Forest Resources Assessment Working Paper 159

CASE STUDIES ON MEASURING AND ASSESSING FOREST DEGRADATION

DEFAUNATION AND FOREST DEGRADATION IN CENTRAL AFRICAN LOGGING CONCESSIONS:

HOW TO MEASURE THE IMPACTS OF BUSHMEAT HUNTING ON THE ECOSYSTEM

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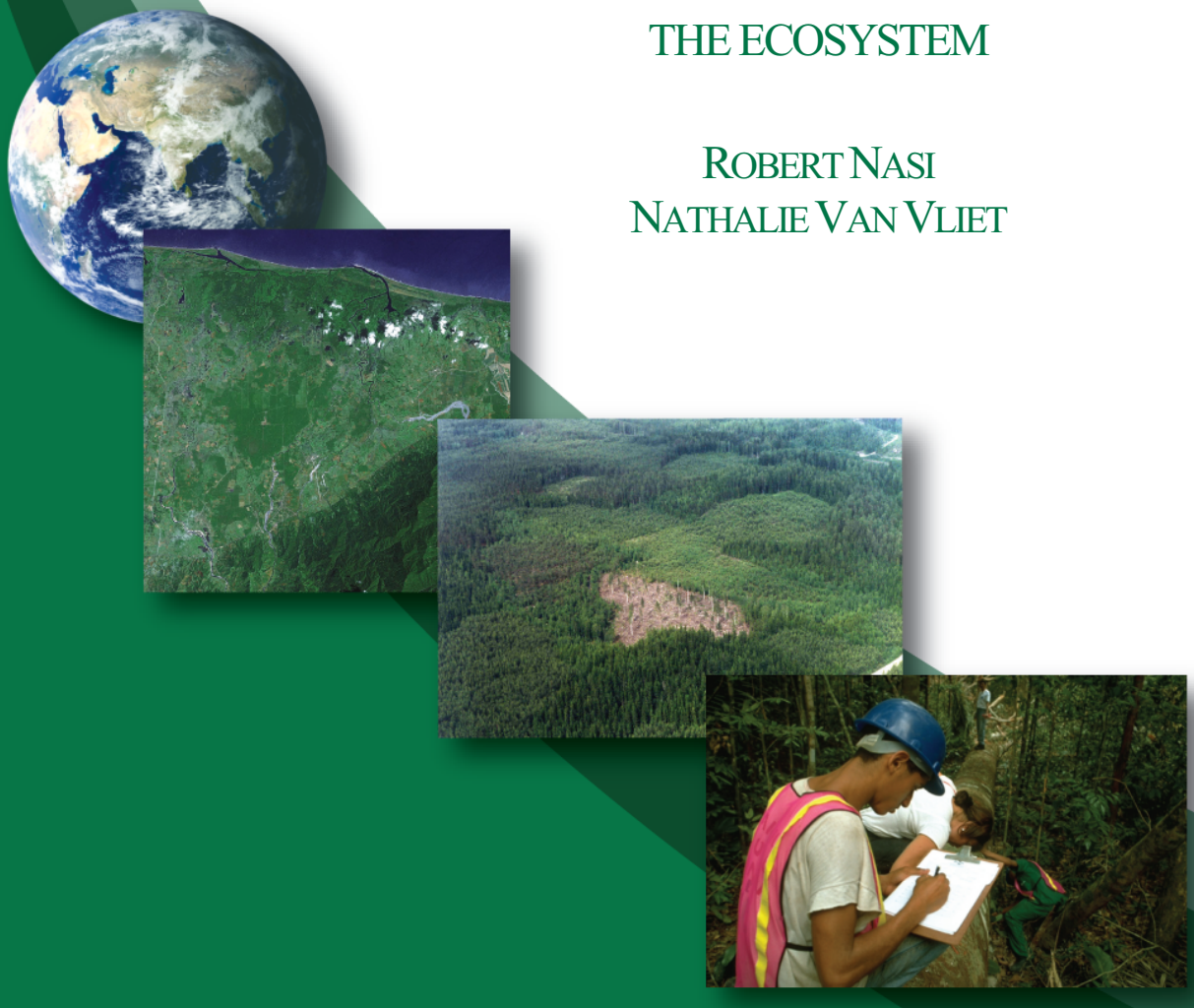

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Sustainably managed forests have multiple environmental and socio-economic functions which are important at the global, national and local scales, and they play a vital part in sustainable development. Reliable and up-to-date information on the state of forest resources - not only on area and area change, but also on such variables as growing stock, wood and non-wood products, carbon, protected areas, use of forests for recreation and other services, biological diversity and forests' contribution to national economies - is crucial to support decision-making for policies and programmes in forestry and sustainable development at all levels.

Under the umbrella of the Global Forest Resources Assessment 2010 (FRA 2010) and together with members of the Collaborative Partnership on Forests (CPF) and other partners, FAO has initiated a special study to identify the elements of forest degradation and the best practices for assessing them. The objectives of the initiative are to help strengthen the capacity of countries to assess, monitor and report on forest degradation by:

- Identifying specific elements and indicators of forest degradation and degraded forests;
- Classifying elements and harmonizing definitions;
- Identifying and describing existing and promising assessment methodologies;
- Developing assessment tools and guidelines

Expected outcomes and benefits of the initiative include:

- Better understanding of the concept and components of forest degradation;
- An analysis of definitions of forest degradation and associated terms;
- Guidelines and effective, cost-efficient tools and techniques to help assess and monitor forest degradation; and
- Enhanced ability to meet current and future reporting requirements on forest degradation.

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Forest Resources Assessment Working Paper

Case Studies on Measuring and Assessing Forest Degradation

Defaunation and Forest Degradation in Central African Logging Concessions: How to Measure the impacts of bush meat hunting on the ecosystem

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Abstract

The present paper is a review of the methods used for assessing defaunation, as a forest degradation component, linked to logging and logging concessions with an emphasis on mammals and Central Africa Rainforests. A discussion on the usefulness and weaknesses of these methods is provided.

Key words: Tropical forest degradation, biodiversity, bushmeat, monitoring

1. Introduction

In central Africa selective logging is the most area extensive extractive industry, with logging concessions occupying 30 – 45% (up to 70% in some countries) of the tropical forests (Global Forest Watch 2002; Nasi et al. 2006, Laporte et al. 2007). Logging is known to have different types of impacts on wildlife that can be classified as direct impacts (usually visible shortly after logging) and indirect impacts (concerning the longer term). Among the direct impacts, the presence of heavy machinery and logging teams has effects on wildlife (Marsh *et al.*, 1987; Plumptre & Reynolds, 1994; Johns, 1997, White, 1994b, White & Tutin, 2001), through direct disturbance and modifications of the structure and composition of the habitat. Logging also increases access to remote forests by opening roads and population density in previously inaccessible areas. Roads provide access to markets and bushmeat becomes a commodity, transforming hunting from a largely subsistence activity into a commercial one (Wilkie *et al.*, 1992). The rate of road construction for logging has increased dramatically in the last decade. Some estimate that logging roads potentially provide access for hunting to an additional 29% of central African forest (Laporte et al. 2007). Settlements linked to forestry company infrastructures and camps attract large numbers of people (workers, family members and traders) into areas that were formerly sparsely populated (Wilkie & Carpenter 1999, Laurance et al., 2006a; Poulsen et al., 2009). Therefore, it is somewhat difficult to separate the effects of logging from those of hunting, as hunting pressure usually increases following logging (Struhsaker 1997).

Hunting in turn, can trigger numerous, yet not completely understood, effects which can alter the overall function, structure and composition of the ecosystem. Often these effects are straightforward and easy to predict, especially for those species directly targetted by hunting activities. Hunting may also have indirect effects, often referred to in the literature as cascading effects, when several steps of consequential effects are involved (*e.g.,* Redford 1992, Wright 2003, Letorneau *et al.* 2004, Terborgh *et al.* 2006). Plant regeneration (loss of pollinators, seed dispersers and seed predators), food webs (loss of top predators or of their prey), and plant diversity (change in herbivory patterns, increased pests) are amongst the various processes dependant upon the presence of fauna. Therefore activities, such as hunting, have the potential to not only impact targeted species but the ecosystem more broadly (see Stoner et al. 2007 for a review). Hunting, like other extractive activities, is therefore degrading forests - to the extreme stage of quasi-total defaunation where they become "empty forests" (Redford 1992).

Although the negative impacts of logging activities and hunting on wildlife are well documented, the role of logging concessions as potential "wildlife reservoirs" compared with unmanaged land is also increasingly recognized (Meijaard et al. 2006, Clark et al. 2009). Indeed, protected areas alone are often too small and fragmented to support wide-ranging or rare species. As around half of Africa's remaining forest cover is allocated to timber exploitation, improved wildlife management in timber concessions is therefore critical. Since hunting is about the only source of protein (with fish, insects and grubs) as well as being an important source of income for a large part of the rural population in the tropics, hunting activities must be managed in such way that they continue to provide income and protein to rural populations, without leading to local extinction of the most vulnerable species (Nasi et al. 2007, van Vliet & Nasi, 2008).

Managing hunting activities in logged areas can only be achieved if appropriate methods to monitor forest degradation and defaunation are available. In this study we present some of the lessons learned from past and recent efforts with the aim of proposing practical ways to assess forest degradation linked to bushmeat hunting in logged-over tropical forests.

2. Methodology

Overview of available methods and indicators

Choice of indicators for forest defaunation in logged-over areas

Wildlife species abundance and/or density appear the most common direct indicators (see Azevedo-Ramos et al. 2005 for a review on animal indicators and logging) of defaunation and hunting impacts. In Central Africa, large mammals' abundance or densities are used as indicators of forest defaunation, with a particular focus on primates and ungulates (White, 1994a; Davies *et al.*, 2001; Plumptre & Johns, 2001). These two groups represent more than half of the biomass in Central African forests and a large number of species are threatened with extinction (IUCN Red-list statistics, 2006). The most studied species are the gorilla (*G. g. Gorilla),* the chimpanzee *(Pan troglodytes troglodytes)*, the elephant (*Loxodonta africana cyclotis*), the bush pig (*Potamochoerus porcus*) and duikers (*Cephalophus spp.*). The following species are usually chosen on the basis of importance as a source of protein and income for rural and urban people living in the Congo Basin (*Cephalophus spp., Potamochoerus porcus,* and small diurnal monkeys), while the following (Gorillas, Chimpanzees and Elephants) are known for their charismatic and international conservation value and protection status in national laws. In most multi-species surveys, as is the case in surveys carried out by logging companies for their management plan, diurnal monkey species (*Cercopithecus cephus, C. nictitans, C. pogonias, Lophocebus albigena*) and red duiker species are lumped together. However, studies carried out by specialized researchers have tried to provide data for each species separately implying increased attention in data collection to avoid species identification errors.

The road network (extent and spatial distribution) has been particularly useful for indirect assessment of defaunation (Laurance et al., 2006b; van Vliet & Nasi 2008). Indeed, the distribution of mammals within a forest concession appears much more influenced by roads and hunting than by the direct effect of logging (Marshall et al., 2006). Most hunting traces are located at less than 3 km from logging roads (van Vliet & Nasi, 2008) and there is a strong correlation between hunting signs and distance from roads. Other indirect indicators used to assess defaunation in logging concessions are 1) hunter's harvesting profiles where data on hunting offtakes is regularly collected for a sample of hunters; 2) hunter effort which is an economic measure of the effort invested by the hunter; 3) bushmeat household consumption and 4) quantities of bushmeat traded in nearby markets.

Survey protocols used to measure mammal abundance and densities

To examine the effects of selective logging on mammal (and other vertebrate) populations, various methods have been used. Some authors used diachronic approaches measuring mammal abundance before and after logging (Plumptre and Reynolds, 1994; Bennett and Dahaban, 1995; Ganhorn, 1995). However, in most cases, data on wildlife abundance before logging were not available and researchers used synchronic approaches comparing neighbouring logged and unlogged (or hunted and not hunted) sites to assess the impacts of

logging and hunting. The most commonly used protocol to survey mammal abundance in logging concessions is line transects (Waltert et al, 2002; Laurance et al., 2006a; Arnehm 2008, van Vliet & Nasi, 2008). Data is collected along straight, parallel transects.

In surveys made by logging companies during their forest management inventories, transects made for vegetation surveys, covering the whole concession with a sampling effort around 1% are also used for wildlife survey and detection of human activities (e.g. hunting). In Central Africa, the more than 30 million hectares inventoried to comply with national forestry laws (Nasi et al., 2006) represent an invaluable and yet largely overlooked database to assess forest degradation (Mathot and Doucet, 2006; van Vliet & Nasi, 2008).

Studies carried out by researchers use shorter more localised transects (1 km – 2 km long); seeking sites that are similar in terms of habitat and representative of unlogged areas, recently logged areas and areas logged more than a certain number of years back. Data collected during line transect survey protocols usually combines daytime visual counts, pellet counts and nest counts for primates. To census effectively, a team of at least two – three persons is needed in order to detect all signs, tracks and nests (White & Edwards, 2000). Transects are walked during the day, early in the morning to maximise direct sightings (from 06h30 to 10h00), at an average speed of 1km/h. For duikers, the call count method (Struhsaker, 1998, van Vliet *et al.* 2009b) as well as night time visual counts (Julve 2005) have also been used.

To obtain data on mammal densities from the line transect records, perpendicular distances of the observations to transects are measured (or estimated). These distances are analysed using distance sampling, in which the measurements of the distances of objects observed from a transect line are used to estimate the probability of observing an object (Buckland *et al.*, 1993). This method requires a minimum number of 60 direct observations for each species studied which can be a limitation given the elusive behaviour of many tropical forest mammals. Data on direct sightings is often necessary to assess mammal densities using Distance Sampling. However, for shy and elusive species, dung counts have often proved to be more practical than direct sightings since the number of observations is often much higher. If data on defecation rates and dung degradation rates are available for each species, dung observations can also be used to assess animal densities using Distance Sampling. While counting dung pellets is an easy method, there are many possible errors associated with it. In general, pellet group counts are unworkable at times because of variable defecation rates, use of transects and latrines by the animals, variable loss of pellets by beetle attack (van Vliet et al., 2009a), extremely dense vegetation or difficulties in identifying pellets of different ungulate species living in the same zone. When the number of observations is scarce, the number of observations per kilometer or KAI (Kilometric Abundance Index) can be used as a measure of abundance (Mathot & Doucet, 2006). This simple index can be used to compare mammal abundance between sites or over a long-term monitoring period.

As a substitute to line transects, some studies (e.g. Forboseh et al. 2007, Hart et al. 2008) use census walks or recces, where the observer follows a path that offers the least resistance through the vegetation. Recces can be used to register diurnal direct sightings, dung piles and nests. The data obtained is not meant to estimate densities but can easily be converted into KAI.

Other survey methods besides line–transect counts are capture-recapture methods using nets (Dubost, 1980; Hart, 1985; Koster & Hart, 1988; Feer, 1989), net hunting encounters by counting the number of animals seen per searched area (Noss, 2000) and densities estimated

from home range size and population structure (Feer, 1996). These methods have been mainly used for duikers and in relatively small areas because they are time consuming and usually require the presence of well trained big teams. Capture recapture methods using non invasive genetic sampling and camera traps are currently being tested for some of the Central African species but the results are still unpublished.

Survey protocols used to measure hunting and trading activities in and around logging concessions

The choice of measure used for the estimation of the volume of bushmeat extracted from the forest has important implications for correctly attributing observed levels of prey abundance to a particular level of hunting, and for the use of hunting statistic data as an index of wildlife abundance (Rist et al., 2008). Studies based on data collected at the village or household level use regular (daily, weekly or monthly) semi structured interviews to assess harvesting profiles, hunting effort or household bushmeat consumption. Data collected to establish harvesting profiles include species hunted and quantities, hunting technique (gun or snares), number of days allocated to hunting activities, quantities of bushmeat sold or consumed and average price and weight of each animal or piece of animal (Fitzgibbon et al., 1995; Delvingt et al., 1997; Noss, 1998ab, 2000; Wilkie et al., 1998; Dethier & Ghuirgui, 1999; Muchaal & Ngandjui, 1999; Ngandjui & Blanc, 2000; Tieguhong and Zwolinski, 2009). As an alternative to the measure of hunting offtakes, the measure of hunting effort can also be used. Hunting effort may be quantified in units of time such as the number of hours (Franzen, 2006), days (Peres and Nascimento, 2006), or months (Noss et al., 2005) spent hunting. Hunter effort can also be measured in a number of ways other than in units of time, such as by an index based on the frequency of encounters with hunter sign (Cullen et al., 2001), by the number of hunters operating in an area (Naughton-Treves et al., 2003), in units of hunting equipment such as the number of nets used (Noss, 1998a) or traps set per unit time (Nielsen, 2006). Other measures are more spatially based, such as the distance of hunting location from human settlement (Rao et al., 2005) or nearest point of human access (Hill et al., 1997), or the distance travelled by a hunter during the hunt itself (Siren et al., 2004). When assessing bushmeat household consumption, detailed information is recorded about the composition of the principal meal of the day (or of the last few meals), including the unit price of animal protein (fish, livestock or bushmeat), the quantities consumed and the species of bushmeat if any (Wilkie et al., 2005; Starkey, 2004; Poulsen et al, 2009).

Most studies using data collected in bushmeat markets to assess impacts of hunting on wildlife do not focus specifically on logging concessions but more broadly on a catchment area at a regional scale (Fa et al., 1995, 2004; Juste et al., 1995). The catchment area is often calculated by the evaluation of the total surface covered by all locations mentioned as bushmeat sources by bushmeat sellers, which usually go beyond the logging concession area. Two main attributes of market dynamics are measured: quantity and daily availability of each species (Juste et al. 1995). These measures are expressed quantitatively as daily abundance of a species and availability of each species in the market. The markets are visited on a regular basis (every day to once a week) and a sample of traders (or all, depending on the size of the market) is interviewed about species sold, quantities and whether meat is smoked or fresh.

3. Discussion

Although the effects of selective logging on large mammal populations measured through field surveys has received particular attention in the last ten years, the majority of studies are limited by methodological shortcomings (Chapman et al. 2005). Studies conducted soon after logging produce a biased perspective because they do not account for the lag time between disturbance and habitat loss. Anthropogenic disturbance lowers recruitment or displaces animals but does not usually kill them (Struhsaker, 1997). Comparisons between neighbouring unlogged and logged sites do not take into account natural variation in mammal abundance within undisturbed forest both in temporal and spatial terms (Johns, 1986; Chapman et al., 1999). A possible way around these shortcomings when long term data is available is to compare abundance over long periods in unlogged and logged areas, to test the variations of mammal populations within and between sites (Chapman *et al*., 2000).

Linear transects provide the possibility to carry out multiple species surveys and have been largely used in the context of logging concessions. However, for regular monitoring, line transects are costly and time consuming. Records from line transects are often too scarce to enable calculating density estimates. These constraints limit the effectiveness of transect surveys as a tool for the monitoring of wildlife population trends (Wilkie & Carpenter, 1999). Line transects also imply collateral environmental impacts such as the degradation of the under-storey and the fact that hunters may use transects to set nets or hunt with guns. For all these reasons, some researchers now prefer to use census walks or recces. Although this survey approach is attractive when large areas need to be surveyed (less logistic constraints), further research is needed to evaluate the quality of the data collected using recces for different mammal species and sign types (including, dung, nests, direct observations). More innovative methods such as capture recapture methods using non-invasive genetic sampling (Petit and Valiere, 2006) and camera traps might open new efficient ways to carry out mammal surveys over large areas. These methods are already used in other contexts for temperate species and their results provide promising applications for tropical species in Central African forests.

Rather than trying to estimate absolute values of densities (with the level of methodological caveats incurred), the aim should be to estimate trends of abundance over time. The Kilometric Abundance Index offers one simple but efficient method to do so (Mathot and Doucet, 2006). Similarly, methods based on the knowledge of local experts (the Pooled Local Expert Opinion, PLEO) also offer an alternative way to monitor wildlife abundance (van der Hoeven et al., 2004). In contrast with classical methods, the PLEO method is inexpensive and ensures better local ownership of the results.

Indirect indicators of the impact of hunting on forest defaunation are recently receiving increased attention although not specifically in the context of logging. The existing literature provides some lessons learnt that also apply to logging concessions. For market studies, Fa et al. (2004) assessed the efficiency of a number of methods for measuring the volume of bushmeat traded and found that: (1) only a large sample of markets allows useful inferences at a regional scale, (2) timing and coordination of sampling may be highly influential, and (3) sampling in blocks of days is as efficient as random sampling in estimating species richness but not carcass volume. One of the main limitations of market studies is that they generally underestimate the real harvest rate because only part of the hunting offtake is sold to markets, the rest being consumed at the village level (Colell et al., 1994; Lahm, 1996; van Vliet, 2008). In that sense, hunter interviews for the estimation of harvesting profiles can be more

appropriate because they are useful to determine both the quantities kept for own consumption and the quantities sold. Estimations of harvesting profiles and of hunting efforts are both time consuming and can only provide accurate results when a certain level of trust exists between the interviwers and the hunters interviewed, limiting the extent of the study to relatively small scales. Additional bias associated with hunter's effort can be summarised as follows (Rist et al., 2008): 1) total time measures can be biased, overestimating biologically relevant effort; 2) quantifying trapping effort is problematic due to variable trap checking rates, variable trap group composition and species trap specificity; and 3) economically relevant measures of catch, taken from the hunter perspective underestimate the true biological impact of hunting.

4. Conclusions

Given the limitations of the different methods discussed in this paper, a well designed survey protocol might imply the use of a combination of approaches with both measures of mammal abundance and measures of hunting and trading activities within the logging concession. Instantaneous measures of these indicators have shown their limits in determining the effect of logging and hunting on wildlife. Instead, long-term monitoring protocols need to be established with the joint effort of governments, logging firms, conservation NGOs and certification bodies. Further research is needed to lower the human and financial costs of monitoring protocols. The development of innovative methods, (such as non invasive genetic methods and camera trapping) associated with new technologies, is to be encouraged. Priority for the coming years should be to develop more standardized protocols that would allow comparisons among sites. Until now, most of the studies carried out in different logging concessions of Central Africa have developed their own protocol for the assessment of forest defaunation. This has resulted in large dissimilarities in the data obtained and the absence of comparable results among sites. The existence of a more standardized protocol at national or regional levels would provide generalized results that could easily be translated into practical recommendations. These recommendations could in turn be included in national laws or certification processes to ensure that wildlife is properly taken into account in logging concessions of Central Africa.

Figure 1. Dung pile, Photo: Nathalie van Vliet
Figure 2. Examples of bushmeat, duikers and monkeys, Photo: Nathalie van Vliet

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