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.

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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).
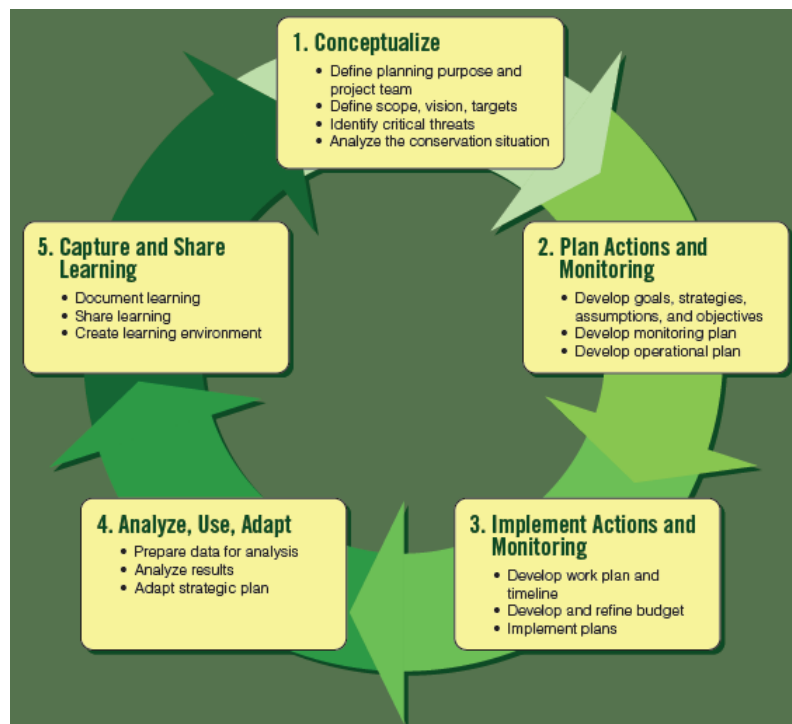

Figure 1 : The adaptive management cycle, as presented by the Conservation Measures Partnership (CMP, 2013).

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 literature[2]. 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.

| | Number of protected areas with: | | | |
Country	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.

| | Approx area (km^2) of protected area with: | | | |
Country	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).
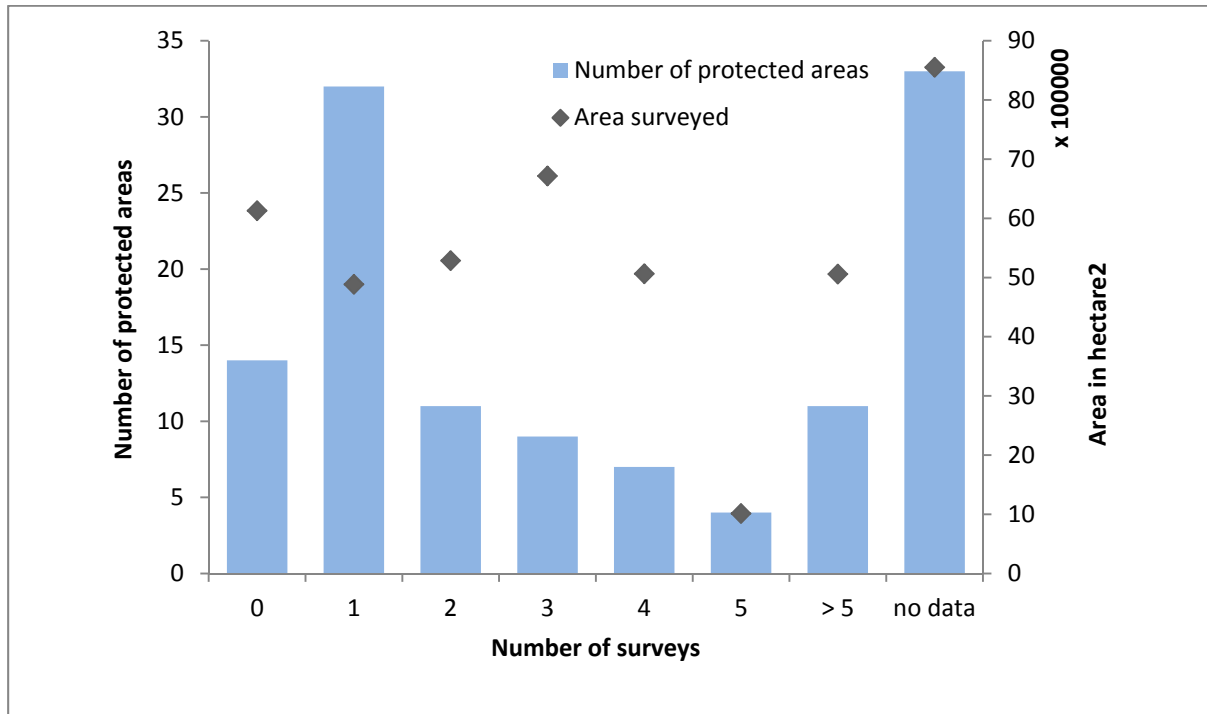
Figure 2 : Number of surveys per protected area and by area surveyed (n=255 surveys across 121 protected areas)

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.

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[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

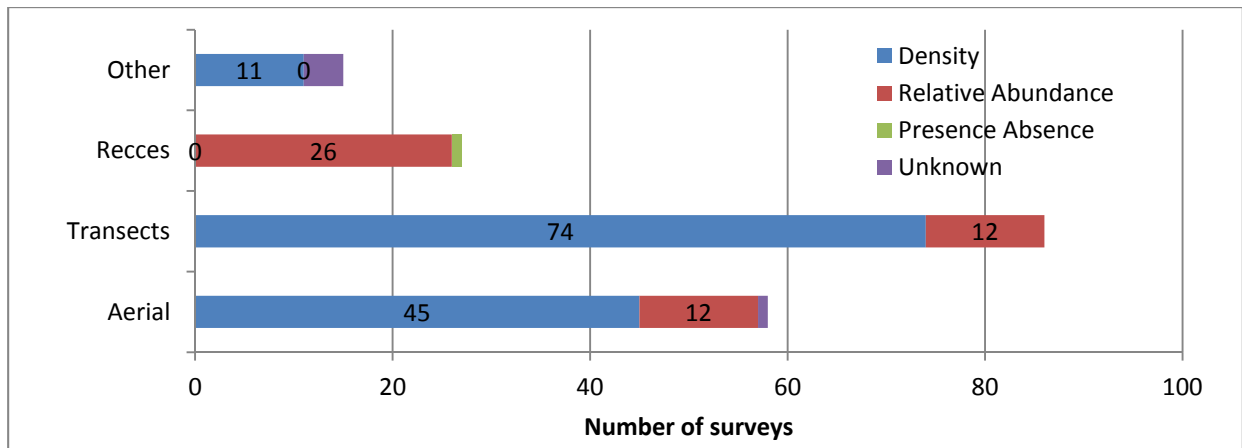By far the most frequently surveyed species is the African Elephant (*Loxodonta africana*). This is followed by the wide-spread great ape sub-species (*Gorilla gorilla gorilla* and *Pan troglodytes troglodytes*), red duiker (a group of medium-sized duiker species), and red-fronted gazelle (*Eudorcas 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.
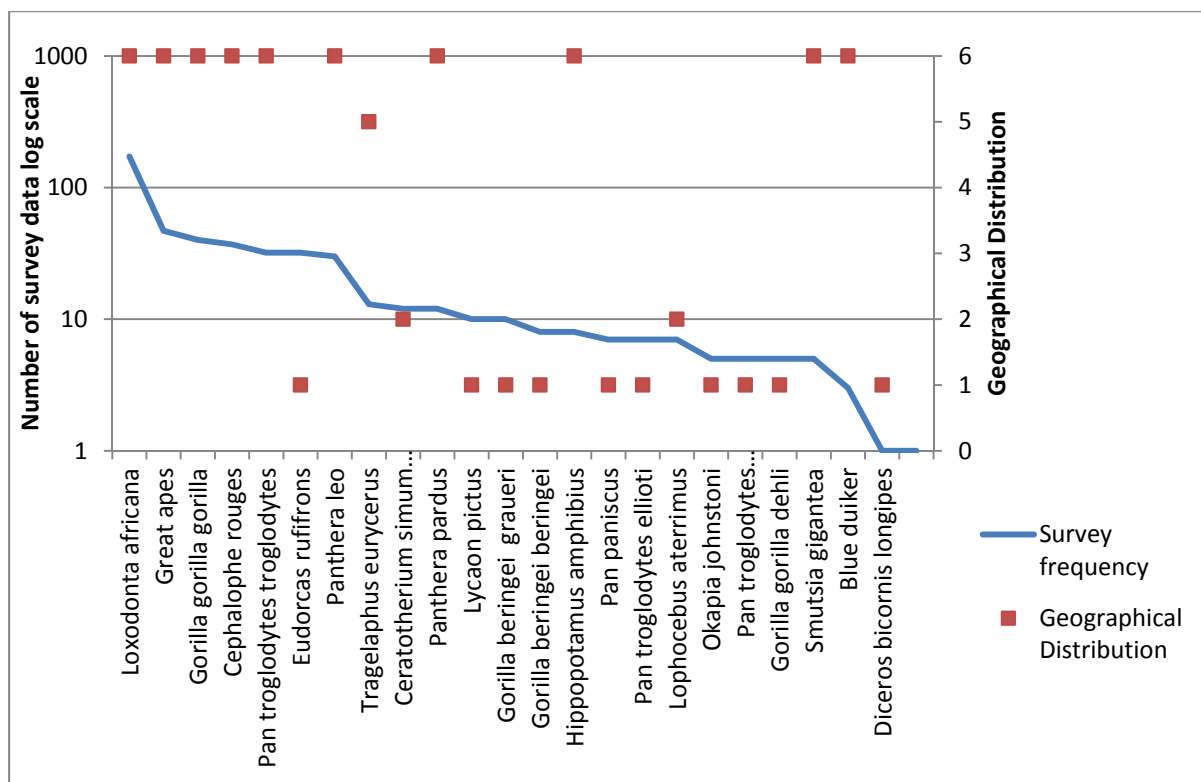
Figure 4 : number of survey data by species, sub-species or species groups, and number of countries in survey scope where they are found

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

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[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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- 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.

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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

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