CONGO BASIN Information SERIES

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#14

Establishing Ecological Monitoring Programs

What, Where and How to Monitor

Key Concepts

- Monitoring of threats to forest resources and changes in the state of forest resources is costly relative to monitoring non-forested landscapes.
- To be cost-effective biodiversity monitoring must be based on: (1) identification and prioritization of the biophysical and socioeconomic factors that threaten forest biodiversity in a given area, (2) clear characterization of the desired or target state of forest biodiversity in the future, (3) identification of direct or proxy measures that will indicate progress toward the desired forest state over time, (4) specification of the techniques to be used to quantify the direct or proxy measures of forest state, (5) estimation of the level of effort in time and money to have confidence in the accuracy of the measures of changing forest state, and (6) have in place a set of responses to likely observed changes in state of direct and proxy measures.
- Relatively cost-effective tools now exist that facilitate monitoring in forests at local- (recce-transect, informant recall, aerial videography) and regional-scale (satellite image analysis).
- Focusing monitoring activities solely within protected areas may not provide sufficient early warning of changes in threats and forest state in surrounding human dominated landscapes that may adversely impact the long-term persistence of the flora and fauna protected within the park or reserve.
- Determining the appropriate scale at which to monitor different threats to biodiversity is critical to ensure that remedial action can avert unacceptable habitat and species losses.

The Importance of Monitoring for Conservation

There is a growing understanding by governments, donors, and conservation NGOs that monitoring is an essential component of effective conservation practice. Yet, it is seldom clear why monitoring is taking place and how monitoring results will be used to produce intangible improvements in the effectiveness of conservation actions. Sadly, many monitoring programs are designed more to characterize how conservation dollars were spent, rather than how that investment resulted in a conservation benefit. Worse, monitoring is even less geared to characterizing how that conservation investment might need to be adapted to benefit from the lessons learned from analysis of the monitoring data.

Monitoring is typically considered as mere research and consequently a luxury in protected area management. This perspective is best exemplified by the fact that most National Parks institutions in Africa do not fund research positions. In those that do, when funding becomes scarce, research and monitoring are often the first areas that are cut from management programs. As an illustrative example, the Uganda Wildlife Authority has stated that it cannot fund research in its parks but encourages NGOs, universities and individual researchers to help them carry out research projects they feel are necessary.

Yet, monitoring should be a central and operational component of all conservation management activities, because if we cannot measure and assess what impact we are having on the conservation of biodiversity, we can never adapt our assumptions and management practices and thus improve the effectiveness of our conservation actions. Monitoring should not be considered a dispensable luxury, but an essential tool for adaptively managing conservation actions as conditions change and we learn from our efforts.

Monitoring should always be planned with potential responses in mind if the monitoring detects levels of unacceptable change in the state of the natural resource base. Monitoring can be expensive and therefore it is important to think very strategically about what to monitor and where to monitor. Monitoring should focus on assessing the outcome of management actions specifically designed to resolve some threat to biodiversity conservation. Monitoring should be able to track, using specific measures of change, progress in achieving the target condition desired (i.e., an ecologically viable population of 600 lowland gorillas). Monitoring should also lead to a response when expected results are not achieved and a change in management actions are required. ■

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Deciding What and Where to Monitor

The first step before a monitoring plan is developed is to carry out a threat analysis for the management area. This allows you to identify the spatial pattern and causes of threats to long term conservation and also to prioritize which threats are more important/immediate and which need to be addressed urgently. A monitoring program should focus on these primary threats when financial resources are limited. Monitoring should measure how the primary threats are reduced by management actions and also be able to detect if the location of the primary threats is changing within the management area. For instance, poaching around a village may be one of the primary threats and so a monitoring program should measure the incidences of poaching activity around the village as management actions to reduce poaching (such as increased patrols and community education programs) proceed. However, the monitoring program should also be able to identify if the management actions have simply shifted poaching to another part of the park. Many of the threat indicators that need monitoring will be socioeconomic rather than biological factors.

If there are additional funds, then it is useful to establish biological monitoring programs that will measure changes in the ecosystem over a longer time period. Natural changes in the vegetation structure, biological community and ecosystem processes take place continuously, but often do so at a rate that makes them difficult to notice unless monitoring continues for several years at least. Yet, understanding how complex communities and ecosystems change is important if we are to manage them effectively. For example, as a result of monitoring efforts we now know that many important timber species require disturbed forest, and that if we want to promote regeneration of these economically valuable resources we may need to artificially disturb some areas during timber harvesting to ensure that seedlings survive and ultimately replace felled trees. A monitoring program should to try to include basic biological surveys whenever feasible. If financial resources are limited, it may be possible to link up with a University in Europe or the United States that would be interested in establishing a research program that would provide this kind of information.

Some types of monitoring require highly trained people who are needed at regular intervals, such as vegetation monitoring using permanent plots where trained botanists or are required to identify tree species. Other types of monitoring are less specialized and can easily be done by protected area rangers as they go about patrolling the landscape. Self-monitoring by local communities can be used to gauge the economic success of new livelihood enterprises and the strength of nascent constituencies for community-based natural resource management. Determining who can collect what data accurately and efficiently is one of the decisions that must be thought about carefully when designing a monitoring program. It is generally best when the people who will use the data are the ones who collect and analyze it themselves.

The scale at which the monitoring program takes place is also very important. For instance, a monitoring program can monitor areas within a protected area, over the whole protected area, and also within and outside a protected area. Determining at what scale monitoring should take place is vital before implementing a monitoring program. Monitoring at sites within a protected area is useful when you want to detect local changes, such as animal numbers around a human settlement. Monitoring across the whole protected area might include systematic surveys of illegal human activities and linking this with information from more ad hoc ranger patrols and patrol effort. At a large scale it may be important to monitor activities outside a protected area that may have an impact on the protected area, such as effluent discharge from a factory upstream of a reserve or road developments in a logging concession adjacent to a reserve. ■

New Techniques that are Useful for Ecological Monitoring

More Robust Detection Methods

Field scientists in Central Africa have been looking at the current field methods that are used in tropical forests and their efficacy for monitoring animal populations. What these analyses show are that economically feasible monitoring using current line transect methods cannot detect increases or declines in mammal populations unless the population changes by more than 30-50% between censuses. To try to improve on this a recce-transect method has been developed that combines the standard transect methods with reconnaissance walks. This method is able to survey more territory with less effort, thereby reducing uncertainty, increasing our confidence that an observed change in population density is real, and making reliable monitoring more affordable.

Aerial Videography

The use of aircraft mounted video as a cheap and easy means of monitoring changes in the environment has been developed and refined over the last 15 years. Video is easy to shoot these days and with digital cameras it is simple to import the information to a computer for interpretation and analysis. For example, in the Nouabalé-Ndoki National Park in northern Congo, an NTSC format Sony VX-1000 Digital Handicam is mounted on a Cessna 172. It has been found that at a ground speed of 100 knots and the focal length of the videocamera set such that a single frame covers a 200 meters wide swath of terrain, about 4,000 ha can be covered in one hour's flying. Aerial videography is particularly useful for repeated surveys over relatively small areas or along linear features such as roads or rivers. When assisted by a GPS

(global positioning system) receiver, a skilled pilot can refly transects in unmarked terrain by using a standard set of way-points. Aerial videography can be used to (1) monitor changes in human settlement (number, distribution and quality of houses) and land clearing for agriculture, (2) track the expansion of roads into frontier areas, (3) detect illegal mining and poaching camps, and (4) count the number of elephants killed near water holes or salt licks. Videography is a useful and underutilized tool for monitor biological and socioeconomic variables over moderate scale between 5 and 500 km².

Satellite Image Analysis

Satellite image analysis is not new, and its use in monitoring programs has increased as multi-date image sets have become available, thereby allowing analysis of changes in land cover and land use over time. With the return of the Landsat program to the U.S. government and a decrease in the price to power ratio of computers, the cost of buying and analyzing remote sensing imagery is now economically feasible for many more protected area projects. Satellite imagery is particularly suited to monitoring land cover and land-use changes where the features of interest are larger than 1 ha, but they cover large areas (1,000 - 10,000 km²). In general they do not provide early warning of forest degradation. The decrease in the cost of computing has made regional time-series analyses using Landsat data feasible, however obtaining cloud free imagery in persistently cloudy areas remains a problem for optical systems. Hyperspatial resolution (1m-3m) data from IKONOS is currently being investigated for identifying forest disturbance and scaling up from field measurements to the resolution of Landsat data. ■

Costs of Ecological Monitoring

Monitoring in forests is significantly more costly than monitoring in savanna ecosystems. In savannas it is relatively cheap to fly an airplane over a protected area and obtain a lot of useful information on habitat patterns, wildlife densities and movement patterns. In forests, monitoring of animal populations and human impacts on animals requires intensive efforts on the ground because we cannot look through the forest canopy and identify individual animals, yet. As a result, wildlife population monitoring has occurred only at a fairly local scale, even though many large-bodied, wide ranging species such as elephants, gorillas, and leopards should realistically be monitored over much larger scales if we are to detect what is happening at the population level. For instance, if monitoring focuses only within protected areas and detects an increase in an animal's population does this mean the population is increasing or animals are fleeing from hunting pressures outside the protected area and hence are artificially increasing the population within the protected area. CITES is trying to develop a monitoring program for forest elephants that aims to look at how you monitor the populations of an animal over the scale of the Congo basin, while at the same time minimizing the costs of the survey effort required. Understanding how to monitor at much larger scales when you need to use methods that are more applicable for more fine scale monitoring, is an important future avenue of research.

Determining the relative merits of different monitoring approaches such as ranger based monitoring versus aerial videography is also important if we are to ensure that monitoring efforts are the most cost effective. To facilitate this analysis conservation projects across the basin should measure and report the costs of monitoring programs and characterize the quality of the data and its utility for tracking changes in the state of the forest. ■

Determining Causes of Change

In many cases regular ecological monitoring allows changes in the natural resource base to be detected, but rarely tells us much about the underlying socioeconomic causes, or whether these driving forces are themselves changing. Ideally a monitoring program should be designed around a conceptual model that incorporates socioeconomic monitoring in threat assessment. In this way, both the factor driving change and the change itself can be monitored. ■

A Cessna used to monitor changes in the forest using aerial videography.

Monitoring changes in wildlife populations within the forest is much more time consuming and costly than in grasslands and scrub savannas.

For More Information

Technical Reports:

Margoluis, R. and N. Salafsky, N. 1998. *Measures of success: Designing, managing, and monitoring conservation and development projects.* Washington, D.C.: Island Press.

Plumptre, A. J. 2000. Monitoring mammal populations with line transect techniques in African Forests. *Journal of Applied Ecology* 37:356-368.

Walsh, P. D. and L. J. T. White. 1999. What will it take to monitor forest elephants? *Conservation Biology* 13:1194-1202.

CARPE ... What Is It?

Central African Regional Program for the Environment (CARPE)

Launched in 1995, the *Central African Regional Program for the Environment (CARPE)* engages African NGOs, research and educational organizations, private-sector consultants, and government agencies in evaluating threats to forest integrity in the Congo Basin and in identifying opportunities to sustainably manage the region's vast forests for the benefit of Africans and the world. CARPE's members are helping to provide African decision makers with the information they will need to make well-informed choices about forest use in the future. BSP has assumed the role of "air traffic controller" for CARPE's African partners. Participating countries include Burundi, Cameroon, Central African Republic, Democratic Republic of Congo, Equatorial Guinea, Gabon, Republic of Congo, Rwanda, and São Tomé e Principe.

Web site:
http://carpe.umd.edu

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