



Managing for timber and biodiversity in the Congo Basin

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ABSTRACT

Multiple-use forest management is considered by many as a preferable alternative to single-use, generally timber-dominant, management models. In the Congo Basin rainforests, integration of timber and non-timber forest resources plays a key role in the subsistence and market economies of rural communities. This is however mainly occurring in “ordinary” forest lands and not in formally gazetted forest lands. In this paper we briefly explore the major land-uses in the Congo Basin and their actual or potential for multiple-use. We then focus on the most extant production system (industrial logging concessions) and analyze the existing issues and options for managing actively both timber and biodiversity with a special emphasis on wildlife and the role of certification. A few promising but yet ‘unfinished’ examples do exist in the region and we review these cases to draw lessons and recommendations. We contend however that true multiple-use could only be realized by expanding beyond boundaries of formal management units through new innovative land-use units, allowing a spatial cohabitation of the interests of local people, of conservation proponents and of extractive industries in the same management unit.

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1. Introduction

Multiple-use forest management (MUM) for timber, non-timber forest products and environmental services is considered broadly by many as a preferable alternative to single-use, generally timber-dominant, management models. MUM implies more equitable strategies of satisfying the demands from multiple stakeholders, and a more benign harvesting approach. It should add more value to forests and make them more robust to conversion. It has become a commonly stated management objective under the paradigm of sustainable forest management (SFM) (García-Fernández et al., 2008; Guariguata et al., 2010). Its implementation in the tropics and in the Congo Basin in particular has however been lagging behind expectations.

In the Congo Basin forests, multiple-use mixing timber and non-timber forest resources plays a key role in the subsistence and market economies of rural communities, enhancing their well-being and reducing economic risk (Ndoye and Tieguhong, 2004). This is however largely happening as an informal and unregulated sector economy of limited overall benefits for the society and the environment. Managing for multiple use in legally designated land-use types (industrial logging concessions, protected areas or cash-crop plantations) is mostly rare, hampered by socio-ecological complexities, spatial overlap of different interests and

bargaining power, the multiple possible uses of some favorite timber species, inadequate institutional support, inappropriate policies and incentives, poor law enforcement and unclear or unrecognized tenure and use rights.

2. Current land uses and related management practices

In the major forest countries of the Congo Basin (Cameroon, Central African Republic – CAR, Congo, Democratic Republic of Congo – DRC, Equatorial Guinea and Gabon) land, except for urban areas, belong to the States under a variable ‘régime de domanialité’ (see Karsenty, 2006). States are the only ones entitled to deliver titles or concessions (logging, protected areas, community forests...) whereas local population use “ordinary” forest lands and their resources outside of these legal entities for their livelihoods without any real control by the “legal” owner of the resource.

2.1. Ordinary forest lands

This category corresponds to forests outside any of the below mentioned officially titled lands, where local user rights, as defined in forestry and other laws, apply without restriction for hunting, fishing, gathering of non-timber forest products (NTFP) and agriculture. Ordinary forests consist of a mosaic of remnant primary forest patches, secondary forests, fallows of various ages and permanent agricultural plots. The most common agricultural system in use in the ordinary forests of the region is still shifting

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cultivation. Permanent agriculture only dominates in the most densely populated areas where forests are only residuals patches in the landscape.

Shifting cultivation is characterized by a shift between fields rather than between crops on the same field, short (1–3 year) cropping periods alternating with longer fallow periods (4–60 years), cutting and burning of the fallow vegetation at the commencement of each cropping period, and the almost exclusive use of human energy in land management operations (Watters, 1971). It creates unique landscapes composed of a shifting patchwork of crop fields, fallows of various ages, secondary forest derived from fallows, and remnants of the original vegetation which appear as a mosaic of forests and croplands on low resolution satellite imagery. The presence of fallows, defined by Burgers et al. (2000) as the vegetation and associated fauna occupying land cleared for cultivation but not currently so used, with their associated multiple uses (provision of firewood or non-timber forest products, hunting grounds, etc.) makes shifting cultivation a true multiple use management system. This is however primarily an agricultural land use system whose purpose is to fulfill nutritional and income needs of local farmers even if it creates landscapes that could maintain high levels of biodiversity (Finegan and Nasi, 2004). Although, this land use type has been blamed as a primary driver of deforestation in the tropics, some studies (e.g., Ickowitz, 2006) claim that there is little evidence to support this statement for Central Africa. If transforming natural forests into shifting cultivation mosaics does generate a significant and permanent loss of carbon stock (Nasi et al., 2009), the transformation into other mechanized monoculture plantations would lead to an even higher decline (Bruun et al., 2009). Though one of the most extant agricultural system, shifting cultivation is not easy to detect using low or medium resolution satellite imagery data but as a first approximation could be estimated at 438,801 km² (Nasi et al., 2009) and thus represents the third largest land use of the region.

2.2. Titled lands or concessions

The two principal “legal” land uses (Table 1) in the Congo Basin sub-region (Nasi et al., 2009) are industrial logging concessions (595,381 km²) and protected areas (444,973 km²). Community forests exist only in Cameroon (though provisions exist in the forestry laws of D.R. Congo and Gabon) and represent around 10,000 km² for 341 community forests. The few significantly sized industrial plantations are the 430 km² (CDC website) of the Cameroon Development Corporation (oil palm, rubber, and bananas), 260 km² of SOCAPALM (oil palm) and the 680 km² of Eucalyptus Fibre Congo (EFC) clonal eucalypts plantations (MAG Industries Website).

2.2.1. Protected areas

About 60% of the forest protected areas (De Wasseige et al., 2009) belong to IUCN categories I (strict nature reserves) and II (national parks), the remaining 40% belong to categories IV

(Habitat/Species Management Area, 16%) and VI (Managed Resource Protected Areas, 24%). The dominant paradigm is therefore strict conservation and the only activities officially recognized in these protected areas are research and recreation (eco-tourism). Protected areas in Central Africa are generally managed for biodiversity and recreation with consideration given to the preservation of other services like water or carbon storage. Their mandate for biodiversity conservation is unquestioned, although not always implemented in a very efficient way and of the 314 protected areas recorded in Central Africa, only 10 sites benefit from a management plan formally approved by the authorities and several important sites (e.g., Garamba and Virunga national parks) are under extreme pressures by armed factions and/or afflux of people displaced by war.

2.2.2. Industrial logging concessions

Among the 293 concessions (Table 2a) officially recognized in 2010, 90 are operating under an approved management plan with another 95 currently designing their management plan, to be finalized in the coming 2–5 years, for a total area of about 221,920 km² (59% of the area allocated for logging). Certified concessions (Table 2b) reach about 4754 km² in 2010 (3040 km² for FSC) or about 13% of the total area under logging concessions. We can characterize such management as optimization for a single good (timber) but with consideration given to the preservation of other goods and services for long term sustainability in the form of constraints to timber profit maximization. The 108 concessions not yet engaged in developing a proper management plan and the more or less 139 authorized annual cut areas, represent 155,233 km² (41% of the area under logging) can safely be considered as having a single use management system, with timber as the sole commodity for an immediate profit, and without long term sustainability concerns. We will look at these concessions and their potential for MUM in the Sections 3 and 4 of the paper.

2.2.3. Community forests

Formal community forests exist only in Cameroon with provisions for such land use in the Gabonese, DRC and CAR recent forestry laws. In Cameroon, a community forest is a forest area from the non-permanent forest domain, smaller than 5000 ha (*de facto* around 3000 ha per community forest) where full use rights to forest resources is granted to a community for a 25-year period. Therefore, community forest status does not carry permanent property rights and is *de facto* similar to a concession, simply smaller and under a different regulatory framework (Ezzine de Blas et al., 2009). Ezzine de Blas and Pérez (2005) show that NTFPs are usually a second-best option compared to timber and extracted only when opportunities are available. However, for some niche products like *Prunus africana* bark, they can yield a substantial income (Ruiz-Pérez et al., 2004).

From this brief review and if we except shifting cultivation in ordinary forest lands, all the current land-use types and associated

Table 1
Area estimates by country and affectation (logging, protection).

Countries	Land	Designated for protection		Designated for logging	
	Area (km ²)	Area (km ²)	% ^a	Area (km ²)	% ^a
Cameroon	465,445	37,450	8.05	60,935	13.09
Central African Republic	620,152	76,743	12.37	34,293	5.53
Congo	342,766	35,993	10.50	147,127	42.93
Democratic Republic of Congo	2328,225	261,063	11.21	248,276	10.66
Equatorial Guinea	26,730	5104	19.09	14,375	42.93
Gabon	262,538	28,620	10.96	90,375	34.60
Congo Basin	40,45,856	444,973	11.00	595,381	14.72

^a % of Land area.

Table 2

Industrial logging concessions; (a) status of management and (b) certification.

Forest management units	Cameroon		Congo		Gabon		C.A.R.		D.R. Congo		Total	
	Area (ha)	N	Area (ha)	N	Area (ha)	N	Area (ha)	N	Area (ha)	N	Area (ha)	N
Management process not started	1,396,884	13	3,696,109	27			674,561	3	91,70,246	65	14,937,800	108
Management plan approved	5,341,895	65	1,907,843	3	3,419,475	12	2,881,142	10			13,550,355	90
Management plan in preparation	1,039,789	38	6,371,718	22	647,379	32	582,789	3			8,641,675	95
Total managed	6,381,684	103	8,279,561	25	4,066,854	44	3,463,931	13			22,192,030	185
Allocated concessions	7,778,568	116	1,1975,670	52	4,066,854	44	4,138,492	16	9,170,246	65	37,129,830	293
Authorized annual cut areas (2007)	247,758	91	181,687	26	74,392	12	81,684	10			585,521	139
Total	8,026,326	–	1,2157,357	–	4,141,246	–	4,220,176	–	9,170,246	–	37,715,351	–
Forest management units	Cameroon		Congo		Gabon		C.A.R.		D.R. Congo		Total	
	Area (ha)	N	Area (ha)	N	Area (ha)	N	Area (ha)	N	Area (ha)	N	Area (ha)	N
Certification of legality												
TLTV, OLB	1,613,245	23	0	0	622,399	2	0	0		1	25,40,685	25
Certification of management												
FSC (FM and FM/COC certificates)	763,146	5	2,726,996	4	1,627,177	3					5,363,647	12
ISO 14001					549,327	1					549,327	1
Keurhout					688,262	2					688,262	2
Total certified for management	763,146	5	2,726,996	4	3,111,094	6	0	0	0	0	6,601,236	15

management models in the Congo Basin focus on only one (rarely two) goods or services within one management unit while, for the most advanced, trying to reduce disturbance and degradation of the other non-managed forest goods and services.

3. Logging concessions, managed forests, certification and biodiversity

We will now focus on logging concessions, the most extant productive industry and see if management for both timber and biodiversity is possible and/or actually carried out.

3.1. Managed forests in the Congo Basin: what does it mean?

Very briefly put industrial logging really started after World War II and since steadily increased in volume extracted and area concerned. One can distinguish three periods: 1945 and 1970 the “pioneer” time with limited capacity to operate far from the coast; 1970–1990 the expansion of logging in the hinterland under a pure timber production paradigm and the emergence of a growing body of research on tropical silviculture but no formal management; and the last two decades that we could characterize as the opening of the forestry sector and the prominence of forest management under the sustainable development paradigm (see Nasi et al., 2006; De Wasseige et al., 2009; Karsenty, 2010 for thorough reviews of the concession system).

In the Congo Basin, the last two decades saw revisions of most forestry laws (CAR in 1990 and 2008, Cameroon in 1994 currently under revision, Congo in 2000, Gabon in 2001 and DRC in 2002) and the emergence of forest management as it exists now and is implemented on several million hectares of logging concession in the region. At the same time, forestry administrations faced the cruel dilemma of not being able to carry out this task of developing and monitoring management plans because of inadequate funding and staffing. As a result, several companies specialized in designing forest management plans were established in the region and hired by the logging companies to develop their management plans in close cooperation with government, scientific institutions and the private sector (Nasi et al., 2006).

In the region, management plans are built around a common set of features and activities and differ only marginally from one

concession or one country to the other (ATIBT, 2007; Bayol and Borie, 2004). First, a set of base maps is developed to support planning and survey operations. A management inventory is then carried out following a systematic sampling design (0.5–1.5% sampling rate). This inventory provides an assessment of the timber resource, its spatial distribution and its production potential. Using the same design, to optimize costs, additional information about regeneration, wildlife, non-timber forest products, human activities, etc. is collected. Data is recorded into a spatially referenced database. Specific studies regarding the socio-economic characteristics of the concession and its surrounding are also conducted to obtain data on human settlements and on the various uses of the forest by local peoples. Based on all available data and information, the specific management parameters for the concession are determined through negotiations between the firm in charge of preparing the plan, the logging company, the national forestry administration and eventually the local authorities. These fundamental parameters are the list of commercial species selected for management, the zoning within the concession (areas for exploitation, for protection, for use by local populations, location of infrastructures), the acceptable recovery rates and the minimum diameter cutting limits (Fargeot et al., 2004). The finalized management plan is then submitted to the approval of the forestry administration and officially agreed by a government decree. The management plan is a *de facto* contract between the State, owner of the resource, and the logging company with the objective of ensuring a steady flow of timber while not jeopardizing future harvests and conserving other forest goods and services.

3.2. Role of management and certification in addressing biodiversity issues

In 2008, with FAO support, one of us (Billand et al., 2010) completed a survey involving 26 industrial logging companies, complemented by interviews of NGOs, forest management experts and certification auditors. Companies were characterized as (i) without a management plan, (ii) in the process of designing a management plan, (iii) implementing a management plan, (iv) certified for management. The survey was aiming at answering four main questions relating to how logging companies were addressing biodiversity in their practices:

Facing increasingly more accurate and demanding norms, what is the level of motivation and involvement of companies' directors and forest managers?

What are the main responses put in place by companies to favor biodiversity?

What are the main obstacles and difficulties encountered by companies when implementing voluntary or legal prescriptions?

Can a typology of companies and responses be identified, relating to biodiversity issues?

The survey demonstrated a clear progression in the intensity of measures to address biodiversity issues, from (i) demonstrating no interest whatsoever to (iv) implementing a range of complex, expensive and externally audited measures. Leaders of companies with or preparing a management plan were somewhat intermediary, showing awareness about biodiversity but promoting limited effective activities on the ground.

Companies (groups ii and iii) developing or implementing a management plan have adopted a similar technical itinerary to collect data related to biodiversity. They all consider that the forest management inventory, designed to assess the situation of commercial timber species within the concession, can be considered as an initial biodiversity inventory, despite the fact that it generally focuses only on tree species above a certain diameter. However, during the last decade, additional biodiversity surveys have been gradually added to the typical forest inventory in order to include surveys of large mammals, with limited account taken to other fauna, of the major NTFP species and of the various signs of human presence or activity in the concession. The data collected is processed as a support to decision making: importance of human activities is assessed and mapped, with an emphasis given on wildlife hunting, presence and abundance of the fauna, with a focus on threatened or sensitive species (mainly mammals other groups tend to be overlooked). As methods are very similar between companies, these huge dataset allowed for large scale comparisons and provide invaluable but still largely untapped sources for research (but see [Vanvliet and Nasi, 2008](#); [Réjou-Méchain et al., 2011](#) for examples of the use of such data).

Implementation of biodiversity specific measures is however almost always absent in these companies. Most of the ones already implementing a management plan expressed difficulties to put in place specific biodiversity measures and identified three major obstacles:

- the cost, real or perceived, of biodiversity measures;
- the lack of motivation by some parts of the companies to implement measures with no direct impact on productivity;
- a lack of standardized technical guidelines, which could facilitate planning for staff, equipments and budgets to allocate for biodiversity conservation.

The survey confirmed that existence of a management plan, a legal requirement, is a necessary but not sufficient condition to motivate the companies towards managing for biodiversity. Only certification seems to provide the incentive or the sense of need for companies to invest significantly in operational procedures for biodiversity conservation. Certified companies (group iv) showed indeed the most successful sets of measures in favor of biodiversity. They put in place and implement an extensive and effective range of measures, including pro-active biodiversity protection activities and regular surveys to monitor progress in order to meet certification standards and answer external audits. Typical activities involve:

- implementation of reduced impact logging;
- improved planning of forest camps and road networks;
- protection of ecologically sensitive sites;
- pro-active control of hunting activities and promotion of alternatives to bushmeat;
- strict control of road network and ban on bushmeat transportation;
- training (RIL) and awareness raising (hunting, protection) of staff;
- regular monitoring of progress.

The progress can be measured by the recognition from research and environmental NGOs that selectively logged forest, managed appropriately and certified, can provide habitat for otherwise threatened species and complement protected areas ([Meijaard et al., 2006](#); [Clark et al., 2009](#)). There is however still much room for improvement and in particular to expand consideration of biodiversity concerns beyond certified concessions.

3.3. *Proposals for improvement in managing for both timber and biodiversity*

3.3.1. *Governance*

The authority practically in charge of biodiversity concerns in forest concessions remains unclear in the region. Forestry administrations look after forest production and have generally limited experience, skills and mandate for biodiversity. On the other hand, entities (administrations, agencies or environmental NGO) in charge of protected areas have the required skills but have generally limited mandate for or access to concessions and their management plans. Each of these administrations (in charge of forest production and protected areas) is considering only its own planning process, without any bridges and very limited procedures to harmonize activities in the field. This separation of responsibilities and actions in the field occurs even in the case of concessions located at the immediate vicinity of a protected area despite the fact that success stories for biodiversity conservation and timber production have been observed where logging concession and protected area managers work closely together. [Clark et al. \(2009\)](#) found that the abundance of large mammals in the four tropical logging concessions studied in northern Congo even rivaled that of the adjacent Nouabale-Ndoki National Park. In Gabon, [Laurance et al. \(2009\)](#) found that a logging concession near Rabi facilitates seasonal movements of forest elephants and other large wildlife species between inland and coastal areas across the nearby Loango and Moukalaba-Doudou national parks and is playing a key role in sustaining biodiversity, by maintaining forest connectivity and by limit human population growth near park borders.

Any significant improvement towards more sustainable management of biodiversity in the Congo Basin will require a better involvement of all stakeholders in the design and implementation of the management plans involving both production and conservation forests. This implies developing platforms at local level where representatives of the international/national/local levels, private/public sectors, informal sector/civil society are consulted about management options and decisions. There is also need for a regional forum where biodiversity, both from conservation and production forests, can be addressed. COMIFAC (Commission des Forêts d'Afrique Centrale) is the formal body in charge of the harmonization of regional forest policies, and of the implementation of the approved regional strategy summarized in the "*Plan de convergence*". Under the COMIFAC umbrella, RAPAC (Réseau des Aires Protégées d'Afrique Centrale) is the regional body dedicated to providing guidance and tools for protected areas and managers. There is however no regional equivalent for production forests, nor for biodiversity at global level. Instead, industrial concessions seek

support from nongovernmental associations, such as ATIBT (Association Technique Internationale des Bois Tropicaux), or from the private sector, such as IFIA (Interafrican Forestry Industry Association) which promotes the industry's interests. As a consequence, national forest institutions have no incentives to harmonize the approaches of their various production and conservation directorates.

3.3.2. Management, guidelines and certification

Forest certification has demonstrated significant progress in the region (from no certified forests in 1995 to about 4.8 million hectares in 2010) and we have shown above that certified concessions are so far the only ones implementing active biodiversity management or mitigation measures. State of the art knowledge about biodiversity conservation in productive landscapes remains however subject to considerable variations in interpretation among the scientific community. Numerous parameters of certification standards and specifically the verifiers remain also too often subject to individual interpretation by auditors. The industry, on the other hand requires as much standardized tools as possible, especially for monitoring and evaluation procedures and biodiversity should not be an exception. Industries require better standardized procedures for biodiversity data collection, analysis, processing, and ultimately decision making. Protected areas also require standardized, comparable procedures and datasets. This calls for harmonized methods and biodiversity indicators for assessing management. There is also a clear need for a much better trained and accessible regional expertise regarding biodiversity. Nowadays, some expertise exists in the administrations, consulting firms, environmental NGOs but their actual capacity is not up to the challenges and the results of the many projects that used such regional expertise are often disappointing (Vandenhoute and Doucet, 2006). These harmonized and pragmatic methods should be disseminated and promoted through practical regional guidelines endorsed by the public and private sector and adopted into locally tailored certification standards.

Several documents providing guidance to concessions managers and certification auditors are indeed available. In 2003, the African Timber Organization in collaboration with the International Tropical Timber Organization (ATO & ITTO, 2003) edited a set of Principles, Criteria and Indicators for sustainable forest management in the Congo later used (2008–2010) as reference in tailoring certification standards e.g., for the FSC Congo Basin regional standard. Guidelines were published in 2009 by ITTO and IUCN for the conservation and sustainable use of biodiversity in tropical timber production forests (ITTO & IUCN, 2009). In 2006–2007, the professional association ATIBT published a set of three practical guidelines specifically designed for the needs of concession owners and managers of Central Africa, one volume dedicated to the production forest (ATIBT, 2007), one volume to the social aspects of forest management (ATIBT, 2006a) and one volume about the management of fauna in forest concessions (ATIBT, 2006b). All these technical documents have been broadly disseminated among the profession and reached the targeted audience but are unfortunately seldom put into use on the ground.

4. Managing for timber and wildlife

Let us consider now the specific example of wildlife and logging as this is probably the major biodiversity (and livelihood) concern in the region.

4.1. Issues around wildlife and logging in the Congo Basin

Four major causes of wildlife disturbance are generally cited in and around timber concessions: roads, hunting activities, human

population growth and habitat disturbance by logging. Logging roads facilitate access to remote forests by opening roads in previously inaccessible areas, thus providing access to markets and transforming hunting from a largely subsistence activity into a commercial one (Thibault and Blaney, 2003; Poulsen et al., 2009). The rate of road construction for logging has increased dramatically in the last decade, potentially opening an additional 29% of Central African forests to more human pressure (Laporte et al., 2007). Roads affect mammal species abundance in different ways according to species and local conditions such as the location of the road, its width and the vehicle traffic. It is also somewhat difficult to measure precisely the direct disturbance by the road and the induced increased hunting. Clark et al. (2009) suggest high negative correlations between proximity to roads and the abundance of elephants, chimpanzees and guenons but other studies find contradictory trends. Vanvliet and Nasi (2008) find no negative effects of roads on elephant and great ape abundance but do find that small monkeys' abundance is higher farther away from roads. Laurance et al. (2008) find that elephants are not affected by roads and nocturnal primates' abundance increases with road proximity but primate species richness decreases. Although they find that the abundance of elephants or blue duikers was not affected by roads. Vanvliet and Nasi (2008) show that yellow-backed duiker, bay duiker and Peter's duiker are more abundant far (more than 10 km) from roads. Some carnivores are known to use roads as ways of conduct and as hunting ground (e.g., African civet, Ray and Sunquist, 2001) are not affected by roads (van der Hoeven et al., 2010) and the abundance of the small pangolin increases close to roads (Laurance et al., 2008).

Increased human densities are linked to company infrastructure and camps, as they offer better facilities than existing urban centers (Nasi et al., 2008) and attract people (workers, family members and traders) into areas that were formerly sparsely populated. Agriculture and hunting activities increase to respond to the increased demand for food generated by the arrival of employees from logging companies in previously remote villages (Laurance et al., 2006). In northern Congo, Poulsen et al. (2009) showed that over 6 years the population of five logging towns rose by an average of 69%, and the biomass of bushmeat in those towns increased by 64% and that 72% of the animals recorded in markets were harvested by immigrants from logging towns who also consumed 66% of all bushmeat. Forestry companies pay relatively high wages, thereby growing the local economy and attracting large numbers of people (workers, family members, and traders) into areas that were formerly sparsely populated. Because most companies – except for the certified ones – have no enforced regulations to ban hunting and trade among their workers and because they also fail to provide them with acceptable substitutes at low costs, most workers are involved in bushmeat hunting. On the contrary hunting pressure around small villages has little effect on most guilds and species (duikers, elephants, great apes or forest buffalo). Only small monkeys appear to avoid the proximity to villages (Vanvliet and Nasi, 2008). Elephants and duikers are more abundant close to villages (Clark et al., 2009) and the abundance of rodents increases in hunted areas (Laurance et al., 2008). In Congo, Clark et al. (2009) suggest that duiker abundance only decreases around villages with over 1000 people, which may be the point at which hunting pressure starts to become unsustainable.

A limited review of the most recently published studies (seven papers published in ISI referenced journals since 2000) concerning the impacts on mammal abundances in logging concessions from Central Africa suggests varied responses to the major sources of disturbance in timber concessions depending on guild and species (see Table 3). In general, the distribution of mammals within a forest concession is more influenced by hunting pressure and roads than by the direct effects of logging (Laurance et al., 2008; Vanvliet

Table 3
Impacts of logging on mammals in logging concessions.

Major cause	Guild	Species or guild	Impact on species abundance	Country	Study
Disturbed habitat (logging)	Duikers		(+)	Congo	Clark et al. (2009)
	Elephant		(–)	Cameroon	Matthews and Matthews (2002)
	Great Apes	Chimpanzees	(–)	Cameroon	Matthews and Matthews (2004)
			(–)	Gabon	White and Edwards (2001)
	Rodent	Brush tailed porcupine	(+)	Gabon	Laurance et al. (2008)
		Murid rodents	(+)	Gabon	Laurance et al. (2008)
	Small monkeys	Collared mongabey	(–)	Cameroon	Matthews and Matthews (2002)
		Guenons	Not affected	Cameroon	Matthews and Matthews (2002)
Hunting	Duikers	Red duikers	(–)	Gabon	van Vliet and Nasi (2008)
		Yellow back duiker	(–)	Gabon	van Vliet and Nasi (2008)
		Elephants	(–)	Congo	Clark et al. (2009)
			Not affected	Gabon	van Vliet and Nasi (2008)
	Great Apes	Chimpanzees	(–)	Cameroon	Matthews and Matthews (2004)
		Gorilla	(–)	Cameroon	Matthews and Matthews (2004)
	Rodent	Brush tailed porcupine	(+)	Gabon	Laurance et al. (2008)
		Murid rodents	(+)	Gabon	Laurance et al. (2008)
Proximity to big villages and towns	Great Apes	Chimpanzees	(–)	Congo	Clark et al. (2009)
	Small monkeys	Guenons	(–)	Congo	Clark et al. (2009)
	Duikers		(–)	Congo	Clark et al. (2009)
Proximity to small village	Duikers		(+)	Congo	Clark et al. (2009)
	Elephant		(+)	Congo	Clark et al. (2009)
	Forest buffalo		Not affected	Gabon	van Vliet and Nasi (2008)
	Great Apes	Chimpanzees	Not affected	Gabon	van Vliet and Nasi (2008)
		Gorilla	Not affected	Gabon	van Vliet and Nasi (2008)
	Small monkeys		(–)	Gabon	van Vliet and Nasi (2008)
Roads	Carnivores		Not affected	Cameroon	Van der Hoeven et al. (2010)
	Duikers	Bay duiker	Not affected	Gabon	Laurance et al. (2008)
		Blue duiker	(–)	Gabon	van Vliet and Nasi (2008)
		Blue duiker	(–)	Gabon	Laurance et al. (2008)
		Duikers	(+)	Congo	Clark et al. (2009)
		Ogylbi duiker	(–)	Gabon	Laurance et al. (2008)
		Peter's duiker	Not affected	Gabon	Laurance et al. (2008)
		Red duikers	(–)	Gabon	van Vliet and Nasi (2008)
		Yellow back duiker	Not affected	Gabon	Laurance et al. (2008)
		Yellow back duiker	(–)	Gabon	van Vliet and Nasi (2008)
			(–)	Congo	Clark et al. (2009)
			Not affected	Gabon	Laurance et al. (2008)
			Not affected	Gabon	van Vliet and Nasi (2008)
	Water chevrotain		Not affected	Gabon	van Vliet and Nasi (2008)
	Bush pig		Not affected	Gabon	van Vliet and Nasi (2008)
	Forest buffalo		Not affected	Gabon	van Vliet and Nasi (2008)
	Great Apes	Chimpanzees	(–)	Congo	Clark et al. (2009)
		Chimpanzees	Not affected	Gabon	van Vliet and Nasi (2008)
		Gorilla	Not affected	Gabon	van Vliet and Nasi (2008)
	Pangolin		(+)	Gabon	Laurance et al. (2008)
	Small monkeys	Guenons	(–)	Congo	Clark et al. (2009)
		Small diurnal monkeys	Not affected	Cameroon	Van der Hoeven et al. (2010)
		Nocturnal monkeys	(+)	Gabon	Laurance et al. (2008)
		Small diurnal monkeys	(–)	Gabon	van Vliet and Nasi (2008)

Impact on species abundance: abundance increases (+), decrease (–) or is not affected by the major cause involved (e.g., hunting was found to increase the abundance of brush-tailed porcupines in Gabon).

and Nasi, 2008; van der Hoeven et al., 2010). Duikers and rodents actually seem to benefit from the presence of patches of disturbed habitat. Great apes and some small monkey groups seem somewhat the exception and potentially seriously disturbed by logging operations. White and Tutin (2001) presume that noise and disturbance can lead to the displacement of an entire chimpanzee community and to violent conflicts with neighboring communities causing high mortality. Matthews and Matthews (2002) showed that densities of the collared mongabey were significantly higher in areas with a low level of logging disturbance.

4.2. Possible measures to manage for both timber and wildlife within concessions

Several documents providing guidance to concessions managers and certification auditors are now available (see Section 3.3.2.) and have been broadly disseminated among the profession. These

documents promote a certain number of practical measures that can be included in the management plan of logging concessions and put into practice to manage both for timber and wildlife.

First, setting up guidelines for road construction before exploitation could help mitigate the severe ecological constraints on wildlife populations in areas that would be fragmented by these roads. The road network seems to be at the heart of the problem since hunting intensity is often strongly correlated with distance to roads. Road construction limits the physical movement of some species (Laurance et al., 2006) and is accompanied by increased hunting, unplanned colonization, and deforestation or forest degradation (Wilkie et al., 2000; Blake et al., 2008). An optimal planning and active management of the logging road network should help limiting the direct impacts (keeping roads away from protected areas boundaries, limiting the number secondary roads...) while a better control of access (blocking used skid trails or secondary roads, manned gates on main roads...) should help limit

commercial hunting activities (Vanvliet and Nasi, 2008). Access to forest roads should be restricted to company vehicles, roads should be closed when not actively used for logging and companies should enforce speed limits (Poulsen et al., 2009). Other measures that facilitate road crossing, such as allowing dense vegetation to recover along the road side or big trees offering “monkey bridges”, could make a decisive difference to the survival of fragmented populations that are otherwise already threatened by hunting and destruction of their habitat (Meijaard et al., 2006; van der Hoeven et al., 2010).

Second, provide workers with sustainable sources of protein is a crucial issue to avoid uncontrolled rises of hunting and bushmeat trade in newly established camps and logging towns. Companies should guarantee the importation or development of protein sources for their workers and their families, keeping prices competitive with bushmeat and fish (Poulsen et al., 2009). Logging inventory teams should not be allowed to take guns with them and companies should forbid their inventory teams to hunt for food. Companies should be responsible for feeding their employees any time they are in the field. Legal hunting activities can be organized for the workers based on sustainable hunting management plans in order to satisfy the need for protein by workers and their families. These hunting management plans should target common game species (*Atherurus africanus* and *Cephalophus monticola*) which are particularly resistant to human pressure such as habitat degradation or hunting. Hunting management models, with spatio-temporal rotation of areas opened to hunting during the year preceding the logging operations could be developed by the logging company (Poulsen et al., 2010; Vermeulen et al., 2009). In addition, traditional systems of resource management (e.g., hunting territories) should be formalized in land-use planning (e.g., management plans for logging concessions) and access to resources for indigenous people should be prioritized (Nasi et al., 2008; Poulsen et al., 2009).

Third, companies should promote and enforce internal regulations to contribute to wildlife law enforcement by ensuring that their workers are not breaking hunting and trade laws (Poulsen et al., 2009). However, as commercial hunting is not necessarily (or not only) practiced by the employees of the company and often implies commercial hunters with political backup, efficient partnerships are needed between the logging company and governmental bodies in charge of law enforcement as a measure to prevent poaching, specially for the most vulnerable species.

Fourth, the need to implement long term monitoring systems of the impacts that can be directly attributed to the logging company and its workers is increasingly highlighted as a priority (TRAFFIC, 2010). Long term partnerships between companies and research centers or/and conservation NGOs are necessary (Billand et al., 2010) to achieve the practical implementation of monitoring tools at different levels (wildlife surveys, levels of hunting, bushmeat consumption and trade, level of compliance with internal rules and national laws...). The results, analyzed on a regular basis will allow to measure the effects of the measures put in place and highlight trends that need urgent attention.

5. Beyond boundaries: landscape approaches in practice

Protected areas alone, often too small with inadequate funding and staffing, will be unable to prevent continued biodiversity loss (Soulé and Sanjayan, 1998; Fagan et al., 2006). As seen in Sections 3 and 4, managed concessions may be especially valuable when they are adjacent to or surround protected areas. The need for complementarity between the two land uses is exacerbated by the fact that efforts to conserve wildlife in one landscape unit can be undermined if the surrounding areas are not adequately

managed. Recently, some sections of the industry have been willing and effective partners in conservation (Elkan et al., 2006; Poulsen et al., 2007; Butler and Laurance, 2008). Industry can promote biodiversity conservation and human livelihoods by moving toward sustainable practices that explicitly consider the direct and indirect effects of their activities on wildlife (Robinson et al., 1999; Milner-Gulland et al., 2003). The large size and varied habitats of sustainably managed and certified logging concessions appears therefore as a complement to the existing network of protected areas, enlarging significantly the “conservation estate” (Putz et al., 2001; Clark et al., 2009). Since 2002, the Congo Basin Forest Partnership (CBFP) has organized its interventions around 12 large landscapes (Altstatt et al., 2009) combining protected areas and other adjacent land uses (logging concessions, customary lands...).

Yet, promising agreements exist between environmental non-governmental organizations and logging companies operating in the Dja-Minkébé-Odzala Tri National landscape. These collaborations have contributed to the mainstreaming of conservation approaches in the logging concession and to the appropriation of biodiversity concerns (mainly linked to bushmeat hunting) by concession managers. Reciprocally it helped the NGOs to better understand the rules of the game and the constraints faced by forest managers (Nasi, 2008). Among the most promising of these examples is the PROGEPP project, a partnership of the Congolese Ministry of Forestry Economy, the Congolaise Industrielle des Bois (CIB) and the Wildlife Conservation Society whose area encompasses about 3 million hectares of FSC certified logging concessions surrounding the Nouabale-Nodki National Park. The project created a wildlife management system in the concessions based on four key principles: regulating access to wildlife resources through land-use planning; promoting selective hunting through law enforcement; involving communities in wildlife management; and developing economic and protein alternatives to hunting and bushmeat (see Poulsen et al. (2010) for details of the lessons learned).

A recent study on another landscape the Tri-National Sangha (TNS), showed that a “mix of logging concessions and protected areas is providing a good balance between conservation and local development. Wildlife remains abundant in the logged areas and the forests recover well after logging. However, neither the environmental indicators nor those for peoples’ livelihoods changed much until 2008. The biggest obstacle to progress was weak governance. However, the 2008 global financial crisis had immediate and surprising impacts. Logging companies curtailed their activities – it was no longer profitable to log in such a remote area – and local people lost their only possibility for gainful employment. The roads, clinics and schools that the logging companies had supported were neglected. The people had no option but to revert to poaching and clearing the forest for subsistence agriculture. Both conservation and development suffered” (Endamana et al., 2010).

These CBFP landscapes could become living examples of conservation/production integrated territories. It however appears that though the results in terms of conservation are real, there is not yet a true integration of conservation and development by multiple use management and challenges or threats remain immense. Development and conservation through such multiple-use management sill appears very much vulnerable to financial cycles or external funding. Given the weaknesses of the Governments in the region, it can only succeed in the long term with an active commitment of the private sector (companies and NGO) and communities supported by external funding, a leveled playing field for the business and increased benefits for all the players (e.g., a larger areas effectively protected for the NGO; premiums for certified timber sales for the company; better infrastructures, recognized hunting rights and employment for the communities.

To our knowledge the most advanced example of such an integrated management for production and conservation is found in the Iwokrama forest (Guyana). Here, the Iwokrama International Centre for Rainforest Conservation and Development (IIC, 2011) invested significant capital, thanks to initial external funding, in surveying, zoning and developing an integrated management model for the Iwokrama forest resources for the benefits of conservation and communities. Of the total area of 371,681 ha, 184,506 ha are designated as a Sustainable Utilisation Area (SUA); the other 186,175 ha being set aside permanently as Wilderness Preserve (WP). The SUA is managed for logging under FSC certification by a joint venture company with private partners and shares attributed to IIC, private partner and local communities. The WP is managed for ecotourism with active participation of the communities. Local communities keep the right to use natural resources within the Iwokrama forest and benefit from employment and economic diversification.

6. Conclusions

In a recent paper Garcia-Fernández et al. (2008) conclude that “multiple-use forest management remains a valid management alternative under specifically favorable local context conditions, especially when practiced at the landscape scale, but these conditions are less frequent than commonly assumed” and that “special scenarios with favorable preconditions are required for MUM to work, including a new mindset and incentives to successfully compete with more specialized land-use options”.

We believe that in spite of the enormous problems of governance and unclear land tenure or use rights it is possible to develop multiple-use forest management units combining protection and production at the landscape scale in the Congo Basin. The above-mentioned cases are glimpses of movement in the right direction but overall progress is low and mentality still need to change both in the private and the public sector towards a real collaboration between conservation and development interests if we really want to move into integrated management for timber and biodiversity in the Congo Basin.

Billand and Nasi (2008) suggested implementing conservation/production territories governed by specific charters similar to the French “Parcs Naturels Régionaux” whose purpose are to protect and valorize large inhabited rural landscapes by fostering policy and financial incentives involving both conservation and production actors. Such partnerships should go much further than existing collaboration between environmental non-governmental organizations and logging companies towards a true co-management with communities’ involvement of large landscapes while ensuring a local redistribution of the benefits of the production side to the communities and to the protection side. This would require wherever possible to realize the full economic potential of the conservation side (eco-tourism, biological prospection, payment for environmental services...); to co-manage and value informal sectors like hunting, fishing or NTFP extraction for local livelihoods; and to use part of the income generated by the production side for the management of the conservation area in search of reciprocal benefits (image of the logging sector, certification of management or labeled products, cash for conservation activities or to compensate local people, etc.).

Several economic, governance, and technical issues still impede further advance towards multiple-use management in the region. Among these the high opportunity costs of maintaining forests and the limited economic benefits, if any, from improved (certified) versus conventional logging practices; the persistence of land tenure and land-use planning issues; or a general failure to enforce forestry regulations because of the lack of finances or qualified

human resources. In addition, the economic crisis starting in 2008 caused a shock which has still not been recovered by logging companies and volumes or prices of exported woods remain below average. We outlined the overall lack of multiple-use management in the Congo Basin region but also some examples showing how obstacles in the way of multiple-use management could be surmounted by (i) creating a political support through either proactive (creating specific land-use units, accepting a redistribution or a waiver on royalties from extractive industries) or, at least, neutral (no undue interference from the State) policies and regulations; (ii) pushing and rewarding the production sector to engage in certification; (iii) involving all the actors in the land-use planning and the development of management plans.

The few successful examples showed that starting funds are needed to cover initial transaction costs to establish the various negotiation platforms and to gather the necessary data on which to base the land-use planning. Given however that such a properly implemented multiple-use management system partnering certified logging operations and protected areas would sequester more carbon than the business-as-usual single use management currently at work, the existing initiatives could be reinforced and/or extended by benefiting directly from REDD+ funding.

We believe that management for both timber and biodiversity is possible in the Congo but it requires new thinking in terms of land-use types and stronger private–public partnerships associating production and conservation parts of the landscape and a renewed long-term support from the international donor community.

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