

— (2009b). Large Mammal Survey and Monitoring in the Dzanga-Sangha Protected Areas: Literature Review and Methodological Critique. WWF, Yaounde, Cameroon.

WRI (2010a). Atlas Forestier Interactif de la République Centrafricaine: version 1.0. Washington, DC, USA.

— (2010b). Atlas forestier interactif de la République Démocratique du Congo: Version 1.0. WRI and Ministère de l'Environnement, Conservation de la Nature et Tourisme de la République Démocratique du Congo, Kinshasa, DRC.

— (2011a). Atlas forestier interactif du Congo: Version 3.0. WRI and MEFDD, Washington DC, USA and Brazzaville, Republic of Congo.

— (2011b). Interactive forest atlas of Cameroon: Version 3.0. WRI and MINFOF, Washington DC, USA and Yaounde, Cameroon.

WUNDER, S. (2007). The efficiency of payments for environmental services in tropical conservation. Conservation Biology 21:1, 48–58.

7. Bibliography

We present here the sources used to compile the maps and tables. We compiled these sources according to the terms of reference of this study and the definitions given in section 2.1. The bibliography therefore includes:

- wildlife surveys that aimed to measure abundance, relative abundance, density or distribution of predetermined species, that specifically aim to detect population changes over time or that have subsequently been used for that purpose;
- surveys from Cameroon, Central African Republic, Democratic Republic of Congo, the continental portion of Equatorial Guinea, Gabon and Republic of Congo;
- terrestrial species only (i.e. not marine or freshwater);
- surveys from within IUCN category I–IV protected areas;
- surveys conducted prior to protected area creation but only if the protected area was in fact created and the survey is subsequently used as a basis for monitoring;
- protected areas-wide surveys; Localised studies, focusing on less than 10% of a protected area are not included, except where that is a stratum of a wider survey, or where that area represents the majority of the occurrence of a target species.

Where there are several reports or papers referring to the same study (for example English and French version), all are included. Individual mission reports are excluded unless they are the only source of data on a survey.

Cameroon

ANON (2006). Comparative evaluation of the evolution of flagships species population and human activities in Boumba Bek National Park from 2004 to 2006. WWF, Yaounde, Cameroon.

BAUER, H. (2003). 'Lion Conservation in West and Central Africa: integrating social and natural science for wildlife conflict resolution around Waza National Park, Cameroon'. PhD Thesis. Institute for Environmental Sciences, Leiden University.

— (2007). Status of large carnivores in Bouba Ndjida National Park, Cameroon. African Journal of Ecology 45: 448–450.

BEKHUIS, P. D. B. M. and H. H. T. PRINS (2003). Forest elephant density and distribution in the southern part of Campo Ma'an National Park, Cameroon. Pachyderm 35: 37–42.

BENE BENE, C., A. GOMSé, M. TCHAMBA and P. DONFACK (1999). Distribution passée, nombre et répartition actuelle du lycaon (Lycaon pictus Temmink, 1820) et d'autres espèces de carnivores (lion, hyène tachetée et chien domestique) au Nord-Cameroun). WWF, Yaounde, Cameroon.

BENE BENE, C. and Z. NZOOH DONGMO (2005). Suivi écologique dans le Parc National de Boumba Bek et sa zone périphérique: donnees de base sur la dynamique des populations de grands et moyens mammifères et des activités anthropiques. WWF, Yaounde, Cameroon.

BENE BENE, L., Z. NZOOH DONGMO and L. USONGO (2002). Résultats prélminaires du suivi écologique dans le Parc National de Boumba Bek. WWF, Yaounde, Cameroon.

BLAKE, S. (2005). Long term system for monitoring the illegal killing of elephants (MIKE). Central Africa forests: Final report on population surveys (2003–2004). WCS, CITES, WWF.

BLAKE, S., S. STRINDBERG, P. BOUDJAN, C. MAKOMBO, I. BILA-ISIA, O. ILAMBU, F. GROSSMANN, L. BENE-BENE, B. DE SEMBOLI, V. MBENZO, D. S'HWA, R. BAYOGO, L. WILLIAMSON, M. FAY, J. HART and F. MAISELS (Apr. 2007). Forest elephant crisis in the Congo Basin. PLoS biology 5:4, e111.

BOUCHé, P., I. DOUGLAS-HAMILTON, G. WITTEMYER, A. J. NIANOGO, J.-L. DOUCET, P. LEJEUNE and C. VERMEULEN (2011). Will elephants soon disappear from West African savannahs? PloS one 6:6, e20619.

BREUER, T. (2003). Distribution and conservation of African wild dogs in Cameroon. Canid News 6:1.

BRUGIèRE, D. (1995). Grande faune et parcs nationaux du nord-Cameroun. Bois et Forets des Tropiques 244: 43–54.

CROES, B. M., G. RASMUSSEN and H. H. DE LONGH (2010). Status of Painted dog Lycaon pictus in the Bénoué Ecosystem, North Cameroon: Final report of the WWF-NL funded project July 2007 – June 2010. June. WWF, Yaounde, Cameroon.

CROES, B., P. FUNSTON, G. RASMUSSEN, R. BUIJ, A. SALEH, P. TUMENTA and H. DE IONGH (2011). The impact of trophy hunting on lions (Panthera leo) and other large carnivores in the Bénoué Complex, northern Cameroon. Biological Conservation 144:12, 3064–3072.

DONFACK, P. (2009). Outils nécessaires à la mise en oeuvre d'un système de suivi écologique pour les aires protégées du Cameroun. 237. MINFOF, Yaounde, Cameroon.

EBOT, B. M. and C. NCHANJI ANTHONY (2001). Large Mammals of Banyang-Mbo Wildlife Sanctuary. WCS Cameroon, Yaounde, Cameroon.

EKINDE, A. and Y. WARREN (2007). The proposed Takamanda National Park: Cross River gorilla surveys February-May 2007. May. WCS Takamanda Mone Landscape Project, Limbe, Cameroon.

EKOBO, A. (1995). Elephants in the Lobéké Forest, Cameroon. Pachyderm 19: 73–80.

— (2007). Surveys of large mammals in the Mount Cameroon forest. WWF, Yaounde, Cameroon.

ESSER, J. D. and L. P. VAN LAVIEREN (1979). Importance, repartition et tendance evolutive des populations de grands herbivores et de l'autruche dans le Parc National de Waza, Cameroun. Terre et Vie 33:1, 3–26.

ETOGA, G. and D. FOGUEKEM (2008). Large mammals surveys in the Campo-Ma'an Nationa Park (Cameroon): an assessment of great apes population status and anthropogenic threats. WWF, Yaounde, Cameroon.

FLIZOT, P. (1962). Les réserves de faune du Cameroun, 28.

FOGUEKEM, D., M. N. TCHAMBA and P. OMONDI (2010). Aerial survey of Elephants (Loxodonta africana africana), other large mammals and human activities in Waza National Park, Cameroon. African Journal of Environmental Science and Technology 4:6, 401–411.

FORBOSEH, P. F., T. C. H. SUNDERLAND and M. ENO-NKU (2007). Priority setting for conservation in south-west Cameroon based on large mammal surveys. Oryx 41:02, 255.

FOTSO, R., M. ENO NKU and J. GROVES (2002). Distribution and conservation statutus of gorilla population in the forests around Belabo, Eastern Province, Cameroon. WCS Cameroon, Yaounde, Cameroon.

GOMSé, A. (2001). Denombrement terrestre des grands mammifères diurnes dans le Parc National de Bouba Ndjida. WWF, Yaounde, Cameroon.

GREENGRASS, E. J. and F. MAISELS (2007). Conservation of the Nigerian-Cameroon Chimpanzee P. t. vellerosus (and other mammals) in and around the Banyang-Mbo Wildlife Sanctuary, South-west Province, Cameroon. WCS Cameroon, Yaounde, Cameroon.

HALFORD, T., H. EKODECK, B. SOCK, M. DAME and P. AUZEL (2003). Statut des populations de gorilles (Gorilla gorilla gorilla) et de chimpanzés (Pan troglodytes troglodytes) dans le sanctuaire à gorilles de Mengamé, Province du Sud, Cameroun: Densité, distribution, pressions et conservation. MINEF and JGI, Yaoundé, Cameroon.

IMONG, I. and Y. WARREN (2008). Gorilla and other large mammals survey of the Okwa-Obonyi trans-boundary area of Cross River National Park (Nigeria) and the proposed Takamanda National Park (Cameroon). WCS Nigeria and WCS Cameroon, Limbe, Cameroon.

IONGH, H. DE, H. BAUER, P. J. FUNSTON and P. HAMLING (2008). 'Review of more than ten years research on lion ecology and lion livestock conflicts in the Waza Logone region, North Cameroon'. In: Management and conservation of large carnivores in West and Central Africa. Ed. by B. CROES, R. BUIJ, H. DE IONGH and H. BAUER. Leiden University, Leiden, The Netherlands, 41–52.

KOCK, M. D. (2001). WWF Cameroon Black Rhino Location and Identification Project Final Report. Yaounde, Cameroon, Yaounde, Cameroon.

LAGROT, I., J.-F. LAGROT and P. BOUR (2007). Probable extinction of the western black rhino, Diceros bicornis longipes: 2006 survey in northern Cameroon. Pachyderm 43, 19–28.

LAVIEREN, L. VAN and J. ESSER (1979). Numbers, distribution and habitat preference of large mammals in Bouba Ndjida National Park, Cameroon. African Journal of Ecology 17: 141–153.

LINDER, J. M. and J. F. OATES (2011). Differential impact of bushmeat hunting on monkey species and implications for primate conservation in Korup National Park, Cameroon. Biological Conservation 144:2, 738–745.

LUCY, L., D. SIMBO and E. EKWOGE (2000). Proposed ecomonitoring programme for Mt Jupe and adjacent mountains. WWF, Yaounde, Cameroon.

MAISELS, F., R. C. FOTSO and D. F. HOYLE (2000). Mbam Djerem National Park. Conservation status, March 2000. Large mammals and human impact. Final report. WCS Cameroon, Yaounde, Cameroon.

MAISELS, F., R. AMBAHE, E. AMBASSA, C. NYEMGAH YARA and B. FOSSO (2009a). Great ape and human impact monitoring in the Mbam et Djerem National Park, Cameroun. August. WCS Cameroon, Yaounde, Cameroon.

MAISELS, F., R. AMBAHE, E. AMBASSA, B. FOSSO, J. B. POUOMEGNE and R. FOTSO (2010a). Wildlife and human impact surveys of the Deng Deng National Park and UFA 10065, 2010. WCS Cameroon, Yaounde, Cameroon.

MAISELS, F., Y. WARREN, R. AMBAHE, E. AMBASSA and R. FOTSO (2008b). Summary of the wildlife and human impact surveys of the Deng Deng area, 2008. WCS Cameroon, Yaounde, Cameroon.

MBOH, H. and Y. WARREN (2007). The proposed Takamanda National Park: Large Mammal Survey February - May 2007. May. WCS Takamanda Mone Landscape Project, Limbe, Cameroon.

MONFORT, A., G. NGANDJUI, Z. NZOOH and R. FOTSO (2007). Etude environnementale du barrage de Lom Pangar: étude complémentaire visant renforcer les connaisances des populations de grands primates en forêt de Deng Deng. ISL-OREADE-BRECHE-SOGREAH, Yaounde, Cameroon.

NCHANJI, A. C. (2003). Large mammal populations and human impact assessment in the Banyang Mbo wildlife. WCS Cameroon, Yaounde, Cameroon.

NGANDJUI, G., N. D. ANYE, L. CHUENU, N. ENO and E. OKIE (2002). Densité, abondance relative et distribution de la faune mammalienne; évaluation de la pression de chasse dans l'UTO Campo-Ma'an. Tropenbos Internation, Kribi, Cameroun.

NGWANYE, V. A. (2008). An annual field report on ecological bai monitoring in the Lobéké National Park. WWF, Yaounde, Cameroon.

NZOOH DONGMO, Z. (2001). Dynamique de la faune sauvage et des activités anthropiques dans la Reserve de Biosphere du Dja et ses environs. MINEF and ECOFAC, Yaounde, Cameroon.

— (2009). Summary of trend [sic] of large mammal population and distribution dynamics in Lobéké National between 2002–2006–2009. WWF, Yaoundé, Cameroon.

NZOOH DONGMO, Z., S. KOUOB BEGNE, V. ANNONG, C. BASSAMA, E. FOUDA and J. P. MAHOP (2006). Suivi écologique dans le Parc National de Nki et sa zone périphériques: données de base sur la dynamique des populations de grands et moyens mammifères et des activités anthropiques. WWF, Yaounde, Cameroon.

OKON, D. and A. EKOBO (2007). Monitoring Large Mammals and Human Activities in Korup National Park. WWF, Yaounde, Cameroon.

OMONDI, P., E. K. BITOK, M. TCHAMBA, R. MAYIENDA and B. B. LAMBERT (2008). Total aerial count of elephants and other wildlife species in Faro, Benoué and Bouba Ndjidda National Parks and adjacent hunting blocks in northern Cameroon. MINFOF and WWF, Yaoundé, Cameroon.

SALEH, A., L. TSAGUE, E. HATUNGUIMANA and J. BATTOKOCK (2002). Rapport de dénombrement de la faune sauvage au Parc National de Waza. Ministry of Environment and Forests, Maroua, Cameroon.

SCHOLTE, P. (2013). Population trends of antelopes in Waza National Park (Cameroon) show escalating effects of poaching and livestock intrusion. African Journal of Ecology, in press.

SCHOLTE, P., S. ADAM and B. K. SERGE (2007). Population trends of antelopes in Waza National Park (Cameroon) from 1960 to 2001: the interacting effects of rainfall, flooding and human interventions. African Journal of Ecology 45:3, 431–439.

STROMAYER, K. A. K. and A. EKOBO (1992). The Distribution and Number of Forest Dwelling Elephants in Extreme Southeastern Cameroon. Pachyderm 15: 9–14.

TCHAMBA, M. N. and P. ELKAN (1995). Status and trends of some large mammals and ostriches in Waza National Park, Cameroon. African Journal of Ecology 33:4, 366–376.

THOMAS, H., E. HERBERT, S. BENJAMIN, D. MIREILLE and A. PHILIPPE (2003). Recensement et distribution des populations d'éléphants (Loxodonta africana cyclotis) dans la Reserve de Mengame, Province du Sud, Cameroun. MINEF / The Jane Goodall Institute / IRAD, Yaounde, Cameroon.

TUMENTA, P., J. KOK, J. VAN RIJSSEL, R. BUIJ, B. CROES, P. FUNSTON, H. DE IONGH and H. UDO DE HAES (2010). Threat of rapid extermination of the lion (Panthera leo leo) in Waza National Park, Northern Cameroon. African Journal of Ecology 48: 888–894.

USONGO, L. and P. R. NGNEGUEU (2000). Towards the Establishment of an Ecological Monitoring Programme In Proposed Lobéké National Park SE Cameroon. WWF, Yaounde, Cameroon.

WALTERT, M., K. FABER and M. MüHLENBERG (2002). Further declines of threatened primates in the Korup Project Area, south-west Cameroon. Oryx 36:03, 257–265.

WALTERT, M., S. HEBER, S. RIEDELBAUCH, L. LIEN and M. MU (2006). Estimates of blue duiker (Cephalophus monticola) densities from diurnal and nocturnal line transects in the Korup region, south-western Cameroon. African Journal of Ecology 44: 290–292.

WANGUE, N. (2010). Monitoring des gorilles et autres grands mammifères dans la clarière forestière d'Ikwa Bai au Parc National de Nki, sud-est Cameroun. WWF, Yaounde, Cameroon.

WARREN, Y. and A. EKINDE (2007). Mone forest large mammal survey nov-dec 2007. December. WCS, Limbe, Cameroon.

WARREN, Y., R. IKFUINGEI and A. NICHOLAS (2009). Kagwene gorilla sanctuary: results of monitoring 2008. WCS Takamanda Mone Landscape Project, Limbe, Cameroon.

WARREN, Y., A. STOTT, A. EKINDE, P. KHUMBAH and A. NICHOLAS (2008). Cross River Gorilla: inter-population nuclei distribution survey. WCS Takamanda Mone Landscape Project, Limbe, Cameroon.

WILLIAMSON, L. and L. USONGO (1995). Survey of primate populations and large mammal inventory, Réserve de Faune du Dja, Cameroun. ECOFAC, Yaounde, Cameroon.

YEM, L. M. (2010). Rapport sur l'analyse des données du suivi écologique et de gestion de la Réserve de Faune du Dja. MINFOF and ECOFAC, Yaounde, Cameroon.

Central African Republic

BLAKE, S. (2005). Long term system for monitoring the illegal killing of elephants (MIKE). Central Africa forests: Final report on population surveys (2003–2004). WCS, CITES, WWF.

BLAKE, S., S. STRINDBERG, P. BOUDJAN, C. MAKOMBO, I. BILA-ISIA, O. ILAMBU, F. GROSSMANN, L. BENE-BENE, B. DE SEMBOLI, V. MBENZO, D. S'HWA, R. BAYOGO, L. WILLIAMSON, M. FAY, J. HART and F. MAISELS (Apr. 2007). Forest elephant crisis in the Congo Basin. PLoS biology 5:4, e111.

BLOM, A. and A. ALMAšI (2001). A survey of the apes in the Dzanga-Ndoki National Park, Central African Republic: a comparison between the census and survey methods of estimating the gorilla (Gorilla gorilla gorilla) and chimpanzee (Pan troglodytes) nest group density. African Journal of Ecology 39: 98–105.

BLOM, A., R. VAN ZALINGE, I. M. HEITKöNIG and H. H. PRINS (2005). Factors influencing the distribution of large mammals within a protected central African forest. Oryx 39:04, 381.

BOKOTO DE SEMBOLI, B. (2007). Statut et distribution des éléphants, primates et autres mammifères dans la réserve spéciale de forêt dense humide de Dzanga Sangha. Ministère des Eaux, Forêts, Chasses et Pêches République Centrafricaine, Bangui, Central African Republic.

BOUCHé, P., P. RENAUD, P. LEJEUNE, C. VERMEULEN, J. FROMENT, A. BANGARA, O. FIONGAI, A. ABDOULAYE, R. ABKAKAR and M. FAY (2010). Has the final countdown to wildlife extinction in Northern Central African Republic begun? African Journal of Ecology 48: 994–1003.

BOUCHé, P. (2010). Inventaire aerien 2010 des grands mammifères dans le nord de la République Centrafricaine. ECOFAC, Bangui, Central African Republic.

BOUCHé, P., I. DOUGLAS-HAMILTON, G. WITTEMYER, A. J. NIANOGO, J.-L. DOUCET, P. LEJEUNE and C. VERMEULEN (2011). Will elephants soon disappear from West African savannahs? PloS one 6:6, e20619.

BOUCHé, P., R. NZAPA MBETI MANGE, F. TANKALET, F. ZOWOYA, P. LEJEUNE and C. VERMEULEN (2012). Game over! Wildlife collapse in northern Central African Republic. Environmental monitoring and assessment 184:11, 7001–11.

BRUGIèRE, D. (1999). Gorilles et Chimpanzes en foret de Ngotto. Francais. ECOFAC and Université de Rennes I, Bangui, Central African Republic.

BRUGIERE, D. and D. SAKOM (2001). Population density and nesting behaviour of lowland gorillas (Gorilla gorilla gorilla) in the Ngotto forest, Central African Republic. Journal of Zoology 255:2, 251–259.

CARROLL, R. W. (1986). Status of the Lowland Gorilla and other wildlife in the Dzanga-Sanga Region of Southwestern Region of Central African Republic. Primate Conservation 7: 38–41.

— (1988). Elephants of the Dzanga-Sangha Dense Forest of South-western Central African Republic. Pachyderm 10: 12–15.

DOUGLAS-HAMILTON, I. and J.-M. FROMENT (1985). Aerial Wildlife Survey in Northern Central African Republic. Nairobi, Kenya.

FAY, J. M. and M. AGNAGNA (1991a). Forest Elephant Populations in the Central African Republic and Congo. Pachyderm 14: 3–19.

HICKS, T. C., R. S. FOUTS and D. H. FOUTS (2009). A Survey of chimpanzees (Pan troglodytes troglodytes) and gorillas (Gorilla gorilla gorilla) in the selectively logged Ngotto Forest, Central African Republic. Journal of applied animal welfare science : JAAWS 12:3, 165–88.

PRINCéE, F. P. (2013). Biomonitoring Survey 2011–2012 in Dzanga-Sangha Protected Areas - DRAFT. WWF, Bangui, Central African Republic.

REMIS, M. J. (2000). Preliminary assessment of the impacts of human activities on gorillas Gorilla gorilla gorilla and other wildlife at Dzanga-Sangha Reserve, Central African Republic. Oryx 34:01, 56.

REMIS, M. J. and J. B. KPANOU (2010). Primate and ungulate abundance in response to multi-use zoning and human extractive activities in a Central African Reserve. African Journal of Ecology 49: 70–80.

RENAUD, P. C., J. M. FAY, A. ABDOULAYé, R. ABAKAR, A. BANGARA, O. FIONGAï, D. MOYER and J. M. FROMENT (2005). Recensement aérien de la faune dans les préfectures de la région Nord de la République Centrafricaine. WCS / MIKE, Nairobi, Kenya, 55.

WALSH, P. D. (2009a). Evaluating Management Effectiveness: a wildlife monitoring system for the Dzanga-Sangha Protected Areas. WWF, Yaounde, Cameroon.

— (2009b). Large Mammal Survey and Monitoring in the Dzanga-Sangha Protected Areas: Literature Review and Methodological Critique. WWF, Yaounde, Cameroon.

WWF (2012). Interim bio-monitoring report Dzanga-Sangha protected areas, Central African Republic. WWF, Bangui, Central African Republic.

Democratic Republic of Congo

ALERS, M. P. T., A. BLOM, C. SIKUBWABO KIYENGO, T. MASUDA and R. F. W. BARNES (1992). Preliminary assessment of the status of the forest elephant in Zaire. African Journal of Ecology 30: 279–291.

AMSINI, F., F. GROSSMANN, J. HART, C. KIBAMBE, B. NYEMBO and C. VYAHAVWA (2005). Identifying conservation priorities for the recovery of the Maiko National Park. Part 2: Post-conflict surveys of wildlife populations and human impact in the North Sector of the park. September. WCS DRC, Kinshasa, DRC.

— (2006). Identifying conservation priorities for the recovery of the Maiko National Park. Part 2: Post-conflict surveys of wildlife populations and human impact in the South Sector (Oso Block). October. WCS DRC, Kinshasa, DRC.

AMSINI, F., O. ILAMBU, I. LIENGOLA, D. KUJIRAKWINJA, J. HART, F. GROSSMANN and A. J. PLUMPTRE (2008). The Impact of civil war on the Kahuzi-Biega National Park: Results of surveys between 2000–2008. WCS and ICCN, Kinshasa, DRC.

AVELING, C. (1990). Comptage aérien total des buffles et éléphants au Parc National des Virunga. IZCN/UE, Kinshasa, DRC.

AVELING, C. and A. H. HARCOURT (1981). A census of the Virunga gorillas. Oryx 18:1, 8–13.

BELEMBO, G. (2008). Monitoring of Large Mammal Populations and Human Activity in the Lomako-Yokokala Faunal Reserve. ICCN and AWF, Kinshasa, DRC.

BLAKE, S. (2005). Long term system for monitoring the illegal killing of elephants (MIKE). Central Africa forests: Final report on population surveys (2003–2004). WCS, CITES, WWF.

BLAKE, S., S. STRINDBERG, P. BOUDJAN, C. MAKOMBO, I. BILA-ISIA, O. ILAMBU, F. GROSSMANN, L. BENE-BENE, B. DE SEMBOLI, V. MBENZO, D. S'HWA, R. BAYOGO, L. WILLIAMSON, M. FAY, J. HART and F. MAISELS (Apr. 2007). Forest elephant crisis in the Congo Basin. PLoS biology 5:4, e111.

BOLAñOS, N. C. (2012). Garamba National Park: Aerial animal census 2012. African Parks and ICCN.

DINO, S., F. KAHINDO, C. VYAHAVWA, J. HART, F. GROSSMANN, A. MASANGA, R. BEYERS and M. CARBO (2008). Réserve de Faune à Okapis: la distribution et fréquence de la grande faune et des activités humaines avec une évaluation de l'impact de 10 ans de conflit: 1996-2006. WCS, Kinshasa, DRC.

GRAY, M., K. FAWCETT, A. BASABOSE, M. CRANfiELD, L. VIGILANT, J. ROY, P. UWINGELI, I. MBURANUMWE, E. KAGODA, M. M. ROBBINS and E. SUMMARY (2010). Virunga Massif Mountain Gorilla Census – 2010 Summary Report. ICCN, UWA and RDB.

GRAY, M., A. MCNEILAGE, K. FAWCETT, M. M. ROBBINS, B. SSEBIDE, D. MBULA and P. UWINGELI (2009). Censusing the mountain gorillas in the Virunga Volcanoes: complete sweep method versus monitoring. African Journal of Ecology 48: 588–599.

GRAY, M., J. ROY, L. VIGILANT, K. FAWCETT, A. BASABOSE, M. CRANfiELD, P. UWINGELI, I. MBURANUMWE, E. KAGODA and M. M. ROBBINS (2013). Genetic census reveals increased but uneven growth of a critically endangered mountain gorilla population. Biological Conservation 158: 230–238.

GROSSMANN, F., J. HART and S. DINO (2006). Réserve de Faune à Okapi Post Conflict Faunal Baseline Surveys 2005 Central Sector ~Zone Verte~ : data presentionat and preliminary interpretation with a special emphasis on elephants and bushmeat species. January 2005. WCS DRC, Kinshasa, DRC.

HALL, J. S., B. I. INOGWABINI, E. A. WILLIAMSON, I. OMARI, C. SIKUBWABO and L. J. T. WHITE (1997). A survey of elephants (Loxodonta africana) in the Kahuzi-Biega National Park lowland sector and adjacent forest in eastern Zaire. African Journal of Ecology 35:3, 213–223.

HALL, J. S., K. SALTONSTALL, B.-I. INOGWABINI and I. OMARI (1998a). Distribution, abundance and conservation status of Grauer's gorilla. Oryx 32:2, 122–130.

HALL, J. S., L. J. T. WHITE, B.-I. INOGWABINI, I. OMARI, H. SIMONS MORELAND, E. A. WILLIAMSON, K. SALTONSTALL, P. D. WALSH, C. SIKUBWABO, D. BONNY, K. PRINCE KIWELE, A. VEDDER and K. FREEMAN (1998b). Survey of Grauer's Gorillas (Gorilla gorilla graueri) and

Eastern Chimpanzees (Pan troglodytes schweinfurthi) in the Kahuzi-Biega National Park Lowland Sector and Adjacent Forest in Eastern Democratic Republic of Congo. International Journal of Primatology 19:2, 207–235.

HART, J. A. and J. S. HALL (1996). Status of Eastern Zaire's Forest Parks and Reserves. Conservation Biology 10:2, 316–327.

HART, J. A. and C. SIKUBWABO (1994). Exploration of the Maiko National Park of Zaire. WCS, Kinshasa, DRC.

HART, J., M. CARBO, F. AMSINI, F. GROSSMANN and C. KIBAMBE (2007). Parc National de Kahuzi-Biega, Secteur de Basse Altitude: Inventaire préliminaire de la grande faune avec une évaluation de l'impact des activités humaines et la situation sécuritaire. WCS DRC, Kinshasa, DRC.

HILLMAN SMITH, A. K. K., M. ATALIA, M. LIKANGO, F. SMITH, J. A. NDEY and G. PANZIAMA (1995). Garamba National Park and Reserves: general aerial count 1995 and evaluation of the status and trends of the ecosystem.

HILLMAN SMITH, A. K. K., E. DE MERODE, F. SMITH, J. A. NDEY, N. MUSHENZI and G. MBOMA (2003). Parc National des Virunga - Nord: comptages aériens de mars 2003. ICCN/ZSL/FZS/USFWS/IRF, Kinshasa, DRC.

HILLMAN SMITH, A. K. K., J. A. NDEY, F. SMITH, P. TSHIKAYA, G. MBOMA, S. IBILIABO and G. PANZIAMA (2006). Garamba National Park: Systematic aerial sample count of large mammals, April 2004 and total block surveys of rhinos and threats, July and November 2004. IRF, ICCN, FZS and UNESCO/UNF, Nairobi, Kenya.

HILLMAN, A. K. K. (1989). Garamba National Park ecosystem resource inventory.

HILLMAN, A. K. K., M. BORNER, M. MA OYISENZOO, P. ROGERS and F. SMITH (1983). Aerial census of the Garamba National Park, Zaire, March 1983 with emphasis on the northern white rhinos and elephants. IUCN, IZCN, WWF.

ICCN (2011). Parc National de Kahuzi-Biega: Plan de monitoring 2011–2016. ICCN, Kinshasa, DRC.

INOGWABINI, B., J. S. HALL, A. VEDDER, B. CURRAN, J. YAMAGIWA and K. BASABOSE (2000). Status of large mammals in the mountain sector of Kahuzi-Biega National Park, Democratic Republic of Congo, in 1996. African Journal of Ecology 38:4, 269–276.

INOGWABINI, B.-I., B. MATUNGILA, L. MBENDE, M. ABOKOME and T. W. TSHIMANGA (2007). Great apes in the Lake Tumba landscape, Democratic Republic of Congo: newly described populations. Oryx 41:04, 532–538.

KALPERS, J., E. A. WILLIAMSON, M. M. ROBBINS, A. MCNEILAGE, A. NZAMURAMBAHO, N. LOLA and G. MUGIRI (2003). Gorillas in the crossfire: population dynamics of the Virunga mountain gorillas over the past three decades. Oryx 37:03, 326–337.

KUJIRAKWINJA, D. (2010). ‘The status and conservation of common hippopotamuses in Virunga National Park, Democratic Republic of Congo’. MSc Thesis. University of Cape Town.

LUSHIMBA KABUNDA, A., P. KASALEVO and A. FOWLER (2012). Estimation de la densité, de l’abondance et de la distribution relative des grands mammifères et l’impact des humains dans la réserve d’Iyondji. African Wildlife Foundation, Kinshasa, DRC.

LUSHIMBA, A. (2012). Recensement des grands mammifères et des impacts humains dans la Réserve de Faune de Lomako-Yokokala. ICCN and AWF, Kinshasa, DRC.

LUSHIMBA, A. and P. KASALEVO (2012). Iyondji Community Bonobo Reserve: Report on monitoring of large mammals and human activities. AWF, Kinshasa, DRC.

MAISELS, F., P. NKUMU and A. BONYENGE (2009c). Salonga National park Terrestrial wildlife and human impact monitoring programme: Survey - Salonga Corridor. WCS DRC, Kinshasa, DRC.

— (2010c). Salonga National park Terrestrial wildlife and human impact monitoring programme: Survey - Eastern Sector of Park. WCS DRC, Kinshasa, DRC.

MBANZIDI, D. (2009). Rapport d’inventaire de reconnaissance dans la réserve Tumba Ledima et ses environs. WWF, Kinshasa, DRC.

MBAYMA, G. and F. MAISELS (2008). Rapport synthèse des recensements des portions nord-est et sud-est du Parc National de Salonga. WCS DRC, Kinshasa, DRC.

MERODE, E. D. E., A. NICHOLAS, A. NDEY and M. LIKANGO (2000). The spatial correlates of wildlife distribution around Garamba National Park, Democratic Republic of Congo. International Journal of Remote Sensing 21:13, 2665–2683.

MERODE, E. D., B.-I. INOGWABINI and G. PANZIAMA (2007). Status of elephant populations in Garamba National Park, Democratic Republic of Congo, late 2005. Pachyderm 42: 52–57.

MERTENS, H. (1983). Recensements aériens des principaux ongulés du Parc National des Virunga, Zaire. Revue d’Ecologie (Terre & Vie) 38:1, 51–64.

MPIANA, N. and G. BELEMBO (2007). Présence, Abondance et distribution des grands mammifères et des activités anthropiques dans la Réserve de Faune de Lomako–Yokokala: rapport du 2ème récensement. AWF, Kinshasa, DRC.

MUBALAMA, L. (2000). Population and Distribution of Elephants (Loxodonta africana africana) in the Central Sector of the Virunga National Park, Eastern DRC. Pachyderm 28.

MURNYAK, D. F. (1981). Censusing the gorillas in Kahuzi-Biega National Park. Biological Conservation 21:3, 163–176.

OMARI, I., J. A. HART, T. M. BUTYNSKI, N. R. BIRHASHIRWA, A. UPOKI, Y. M'KEYO, F. BENGANA, M. BASHONGA and N. BAGURUBUMWE (2009). The Itombwe Massif, Democratic Republic of Congo: biological surveys and conservation, with an emphasis on Grauer's gorilla and birds endemic to the Albertine Rift. Oryx 33:04, 301.

PLUMPTRE, A. J., F. AMSINI, A. BAMBA, P. SHAMAVU and D. KUJIRAKWINJA (2010a). Final Report for Biological Surveys for Itombwe and Support to Process of Establishment of Misotshi-Kabogo as a Protected Area. June. WCS, WWF.

PLUMPTRE, A., D. KUJIRAKWINJA, D. MOYER, M. DRICIRU and A. RWETSIBA (2010b). Greater Virunga Landscape large mammal surveys, August 2010. August. ICCN, UWA and WCS, Kampala, Uganda.

ROBBINS, M. M., M. GRAY, K. A. FAWCETT, F. B. NUTTER, P. UWINGELI, I. MBURANUMWE, E. KAGODA, A. BASABOSE, T. S. STOINSKI, M. R. CRANfiELD, J. BYAMUKAMA, L. H. SPELMAN and A. M. ROBBINS (2011). Extreme conservation leads to recovery of the Virunga mountain gorillas. PloS one 6:6, e19788.

ROBBINS, M. M. and A. M. ROBBINS (2004). Simulation of the population dynamics and social structure of the Virunga mountain gorillas. American journal of primatology 63:4, 201–23.

SMITH, A. K. K. H., E. D. MERODE, F. SMITH, A. NDEY and N. MUSHENZI (2003). Parc National des Virunga – Nord: comptages aériens de mars 2003. ICCN, Kinshasa, DRC.

VANLEEUWE, H. (2009). Recensement des grands mammifères et impacts humains: Parcs Nationaux de l'Upemba et des Kundelungu. November. WCS, New York, USA.

VOSPER, A. (2010). Large mammal survey in the Faunal Reserve of Lomako-Yokokala. African Wildlife Foundation, Kinshasa, DRC.

VOSPER, A., J. MASSELINK and F. MAISELS (2012). Great ape and human impact monitoring in Okapi Faunal Reserve, Democratic Republic of Congo. WCS DRC, Kinshasa, DRC.

WEBER, A. and A. VEDDER (1983). Population dynamics of the Virunga gorillas: 1959–1978. Biological Conservation 26:4, 341–366.

YAMAGIWA, J., N. MWANZA, A. SPANGENBERG, T. MARUHASHI, T. TUMOTO, A. FISCHER and B. STEINHAUER-BURKART (1993). A census of the eastern lowland gorillas Gorilla gorilla graueri in Kahuzi-Biega National Park with reference to mountain gorillas G. g. beringei in the Virunga region, Zaire. Biological Conservation 64: 83–89.

Equatorial Guinea

MURAI, M., H. RUfflER, A. BERLEMONT, G. CAMPBELL, F. ESONO, A. AGBOR, D. MBOMIO, A. EBANA, A. NZE and H. S. KüHL (Sept. 2013). Priority Areas for Large Mammal Conservation in Equatorial Guinea. PLoS ONE 8:9. Ed. by D. RUSSO, e75024.

RUfflER, H. and M. MURAI (2011). A Conservation Survey of Great Apes and Elephants, Río Muni, Equatorial Guinea. Conservation International, Washington DC, USA.

SMITH, T. B., B. MILá, C. ROBERT, C. E. GRISWOLD, J. V. VINDUM, K. O. KEEFE, J. NGUEMA and R. C (1999). Biotic Surveys of Bioko and Rio Muni, Equatorial Guinea. Biodiversity Support Programme.

Republic of Congo

BERMEJO, M. (2003). Recensements de la faune sur le sanctuaire de gorilles de Lossi, zone affectée par le virus ebola. Groupement AGRECO GEIE-SECA-CIRAD Forêt.

BLAKE, S. (2005). Long term system for monitoring the illegal killing of elephants (MIKE). Central Africa forests: Final report on population surveys (2003–2004). WCS, CITES, WWF.

BLAKE, S. (2006). Rapport finale sur les inventaires d’éléphants et de grands singes du Parc National d’Odzala-Kokoua, 2005. WCS Congo, MIKE, ECOFAC, Brazzaville, Republic of Congo.

BLAKE, S., S. STRINDBERG, P. BOUDJAN, C. MAKOMBO, I. BILA-ISIA, O. ILAMBU, F. GROSSMANN, L. BENE-BENE, B. DE SEMBOLI, V. MBENZO, D. S’HWA, R. BAYOGO, L. WILLIAMSON, M. FAY, J. HART and F. MAISELS (Apr. 2007). Forest elephant crisis in the Congo Basin. PLoS biology 5:4, e111.

DEVOS, C., C. SANZ, D. MORGAN, J.-R. ONONONGA, N. LAPORTE and M.-C. HUYNEN (2008). Comparing ape densities and habitats in northern Congo: surveys of sympatric gorillas and chimpanzees in the Odzala and Ndoki regions. American journal of primatology 70:5, 439–451.

DOWNER, A. (1998). ‘A Series of Preliminary Surveys: Ecological, Demographic and Socioeconomic, and their Implications as Regards the Sustainability of the Lefini Game Reserve, Republic of Congo’. Masters Dissertation. University of Edinburgh, UK.

FAY, J. M. and M. AGNAGNA (1991a). Forest Elephant Populations in the Central African Republic and Congo. Pachyderm 14: 3–19.

— (1992). Census of gorillas in northern Republic of Congo. American Journal of Primatology 27:4, 275–284.

FAY, M. J. and M. AGNAGNA (1991b). A population survey of forest elephants (Loxodonta africana cyclotis) in northern Congo. African Journal of Ecology 29: 177–187.

IKOLI, F., Y. MADZOU and A. MOUKASSA (1998). Répartition des grands mammifères dans la Reserve de Faune de la Lefini et ses Environs. Global Environment Facility (GEF), The Wildlife Conservation Society, Projet Léfini (Congo), Brazzaville, Republic of Congo.

INKAMBA-NKULU, C. and R. TSOUMOU (2007). Sondage des éléphants de forêt (Loxodonta africana cyclotis, Matschie 1900) autour des sources de la rivière Nambouli. WCS Congo, Brazzaville, Republic of Congo.

INKAMBA-NKULU, C., F. MAISELS and P. TELFER (2013). Conservation of forest elephants in the Ogooué-Leketi National Park, Republic of Congo (Batéké Plateaux, Congo) Phase III. WCS Congo, Brazzaville, Republic of Congo.

IYENGUET, F. C., B. MADZOKé, F. TWAGIRASHYAKA, F. MAISELS, S. STRINDBERG and D. ESSIENI-ELONDZA (2012). Great Ape Conservation and Monitoring in the Lac Télé Landscape. GACF Agreement: 96200-1-G196 Final report to USFWS. WCS Congo, Brazzaville, Republic of Congo.

IYENGUET, F. C., G.-A. F. MALANDA, B. MADZOKé and F. TWAGIRASHYAKA (2008). Inventaire des grands mammifères et activités humaines dans la Zone Impfondo. WCS Congo, Brazzaville, Republic of Congo.

MAISELS, F., S. STRINDBERG, F. KIMINOU, C. NDZAI, R. NGOUNGA, A. OKONDZA, G. MALANDA, J.-P. SURAUD, G. LE FLOHIC, S. YABA-NGOUMA, A. LEPALE, J.-B. LEPALE, S. NGOUMA, M. DZANGA, D. EKOKO-MBOUNGOU and L. LAMPRECHT (2013). Wildlife and Human Impact Survey 2012, Odzala-Kokoua National Park. Fondation Odzala-Kokoua / WCS, Brazzaville, Republic of Congo.

MAISELS, F. and A. J. CRUICKSHANK (1996). Projet Conkouati: Inventory and census of large mammals. IUCN Projet Conkouati, Pointe Noire, Congo.

MAISELS, F., T. NISHIHARA, S. STRINDBERG, P. BOUDJAN, T. BREUER, P. ACZEL, C. SOURMAIL, R. MALONGA, P. C. BAKABANA, F. IYENGUET, F. KIMINOU, G.-A. MALANDA, O. MBANI, G. MOUKALA, C. NDZAI, F. NZOLANI and P. TELFER (2012). Great Ape and human impact monitoring training, surveys and protection in the Ndoki Likouala Landscape. GACF Agreement: 96200-9-G247 Final report to USFWS. WCS Congo, Brazzaville, Republic of Congo.

MAISELS, F. and J. R. ONONONGA (2006). Conkouati-Douli National Park: Conservation Status Jan/Feb 2000 Large mammals and Human Impact. WCS Congo, Brazzaville, Republic of Congo.

MALONGA, R. (2008). Final report on elephant and great apes survey in the Ngombe FMU and Ntokou-Pikounda forest: Contribution to a status survey of great apes in the Ntokou-Pikounda forest, Republic of Congo. WCS Congo, Brazzaville, Republic of Congo.

MALONGA, R., F. MAISELS, F. KIMINOU, G. MOUKALA, A. ALLAM and C. NDZAI (2009). Rapport d'inventaire des grands singes et d'éléphants dans le parc national d'Odzala-Koukoua. WCS Congo, Brazzaville, Republic of Congo.

MATHOT, L., F. IKOLI and B. MISSILOU (2006). Rapport annuel de monitoring de la faune du Projet Lésio-Louna, 2006. The John Aspinall Foundation, Brazzaville, Republic of Congo.

MOKOKO, J., R. MOBONGO, B. MADZOKé and F. BOEKANIA (2009). Dénombrements d'oiseaux d'eau et suivi de l'influenza aviaire dans le site Ramsar de la Reserve Communautaire du Lac Télé, République du Congo. WCS Congo, Brazzaville, Republic of Congo.

RAINEY, H. J., F. C. IYENGUET, G.-A. F. MALANDA, B. MADZOKé, D. D. SANTOS, E. J. STOKES, F. MAISELS and S. STRINDBERG (2009). Survey of Raphia swamp forest, Republic of Congo, indicates high densities of Critically Endangered western lowland gorillas Gorilla gorilla gorilla. Oryx 44:01, 124–132.

STOKES, E. E. J., S. STRINDBERG, P. P. C. BAKABANA, P. W. ELKAN, F. C. IYENGUET, B. MADZOKé, G.-A. F. MALANDA, B. S. MOWAWA, C. MOUKOUMBOU, F. K. OUAKABADIO, H. J. RAINEY, F. MALANDA, K. FRANCK and G. AIME (2010). Monitoring great ape and elephant abundance at large spatial scales: measuring effectiveness of a conservation landscape. PLoS One 5:4, e10294.

STOKES, E. J. (2007). Programme de suivi écologique, landscape Ndoki-Likouala, 2006–2007: Résumé des Résultats. WCS Congo, Brazzaville, Republic of Congo.

STOKES, E., R. MALONGA, H. RAINEY and S. STRINDBERG (2008). Western Lowland Gorilla surveys in Northern republic of Congo, 2006–2007: summary scientific report. WCS Congo, Brazzaville, Republic of Congo.

VANLEEUWE, H. (2010). Ecological surveys 2005, 2008 and 2010: Large mammal and human impact distribution and elephant and great ape densities at Conkouati-Douli National Park, République of Congo. Ministère du Développement Durable et de l'Envionnement et WCS Congo, Pointe Noire, Congo.

WCS (2006). Protocole du suivi écologique, Paysage Ndoki-Likouala. WCS Congo, Brazzaville, Republic of Congo.

— (2008). Protection and monitoring of Great Apes in Odzala-Kokoua NP, Congo. WCS Congo, Brazzaville, Republic of Congo.

Gabon

ABA'A, R. (2006). Abondance relative des grands mammifères et des activités humaines au Parc National des Monts de Cristal et sa périphérie. WCS Gabon, Libreville, Gabon, 40.

ABA'A, R. and A. BEZANGOYE (2007). Estimation de la densité, de l'abondance et de la distribution relative des grands mammifères et l'impact des activités anthropiques au Parc National des Monts Birougou et ses environs: Etablissement d'une ligne de base pour le monitoring. WCS Gabon, Libreville, Gabon.

ABITSI, G. (2006). Inventaire de reconnaissance des grands mammifères et de l'impact des activités anthropiques: Parc National de Waka, Gabon. WCS Gabon, Libreville, Gabon.

ANPN (2013). Wildlife and poaching assessment in Northeast Gabon/Evaluation sur la faune et braconnage dans la Nord-est du Gabon: Results of the pilot study Final Report. ANPN, WCS and WWF, Libreville,Gabon.

BEZANGOYE, A. and F. MAISELS (2010a). Great ape and human impact monitoring in the Lopé-Waka Exceptional Priority Area, Gabon. Part 1: Lopé National Park. April 2008. WCS Gabon, Libreville, Gabon.

— (2010b). Inventaire des grands mammifères et de l'impact des activités humaines, Parc National de la Lopé: 2ème cycle. WCS Gabon, Libreville, Gabon.

BLAKE, S. (2005). Long term system for monitoring the illegal killing of elephants (MIKE). Central Africa forests: Final report on population surveys (2003–2004). WCS, CITES, WWF.

BLAKE, S., S. STRINDBERG, P. BOUDJAN, C. MAKOMBO, I. BILA-ISIA, O. ILAMBU, F. GROSSMANN, L. BENE-BENE, B. DE SEMBOLI, V. MBENZO, D. S'HWA, R. BAYOGO, L. WILLIAMSON, M. FAY, J. HART and F. MAISELS (Apr. 2007). Forest elephant crisis in the Congo Basin. PLoS biology 5:4, e111.

BOUT, N. (2006). Parc National des Plateaux Batéké, Gabon: suivi écologique des grands mammifères et de l'impact humain. WCS Gabon, Libreville, Gabon.

— (2008). Etude de l'écologie et des caractéristiques de la population des éléphants de la région des Plateaux Batéké, Gabon. Programme de Recherche et de Conservation des Eléphants des Plateaux Batéké (WCS/CIRMF/CIRAD), Franceville.

LE-DUC YENO, S. and M. A. ELLA AKOU (2012). Suivi des baïs et cartographie des pistes d'éléphants dans le Parc National de Mwagna. WWF, Libreville, Gabon.

HENSCHEL, P. (2003). Hunting pressure and large mammal abundance in the Plateaux Batéké National Park (PBNP) and surrounding areas: Results of two WCS field surveys in 2001 and 2003. WCS Gabon, Libreville, Gabon.

KOKANGOYE, M. (2007). Monitoring des grands mammifères terrestres dans le Parc National de Loango : cas de la partie nord. WCS Gabon, Libreville, Gabon.

KUEHL, H. S., C. NZEINGUI, S. LE DUC YENO, B. HUIJBREGTS, C. BOESCH and P. D. WALSH (2009). Discriminating between village and commercial hunting of apes. Biological Conservation 142:7, 1500–1506.

LATOUR, S. (2006). Recensement d'éléphants et de grands singes dans la région du Parc National de Pongara, Gabon. WCS Gabon, LIbreville.

MAISELS, F. (2004). Large mammals and human impact, first results of the transects; Ivindo National Park. WCS Gabon, Libreville, Gabon.

— (2009). Loango National Park: Nord et Sud. Densités des nids des grands singes, et crottes des elephants et des cephalophes de moyenne taille. WCS, Libreville, Gabon.

MAISELS, F., G. ABITSI and A. BEZANGOYE (2008a). Great ape and human impact monitoring in the Lope-Waka Exceptional Priority Area, Gabon. Part 2: The Lope-Waka Corridor. WCS Gabon, Libreville, Gabon.

MAISELS, F. and M. E. AKOU (2013). Mwagna National Park: Report on survey transects 2012. ANPN, WCS and WWF, Libreville, Gabon.

MAISELS, F., M. BECHEM and Y. MIHINDOU (2005a). Lope National Park, Gabon: Large Mammals and Human Impact Summary 2004-2005. WCS Gabon, Libreville, Gabon.

— (2005b). Parc National de le Lopé, Gabon: Grands mammifères et l'impact humaine 2004–2005. WCS Gabon, Libreville, Gabon.

MAISELS, F., M. A. ELLA, M. DOUCKAGA and A. MOUNDOUNGA (2004). Mwange National Park Gabon. Trip report, Nov-Dec 2004. Large Mammals and Human Impact. WCS Gabon, Libreville, Gabon.

MAISELS, F., P. MOTSABA and R. ABA'A (2010b). Great ape and human impact monitoring in the Ivindo Landscape, Gabon. WCS Gabon, Libreville, Gabon.

MAISELS, F., P. MOTSABA, J.-P. TEZI and R. ABA'A (2009b). Great ape and human impact monitoring in the Ivindo Landscape, Gabon: Completion of the second cycle of monitoring in the park. 2009. WCS Gabon, Libreville.

MAKAYA, Q. P. (2007). Monitoring écologique terrestre sur les grands mammifères et l'impact des humains dans le parc national de Mayumba, Gabon: 2007. WCS Gabon.

— (2008). Monitoring des grands mammifères et l'impact des humains dans le Parc National de Mayumba, Gabon: 2008. WCS Gabon, Libreville, Gabon.

— (2009). Monitoring écologique terrestre des grands mammifères et l'impact anthropique dans le Parc National de Mayumba, Gabon: 2009. WCS Gabon, Libreville, Gabon.

— (2010). Monitoring de grands mammifères terrestres et l'impact des humains dans le Parc National de Mayumba, Gabon: 2010. WCS Gabon, Libreville, Gabon.

MOTSABA, P. and R. ABA'A (2011). Réserve Presidentielle de Wonga-Wongué : Etude pilote de grands mammifères et des activités anthropiques. WCS Gabon, Libreville, Gabon.

MOTSABA, P., J.-P. TEZI, R. ABA'A and F. MAISELS (2009). Recensement des grands mammifères et des impacts humains au Parc National d'Ivindo, Gabon. WCS Gabon, Libreville, Gabon.

WALSH, P. D., L. J. T. WHITE, C. MBINA, D. IDIATA, Y. MIHINDOU, F. MAISELS and M. THIBAULT (2001). Estimates of forest elephant abundance: projecting the relationship between precision and effort. Anglais. Journal of Applied Ecology 38: 217–228.

YENO, S. L.-D. (2006). Suivi des grands mammifères dans le secteur Sud Parc National de Loango. WWF Gabon, Libreville, Gabon.

Appendix I Protected Areas Surveyed

Country	PA Name	PA_type	Ecological Data Status	Management Plan	Date created	Area hectares
Cameroun	Banyang-Mbo	Faunal Sanctuary	Data	Pas encore (confirmé par ancien conservateur)	1996	69 093
Cameroun	Bénoué	National Park	Data	Validé	1968	199 241
Cameroun	Bouba Ndjida	National Park	Data	En cours	1968	213 414
Cameroun	Boumba Bek	National Park	Data	En cours	2005	238 941
Cameroun	Campo Ma'an	National Park	Data	Validé	2000	260 944
Cameroun	Deng Deng	National Park	Data	Pas de données	2010	75 182
Cameroun	Dja	Wildlife Reserve	Data	Validé	1950	590 053
Cameroun	Douala Edéa	Wildlife Reserve	No Data	Pas encore	1932	168 116
Cameroun	Faro	National Park	Data	Validé	1947	342 887
Cameroun	Kagwene	Gorilla sanctuary	Data	Pas encore	2008	1 931
Cameroun	Kala-Maloué	National Park	Never Surveyed	Pas encore	1972	6 757
Cameroun	Kilum-Ijim	Sanctuary	Data		1987	1 006
Cameroun	Kimbi	Wildlife Reserve	No Data	Pas encore	1964	5 163
Cameroun	Korup	National Park	Data	Validé	1986	129 457
Cameroun	Lac Ossa	Wildlife Reserve	Never Surveyed	Pas encore (confirmé par conservateur)	1968	4 539
Cameroun	Lobéké	National Park	Data	Validé	2001	218 372

Cameroun	Mbam et Djerem	National Park	Data	Validé	2000	430 242
Cameroun	Mengamé	Gorilla sanctuary	Data	En cours	2008	120 646
Cameroun	Mont Cameroun	National Park	Data	Pas de données	2009	58 148
Cameroun	Monts Bakossi	National Park	No Data	Pas encore	2007	36 000
Cameroun	Mozogo Gokoro	National Park	Never Surveyed	Pas encore	1968	1 736
Cameroun	Mpem et Djim	National Park	Never Surveyed	Pas encore	2004	104 138
Cameroun	Nki	National Park	Data	En cours	2005	326 567
Cameroun	Santchou	Wildlife Reserve	No Data	Pas encore	1964	9 500
Cameroun	Takamanda	National Park	Data	En cours	2008	62 716
Cameroun	Vallée du Mbere	National Park	Never Surveyed	Pas encore	2004	74 884
Cameroun	Waza	National Park	Data	Validé	1968	141 939
Congo	Conkouati-Douli	National Park	Data	En cours	1999	513 952
Congo	Dimonika	Réserve de biosphère/ ou Faunal reserve?	Data	Pas encore	1988	147 321
Congo	Lac Télé	Community reserve	Data	En cours	2001	459 939
Congo	Lefini	Faunal reserve	Data	Pas encore	1951	658 021
Congo	Lesio-Louna	Gorilla sanctuary	Data	En cours	1993	53 254
Congo	Lossi	Gorilla sanctuary	Data	Pas encore	2001	80 864
Congo	Mont Fouari	Faunal reserve	Data	Pas encore	1956	28 809
Congo	Mont Mavoumbou	Faunal reserve/ ou Hunting reserve?	No Data	Pas encore	1956	22 910
Congo	Nouabalé-Ndoki	National Park	Data	En cours	1993	415 906
Congo	Ntokou-Pikounda	National Park	Data	En cours	2012	457 200
Congo	Nyanga Nord	Faunal reserve/ ou Hunting reserve?	Never Surveyed	Pas encore	1956	8 818

Congo	Nyanga Sud	Faunal reserve/ ou Hunting reserve?	Never Surveyed	Pas encore	1970	21 051
Congo	Odzala-Kokoua	National Park	Data	En cours (confirmé par conservateur)	2001	1 373 282
Congo	Tsoulou	Wildlife Reserve	No Data	Pas encore	1963	28 908
Equatorial Guinea	Altos de Nsork	National Park	Data	En cours	2000	69 245
Equatorial Guinea	Estuario de Muni	Natural reserve	Data	Pas encore	2000	60 188
Equatorial Guinea	Monte Alén	National Park	Data	En cours	1990	189 586
Equatorial Guinea	Monte Temelón	Natural reserve	Data	Pas encore	2000	25 721
Equatorial Guinea	Pedra Nzaz	Monument Naturel	Data	Pas encore	2000	18 527
Equatorial Guinea	Piedra Bere	Monument Naturel	Data	Pas encore	2000	20 436
Equatorial Guinea	Punta Liende	Natural reserve	Data		2000	8 407
Equatorial Guinea	Rio Campo	Natural reserve	Data	En cours	2000	33 721
Gabon	Birougou	National Park	Data	Pas encore	2002	69 000
Gabon	Iguéla	Hunting reserve	Data		1966	80 000
Gabon	Ivindo	National Park	Data	Pas encore	2002	300 200
Gabon	Loango	National Park	Data	En cours	2002	149 000
Gabon	Lopé	National Park	Data	Validé	2002	495 600
Gabon	Minkébé	National Park	Data	Pas encore	2002	753 500
Gabon	Mondah	Forêt classée	Never Surveyed		1951	5 600
Gabon	Monts de Cristal	National Park	Data	Pas encore	2002	119 150
Gabon	Moukalaba	Faunal reserve	Never Surveyed		1962	21 740

Gabon	Moukalaba-Doudou	National Park	Data	Pas encore	2002	445 800
Gabon	Mwagna	National Park	Data	Pas encore	2002	116 650
Gabon	Ngove-Ndogo	Hunting reserve	Data		1966	278 850
Gabon	Ouanga	Faunal reserve	Never Surveyed		1966	10 900
Gabon	Plateaux Batéké	National Park	Data	Validé	2002	204 150
Gabon	Pongara	National Park	Data	Pas encore	2002	96 000
Gabon	Sette Cama	Hunting reserve	Data		1986	240 500
Gabon	Waka	National Park	Data	Pas encore	2002	106 130
Gabon	Wonga-wongué	Réserve présidentielle	Data		1972	429 900
RCA	André Félix	National Park	No Data	Pas encore	1940	170 000
RCA	Aouk-Aoukalé	Faunal reserve	Data	Pas encore	1939	330 000
RCA	Awakaba	Parc Présidentiel	Data	Pas encore	1968	178 608
RCA	Bamingui-Bangoran	National Park	Data	Pas encore	1933	1 070 000
RCA	Basse Lobaye	Réserve de biosphère	No Data	Pas encore	1951	14 600
RCA	Dzanga-Ndoki	National Park	Data	En cours (confirmé)	1990	49 500
RCA	Gribingui-Bamingui	Faunal reserve	Data	Pas encore	1940	450 000
RCA	Manovo Gounda St Floris	National Park	Data	Pas encore	1933	1 740 000
RCA	Mbaéré Bodingué	National Park/ ou réserve intégrale?	Data	Pas encore	1996	86 900
RCA	Vassako Bolo	Natural reserve intégrale	Data	Pas encore	1933	86 000
RCA	Yata Ngaya	Faunal reserve	No Data	Pas encore	1940	420 000
RCA	Zemongo	Faunal reserve	No Data	Pas encore	1970	1 010 000
RDC	Alunda et des Tutshokwe	Hunting reserve	No Data	Pas encore	1954	237 279
RDC	Azande	Hunting reserve	Data	Pas encore	1974	405 789
RDC	Basse Kando	Hunting reserve	Never Surveyed	Pas encore	2006	49 283
RDC	Bili-Uere	Hunting reserve	Never Surveyed	Pas encore	1974	3 274 838

RDC	Bombo Lumene	Hunting reserve	No Data	Pas encore	1968	206 395
RDC	Bomu	Faunal reserve	No Data	Pas encore	1974	1 066 711
RDC	Bushimaie	Hunting reserve	No Data	Pas encore	1958	436 870
RDC	Gangala-na Bodio	Hunting reserve	Data	Pas encore	1974	373 753
RDC	Garamba	National Park	Data	En cours	1938	511 195
RDC	Itombwe	Natural reserve	Data	Pas encore	2006	656 000
RDC	Iyondji Community Bonbo Reserve	Réserve scientifique	Data		2012	22 559
RDC	Kahuzi-Biega	National Park	Data	En cours (confirmé par conservateur)	1970	668 937
RDC	Kisimba Ikobo	Natural reserve	No Data	Pas encore	2006	96 327
RDC	Kiziba-baluba	Hunting reserve	No Data	Pas encore	2006	150 813
RDC	Kundelungu	National Park	Data	Pas encore	1970	823 636
RDC	Lomako-Yokokala	Natural reserve	Data	En cours	2006	360 188
RDC	Luama-Katanga	Hunting reserve	No Data	Pas encore	1954	340 841
RDC	Luama-Kivu	Hunting reserve	No Data	Pas encore	1935	390 028
RDC	Lubudi-Sampwe	Hunting reserve	No Data	Pas encore	1959	348 876
RDC	Luki	Réserve de Biosphère	No Data	Pas encore	1979	31 059
RDC	Maika-Penge	Hunting reserve	No Data	Pas encore	1951	149 864
RDC	Maiko	National Park	Data	Pas encore	1970	1 088 578
RDC	Mangai	Natural reserve	No Data	Pas encore	1944	331 870
RDC	Mondo-Missa	Hunting reserve	Data	Pas encore	1974	195 761
RDC	Mufufya	Hunting reserve	No Data	Pas encore	1954	91 097
RDC	Mulumbu	Hunting reserve	No Data	Pas encore	1957	126 785
RDC	Mwene Kay	Hunting reserve	No Data	Pas encore	1954	54 051
RDC	Mwene Musoma	Hunting reserve	No Data	Pas encore	1954	132 346
RDC	Okapis	Faunal reserve	Data	Pas encore	1992	1 384 674
RDC	Oshwe	Hunting reserve	No Data	Pas encore	2004	1 325 177
RDC	Parc Président Mobutu	Natural reserve	No Data	Pas encore	1983	3 569

RDC	Plateau de Kundelungu	Hunting reserve	No Data	Pas encore	1953	164 518
RDC	Rubi-Tele	Hunting reserve	No Data	Pas encore	1930	619 143
RDC	Rutshuru	Hunting reserve	No Data	Pas encore	1974	66 067
RDC	Salonga	National Park	Data	En cours	1970	3 316 587
RDC	Sankuru	Natural reserve	Never Surveyed	Pas encore	2007	2 441 964
RDC	Sarambwe	Natural reserve	No Data	Pas encore	2006	75 266
RDC	Swa-Kibula	Hunting reserve	Never Surveyed	Pas encore	1952	100 375
RDC	Tayna	Natural reserve	Data	Pas encore	2006	89 292
RDC	Upemba	National Park	Data	Pas encore	1939	1 367 365
RDC	Virunga	National Park	Data	En cours	1925	776 893
RDC	Yangambi	Réserve de Biosphère	No Data	Pas encore	1976	221 472

Appendix II Species surveyed

Species	Survey frequency	Geographical Distribution[3]	IUCN
Loxodonta africana	172	6	VU
Great apes	47	6	
Gorilla gorilla gorilla	40	6	CR
Cephalophe rouges	37	6	
Pan troglodytes troglodytes	32	6	EN
Eudorcas rufifrons	30	1	VU
Panthera leo	13	6	VU
Tragelaphus eurycerus	12	5	NT
Ceratotherium simum cottoni	12	2	CR
Panthera pardus	10	6	NT
Lycaon pictus	10	1	EN
Gorilla beringei graueri	8	1	EN
Gorilla beringei beringei	8	1	EN
Hippopotamus amphibius	7	6	VU
Pan paniscus	7	1	EN
Pan troglodytes ellioti	7	1	EN
Lophocebus aterrimus	5	2	NT
Okapia johnstoni	5	1	NT
Pan troglodytes schweinfurthii	5	1	EN
Gorilla gorilla dehli	5	1	CR
Smutsia gigantea	3	6	NT
Blue duiker	1	6	LC
Diceros bicornis longipes	1	1	EX

[3] Number of countries with the study scope where the species, sub-species or species group occurs