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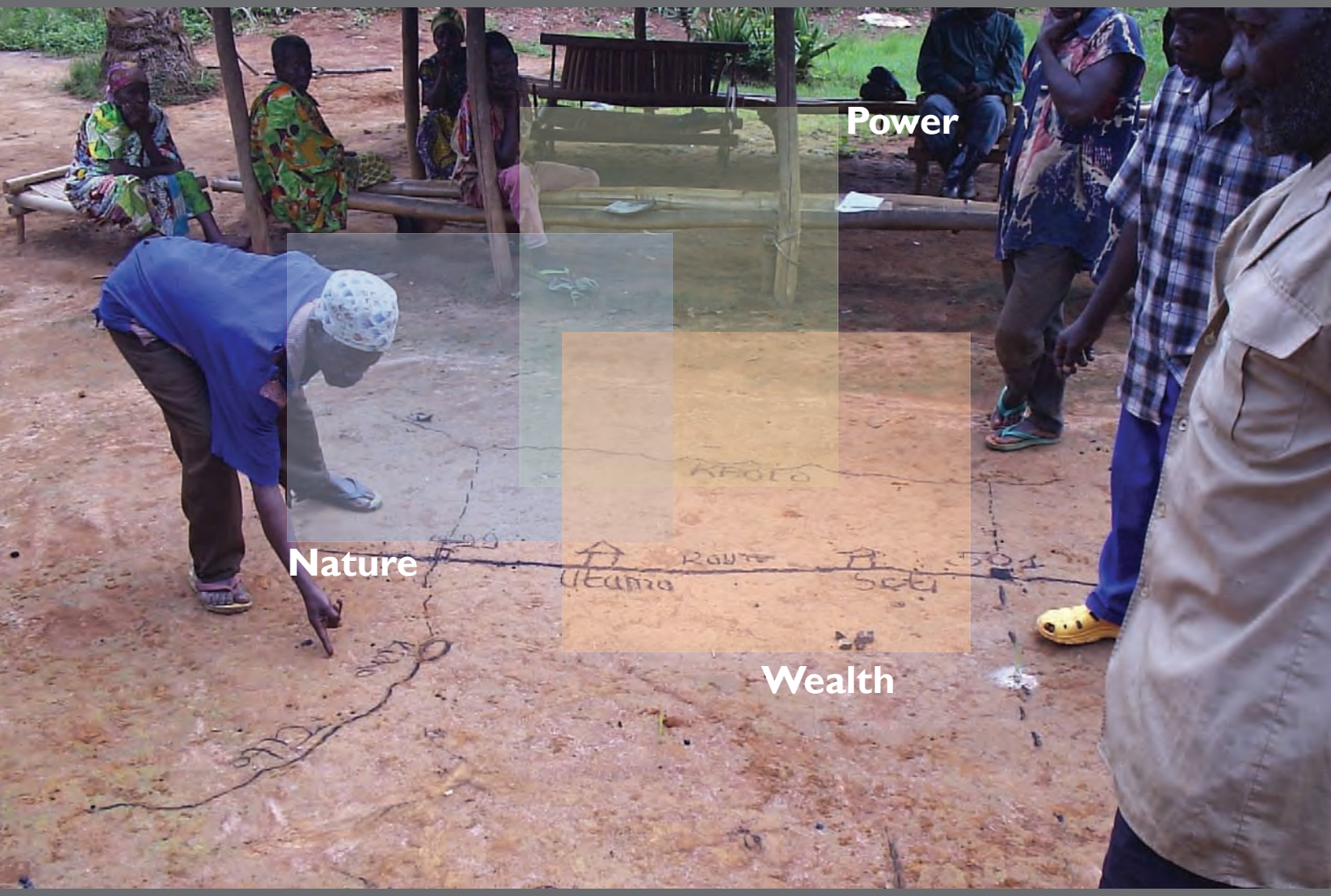

Case Study:

Participatory Land Use Zoning in Okapi Wildlife Reserve (OWR), Democratic Republic of Congo (DRC)

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Report prepared for WCS TransLinks Program

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Acronyms

CARPE	Central African Regional Program for the Environment
CBNRM	Community-Based Natural Resource Management
DRC	Democratic Republic of Congo
ICCN	l'Institut Congolais pour la Conservation de la Nature (Congo's protected areas authority)
OWR	Okapi Wildlife Reserve
USAID	United States Agency for International Development
WCS	Wildlife Conservation Society

Introduction

Zoning is an essential tool for landscape management which attempts to reconcile the typically overlapping and conflicting economic and resource use interests of local, national, international and private sector stakeholders. Thus, zoning allows a range of different land uses, with different objectives, to occur in discrete spaces within the same overall area. Zoning in a post-conflict nation with unclear land tenure and spotty or, worse, arbitrary rule-of-law is a challenge, but one that has to be met if ecosystem services are to be conserved and local resource-dependent economies secured. This case study describes a practical but rigorous approach to zoning that was piloted in the Okapi Wildlife Reserve (OWR), a protected area in eastern Democratic Republic of Congo (DRC). The OWR is part of the Ituri-Epulu-Aru landscape (Figure 1), a pilot site for land-use planning and participatory natural resource management in the Congo Basin, supported by USAID CARPE. USAID CARPE focuses on land-use planning in three types of macrozones: protected areas, community-based natural resource management (CBNRM) zones and extractive resource use zones[1]. Because it is a reserve, the OWR is not easily categorized as a homogeneous macrozone. Unlike national parks, reserves in DRC may be legally inhabited by human populations practicing subsistence activities such as farming, hunting and gathering, as is the case with the OWR, where the resident population depends on forest resources for their livelihoods.

Site Description

DRC contains the majority of the Congo Basin's 3.6 million km^2 of tropical rain forest. The Ituri Forest in northeastern DRC extends over 65,000 km^2 and retains high levels of biodiversity and endemism. The Okapi Wildlife Reserve (OWR), covering 13,720 km^2 in the heart of the Ituri Forest was gazetted in 1992 and is named after an endemic forest giraffe that is iconic of the landscape. The OWR covers three administrative territories and ten chefferies (chieftainships) or collectivités. The latter is a political unit, initially established by pre-independence Belgian colonial authorities, that includes several villages whose residents mostly represent one or two ethnic groups, with their own languages.

1 See http://carpe.umd.edu/ for full description of zones.

The OWR is a UNESCO World Heritage site that supports several species of conservation importance, including the okapi, forest elephant, chimpanzee, more than a dozen species of monkeys, several species of forest antelopes (duikers), leopard and buffalo. The landscape is also home to ethnically diverse human communities including hunter-gatherers (Mbuti and Efe Pygmies)[2] and Bantu and Sudanic-speaking shifting cultivators (Bila, Ndaka, Lese, Mbo, Mamvu and Budu). The reserve is under the management authority of l'Institut Congolais pour la Conservation de la Nature (ICCN). ICCN receives technical assistance from two international conservation NGOs, the Wildlife Conservation Society (WCS) and Gilman International Conservation (GIC), and together these three organizations constitute the reserve's management committee.

The human population of the 40,862 km^2 Ituri-Epulu-Aru landscape is estimated at 300,000 (approximately 7 people per km^2). Mambasa and Nia-Nia, the two major towns in the landscape, have approximately 20,000 inhabitants each and are growing rapidly. At the time of a 2003 population census conducted by WCS/ICCN, 17,000 people lived inside the OWR, and an additional 37,000 within 15 km of the reserve's

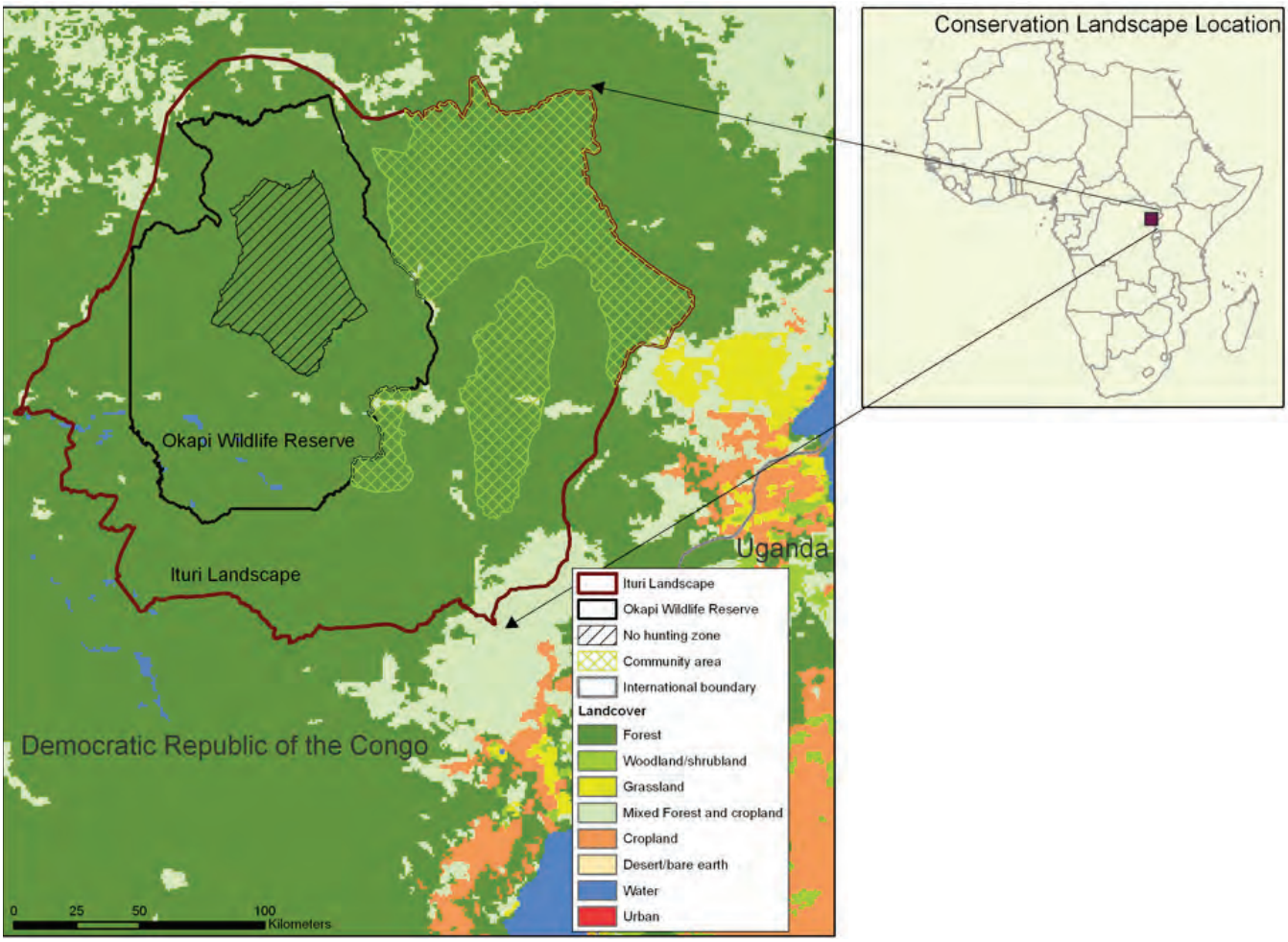

Figure 1. Ituri-Epulu-Aru landscape map showing location of Okapi Wildlife Reserve.

2 This paper will use the general term Pygmies and hunter-gatherers interchangably but it includes Mbuti and Efe.

borders. Preliminary 2009 census results show 20,100 people living inside the reserve (approximately 1.5 people per km^2), with most of these living less than 5 km from a road. Almost all households rely on harvesting multiple resources from the forest and on crops from small farms cleared from the forest. Sources of income include wage labor, gifts (including dowry payments), reciprocal exchange and the sale of forest products, crops and manufactured goods.

Historical Context

Over the past century, Belgian colonialism, post-independence rebellions, crashing commodity prices, immigration and civil wars have all buffeted local socio-economic systems and altered settlement patterns and natural resource use. Before the east-west road (Route Nationale 4, RN4) that bisects the OWR was built in the 1930s, both Pygmy and Bantu groups were living adjacent to rivers throughout the forest, with small agricultural clearings scattered within 1-2 km of their settlements. Belgian colonial authority pressed local residents into road construction and then forcibly resettled all forest-interior villages alongside the roads (Peterson 2001), a pattern of land occupancy and use that remains today, with almost all villages and agricultural clearings concentrated along the roads and Pygmy camps set up along the edge of the agricultural clearings where the forest begins (Figure 2).

Prior to independence in 1960, large agribusinesses managed the production of cash crops (e.g., coffee, cacao, oil palm) on extensive plantations, particularly in the north and north-west. The post-independence years saw the forest “opened up” to commercial traders and migrants in search of land, minerals, ivory and bushmeat. Beginning in the 1970s with President Mobutu’s disastrous nationalization campaign, and aggravated in the mid 1980s with declines in world prices for robusta coffee beans, commercial agriculture within the Ituri began to collapse, and road repair effectively stopped. By the start of the millennium, most plantations had been abandoned and the roads were little more than rutted bike paths that were often impassible during the heavy rains from September to December.

The area that is today the OWR has attracted anthropologists (e.g., Patrick Putnam in the 1930s and Colin Turnbull in the late 1950s) and wildlife scientists since the colonial period. In the 1950s, a Portuguese hunting officer lived on the site of what is now the reserve headquarters and ran an okapi capture station to supply the rare okapi to European zoos. He negotiated with local villages to set aside undisturbed forest areas so that okapi could be more easily captured. These capture zones remain in local oral histories, especially those of the oldest generation living in the OWR, and are, in many ways, a precursor to today’s zoning system.

During the 1980s and early 1990s a series of long-term projects on okapi ecology, botany, Pygmy hunting and social anthropology were undertaken. In 1992, the OWR was gazetted as a national protected area due to the work of ICCN, in collaboration with conservation NGOs including WWF, GIC and WCS. Four years later, the OWR was declared a UNESCO World Heritage Site. In October 1996, Laurent Kabila, with support from Rwanda and Uganda, launched a full-scale rebellion against President Mobutu whose kleptocratic regime had reigned unchallenged for almost all of the post-independence years. On May 17, 1997 Mobutu fled the country and Kabila declared himself president. In August 1998, disgruntled Rwanda-backed military mutinied, starting a second civil war that lasted until December 2002. During these chaotic years, the roads continued to collapse, Ituri became effectively

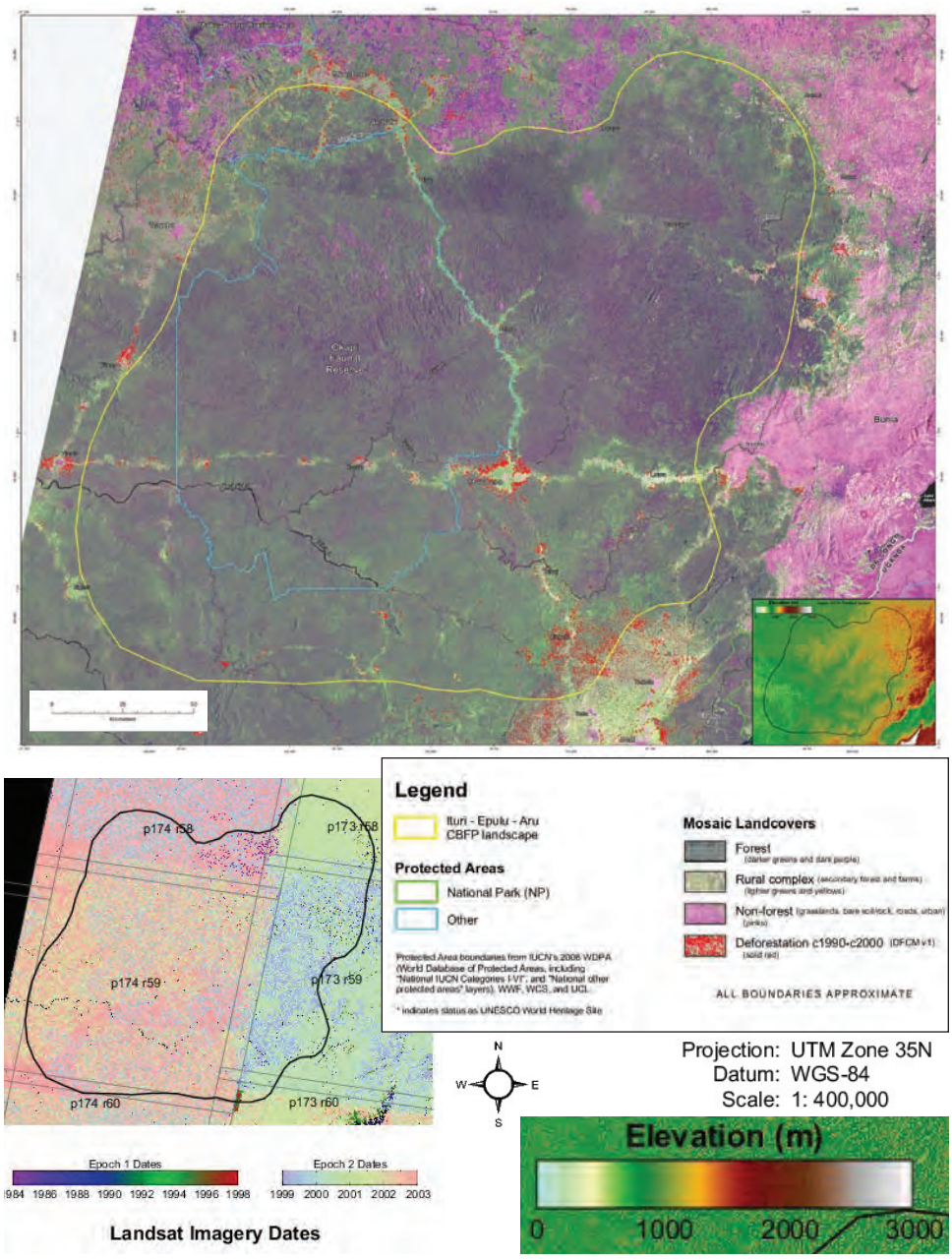

Figure 2. Ituri-Epulu-Aru Congo Basin Forest Partnership Landscape, Democratic Republic of the Congo: Shaded Relief Landsat Mosaic and Decadal Forest Change Map (1990-2000).

isolated, economically and politically, and park staff found it increasingly difficult and dangerous to enforce reserve regulations. During this time, illegal miners[3] were operating at multiple sites in the OWR and wildlife populations were subjected to increased hunting as militias and miners slaughtered tens of thousands of duikers and monkeys for food and sale. Proliferation of guns in the hands of soldiers and rebels intensified elephant poaching[4] for ivory and meat. In the period following the end of the war in 2003, reserve managers worked to secure the forest and stop illegal activities. Teams of ICCN eco-guards, with the support of the Congolese Army, evacuated people from active gold mines and poaching camps in the reserve. In 2006, DRC held its first presidential election in over 30 years and has since invested in building and strengthening civil society groups. Widespread national road rehabilitation is underway, including repair of the national road that bisects the OWR (RN4). The reserve management plan is being revised with detailed guidelines on access to, and use of, land and natural resources.

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Bushmeat, near Wamba

3 Mining was mainly for gold but also for coltan (columbite-tantalite, a component of electronics such as cell phones).

4 Poaching refers to the illegal hunting and killing of protected species. This differs from commercial bushmeat hunting which may result in large quantities of non-protected species being killed.

Social Context: Pygmy and Bantu

In the Ituri forest, farmers and hunter-gatherers have been socio-economically linked for centuries, and much has been written about the relationship between Pygmies and their Bantu and Sudanic neighbors in Central Africa (Turnbull 1961, 1966; Vansina 1990, Grinker 1994). Political clientelism, a voluntary relationship between two people with a degree of inequality regarding power and access to resources (Landé 1977), has persisted in Congo Basin societies for millennia. In the Ituri forest, Bantu and Sudanic speaking ethnic groups are generally the patrons and Mbuti or Efe hunter-gatherers are the clients.

Clientelism is not restricted to Bantu-Pygmy pairs, and these relations can be seen between farmers as well, especially where chiefs and "big men" control land and resources and depend on labor from economically weaker groups. This patron-client system is flexible and resilient and has survived colonialism, independence, rebellions, migration and recent wars. It is important for understanding natural resource use and land tenure because it plays an important role in the "organization or regulation of exchange or flow of resources between social actors" (Eisenstadt and Roniger 1981).

Though these patron-client relationships are often characterized by power inequalities, there are benefits for both parties. For example, in the Ituri forest Pygmies exchange game meat (mostly duikers), honey, forest plants, mushrooms and field labor for metal tools, clothing and cultivated foods such as manioc, rice and plantains. In 1988, more than 60% of the caloric intake of hunter-gatherers was estimated to come from their system of "trading field labor and forest goods with farmers" (Bailey & Peacock 1988 cited in Wilkie et al. 1998). In addition to material exchange, these groups also have a deep history of cultural interdependence (Turnbull 1961).

Impacts of Immigration

The OWR is located within a settlement frontier, with most immigrants coming from the Kivu, a region to the southeast where population density exceeds 100 people/km^2 (Vlassenroot 2004) and land is relatively scarce. Since the 1980s, and more recently during the two civil wars, the region has seen an influx of immigrants who come fleeing conflict, searching for land or looking to make their fortunes mining gold and coltan. This has led to a spreading wave of wildlife hunting (to be sold in mining camps and more distant markets) and deforestation, as land is cleared for agriculture.

Immigration has also changed social relations between Pygmies and their farming exchange partners. Until the 1960s, the relationship between hunter-gatherers and their farming patrons was described as one of mutual, if unequal, exchange (Peterson 2001). However, population movement because of artisanal mining and civil wars has seen new ethnic groups replace traditional patrons, and clientelism

based on barter and cultural ties is being supplanted by the direct purchase of client services with goods and cash. Such changes to the social systems that regulate how land and resources are used are an important part of the context in which zoning is taking place.

Immigration is one of the greatest threats to the OWR because it drives deforestation (via agricultural clearing) and bushmeat hunting and because it affects wildlife abundance, soil fertility and local human population size. Zoning must therefore address the arrival of new immigrants as well as the resource claims of people who have migrated to the area in the past and have since integrated into local social institutions (such as the patron-client system). An understanding of local social and power dynamics is necessary to reconcile rights and ensure that, in the case of competing claims to resources, the rights of economically and/or politically powerful groups do not always trump those of other groups.

Objectives of Zoning Program

In Central Africa, the state owns all land, holding it in trust for its citizens. Perhaps unsurprisingly, land use planning and zoning have historically been done in a very top-down manner by the state with little consultation with land-users and little regard for the actual needs of local residents, both now and into the future. In contrast, zoning within the OWR was designed to: 1) meet the present and future needs of farmers and hunter-gatherers; 2) secure prior and legitimate land and resource access and use claims of long-term OWR residents; 3) clarify local communities' property rights as a way to constrain further immigration into the OWR; and 4) reconcile the OWR's dual goals of biodiversity conservation and sustainable resource use by local people.

Zoning is a framework which is useful for managing the dual concepts of protected areas and community-based natural resource management in a defined space that includes customary and state land-use regimes and is influenced by international notions of global heritage and biodiversity conservation (as is the OWR). The reserve landscape is organized into four politically hierarchical and increasingly larger spatial divisions: localité (village) – groupement – collectivité – territoire. This case study characterizes the approach that WCS developed and piloted within the reserve to respect the prior claims of long-term resident farmers and hunter-gatherers and to ensure that their agriculture and hunting zones were of a size and configuration sufficient to meet their present and future needs; zoning activities focus on the localité or village level with approval from the higher-level political divisions.

Despite the enormous post-conflict challenges that the OWR faces, thousands of square kilometers of its rainforest still harbor important populations of plants and wildlife, providing livelihoods for the more than 20,000 people who live within the reserve's boundaries. By recognizing tenure and resource claims, zoning can help empower the indigenous people and long-time residents of the reserve, giving

them a formal stake in the future of the OWR and encouraging them to manage their natural resources in a sustainable way. The success of the zoning system depends on meeting the needs of the resident human population, making access to the reserve's resources more difficult for non-residents, ensuring that core areas are not subjected to human disturbance and implementing and monitoring land-use policies and practices as agreed upon.

To achieve the dual goals of the OWR, three general zoning categories were defined for the reserve: 1) Agriculture Zones where most human activities are permitted, including habitation, agriculture, hunting and gathering; 2) Hunting Zones where sustainable levels of hunting and gathering are permitted but no forest clearing for agriculture or habitation are allowed, with the exception of temporary Pygmy forest camps; and 3) generally large, ecologically important Conservation Zones where most human activities are not permitted, with the possible exceptions of honey gathering, cultural rites and scientific research.

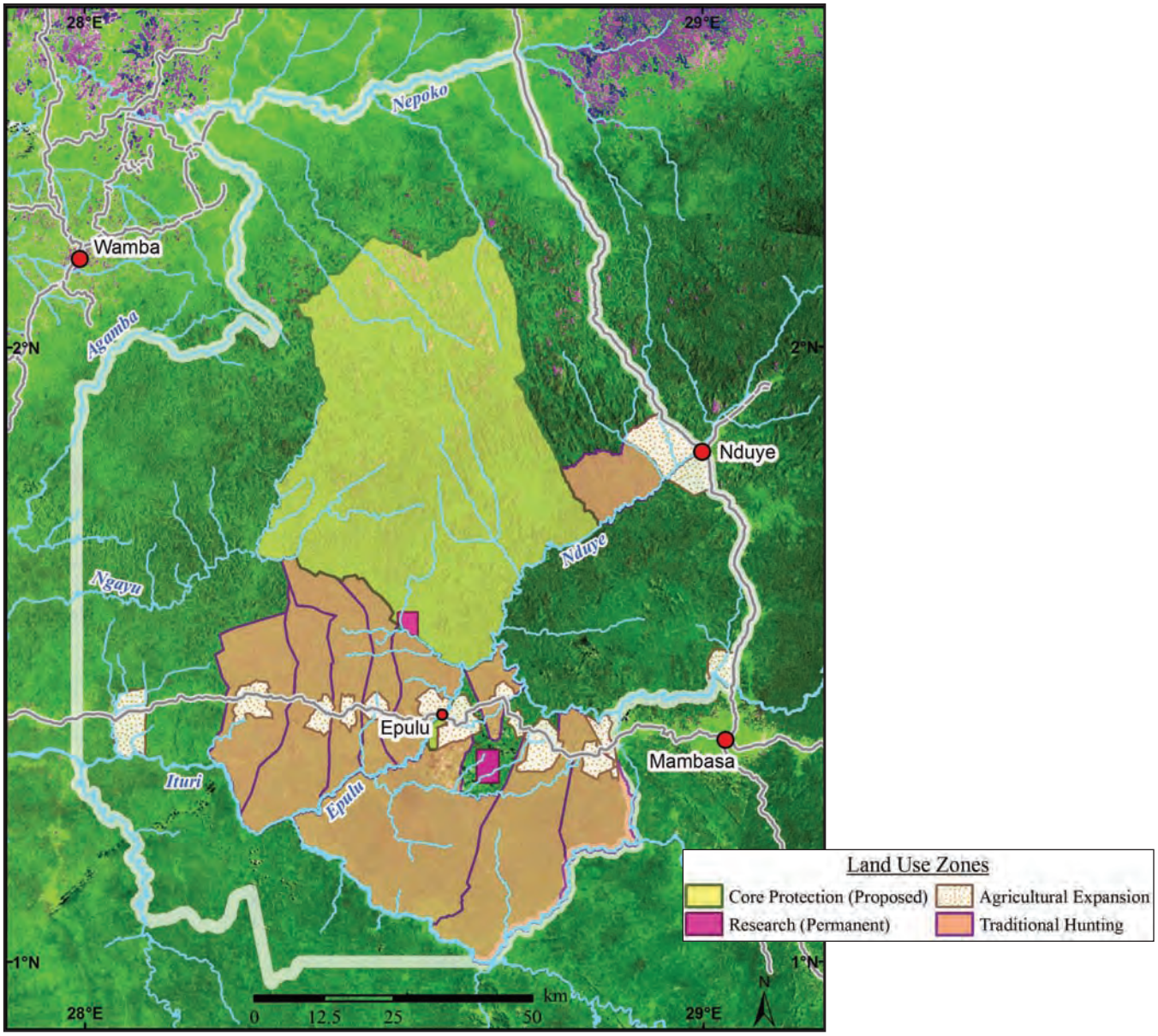

Figure 3. Map of the land use zones of the Okapi Wildlife Reserve.

Agricultural Zones

Agricultural practices in the OWR

Agriculture zones are comprised of one or more villages, their farms and fallow plots, and secondary and primary forest. In a slash-and-burn farming system, only small patches of forest are cleared each year and large trees are typically left standing in fields because of the difficulty of felling them with crude metal axes. Patches of forest near springs, along rivers and/or those otherwise deemed unsuitable for farming are scattered throughout these agricultural zones. Cassava, plantain, bananas, rain-fed rice, beans, sweet potatoes and groundnuts are the principle crops grown in the landscape. Farmers practice a field rotation system with two years of cropping on the same land (0.5 – 1 ha) followed by 10-15 year fallow periods, which allow the soil to regain its fertility and the weed seed bank to die. Even when not actively farmed, fallows continue to be visited to harvest plantains and oil palm. Beyond the area of active agriculture and fallows of various ages, communities lay claim to village-owned forest that has not been cleared in the recent past but can be if need be.

During the Belgian colonial era, agricultural law dictated that a married man should cultivate 1 ha per year and a single man should cultivate 0.5 ha per year; men with more than one wife may have been encouraged by this law to open additional fields. According to recent surveys in the OWR, the average field size per household is about 1 ha per year, with actual clearing rates varying dramatically between small indigenous households and some immigrant businessmen. For the purposes of predicting the area of land necessary to support farming households, 1 ha was used as the average annual field clearing rate.

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Sign indicating the end of an Agricultural Zone

To estimate the total area required to support farming households using present practices, one must consider the area of land required for growing crops, including active fields and fallows, the area needed for housing and how much land in a given area is typically unsuitable for farming. The OWR zoning team used participatory land-use mapping to determine local perceptions of land ownership and the area of land believed sufficient to meet local needs. The team adapted a formula proposed by Wilkie et al. (1998), to empirically assess whether local perceptions of territorial needs were likely to be sufficient given present agricultural practices and likely population growth in the future. It was also assumed that a percentage of the total land area is not suitable for farming, due to the presence of rivers, streams, rocky outcroppings or other such features; for simplicity, we assumed that 10% of the total area is unsuitable for farming.

The area required for sustainable agriculture given prevailing fallow farming practices for a given year (time t) with H farming households, is calculated by:

$$(Sn + Sn \times F) \times H + (H \times 0.05)$$

Where: S = average field size per household per year, n = number of fields planted per household per year, F = fallow period (years) and H = number of agricultural households

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Peanut harvest

Tables 1-3 are from an agriculture zone in the OWR that, based on participatory mapping, is 2282 ha in size. Using the assumption that 10% of this is unsuitable for farming, the zone area is adjusted to 2053.8 ha for the purpose of future scenarios modeling. The size of future agricultural areas is easily computed assuming an annual human population growth rate of 3%.

Table 1 shows how the formula above can be used to project future land requirements of human populations in agricultural zones. In this example, the agriculture zone is 2282 ha, the area claimed by local residents and agreed upon as the limits to future agricultural expansion for the village. At the time that the zone was created, there were 57 agricultural households in the village and each household was assumed to be employing present farming practices, cultivating, on average, one 1-hectare field per year and practicing a 10-year fallow period. Given these assumptions, the formula above was used to estimate the theoretical area required to support these 57 households today (year 0) and four decades into the future. At year 40, the area required to fulfill the needs of the agricultural households is 2054.59 ha, just over the 2053.8 ha agreed upon by the village (and assuming that 10% is unsuitable for agriculture). Using a 3% annual growth rate, by year 40 the number of households will be 186, which can be thought of as the carrying capacity for this agriculture zone.

Table 1. Hypothetical future projection of area needed in an agriculture zone to support household farming and habitation needs. S = 1, n = 1, F = 10.

Agriculture Zone (ha) – 10% adjustment	H	Area required for farming and habitation (ha) year 0	10 year projection (ha)	20 year projection (ha)	30 year projection (ha)	40 year projection (ha)	Carrying capacity of agriculture zone (H)
2053.8	57	629.85	846.47	1137.58	1528.81	2054.59	186

Table 2. Longer fallow period: F=15, S = 1, n = 1.

Agriculture Zone (ha)	H	Area required for farming and habitation (ha) year 0	10 year projection (ha)	20 year projection (ha)	30 year projection (ha)	40 year projection (ha)	Carrying capacity of agriculture zone (H)
2053.8	57	914.85	1229.48	1652.32	2220.58	2984.28	127

Table 3. Smaller field size per household. S = 0.5, n = 1; two fallow period scenarios F = 10 and F = 15.

Agriculture Zone (ha)	H	Fallow Period (F)	Area req. for farming & habitation (ha) year 0	10 year projection (ha)	20 year projection (ha)	30 year projection (ha)	40 year projection (ha)	Carrying capacity of agriculture zone (H)
2053.8	57	10	316.35	425.15	571.36	767.86	1031.95	366
2053.8	57	15	458.85	616.66	828.73	1113.75	1496.77	257

Alternative scenarios

Table 2 shows a scenario with a longer, 15-year fallow period, which would reach the theoretical limits of the agriculture zone at approximately year 27 with a carrying capacity of 127 households.

Table 3 shows scenarios where field size is reduced to 0.5 ha, with either a 10- or a 15-year fallow period. At this field size, and utilizing a 10-year fallow period, agriculture would reach the limit of this zone at approximately year 63, with 366 households. In this scenario, a 15-year fallow period would lead to the agricultural zone limits being reached at approximately year 51, with 257 households.

Though the zone area calculated from this equation is a rough estimate based on broad assumptions, it is nonetheless a valuable starting point for thinking about land-use management and regulation options, and for raising awareness. As these tables illustrate, there are many possible future scenarios, based on different combinations of variables. This sort of scenario-building can illustrate the potential impacts of different land-use practices and policies. For instance, it is clear from the tables that the adoption of the colonial era decree of annual cultivation of a 1 hectare field for married male heads of households affects the carrying capacity of agricultural zones. Agriculture zone rules that limit field size and the number of fields permitted per year affect the outcome, as do agroforestry projects which shorten fallow periods. Using this formula to work through alternative future scenarios can stimulate discussion and debate among farmers, who have a direct stake in the estimated duration that an agricultural zone can support local populations.

Though WCS staff found it very useful to develop scenarios to guide the process of agricultural zoning, it is not appropriate to present this formula to people who do not relate to this kind of information. Rather, the variables present in the formula can be conveyed to audiences through such means as concrete examples, mapping (sketch maps and/or participatory GPS), focus groups and meetings.

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Weeding a field

BOX 1: Agricultural Zoning Steps

1. Outreach: The first step in the land use zoning process is to introduce the notion of zoning in the reserve through a series of formal and informal meetings with village chiefs, landowners (people who have ancestral claims to land), and various members of the community, especially indigenous farming groups.
2. Signature of collaboration protocol: A collaboration protocol is signed between representatives from the reserve (ICCN and WCS) and the local community (usually village chief and/or elders) that states that the village is ready to proceed with the process of zoning. This document does not mention limits or area; it is only a step to formalize the beginning of the process.
3. Census of agricultural households: A census of agricultural households (heads of household who have farmland in the village) is conducted in order to estimate the area of land required for farming.
4. Socioeconomic studies: Socioeconomic studies are conducted to document village history, ethnic groups present, sources of revenue, hunting and farming methods, agricultural production, educational level, social problems, conflicts between different groups, and the relative power of chiefs and land owners. The order of steps 2-4 is flexible. For instance, a census of agricultural households and socioeconomic studies may be conducted before a collaboration protocol is signed to begin the zoning process.
5. Proposal of agriculture zone limits by village elders (customary land owners): The village elders, who are recognized as the customary land owners, make the first proposal for the size and outer limits of an agriculture zone. Often they propose natural limits such as rivers and hills that lie beyond the forest that has been cleared in recent history. Zoning technicians review their proposal in terms of area (ha) and limits, and evaluate it using the equation explained above.
6. Participatory mapping of the outer limits proposed by village elders with GPS: A team composed of village representatives and zoning technicians map the limits proposed by customary landowners using GPS units.
7. Identification and mapping of the current extent of agricultural land clearing with GPS: A mapping team of WCS field technicians and village residents (generally including members of land owning clans) walks along the perimeter of active fields and fallows to create a map of the current limits of agricultural land clearing – where fields and fallows meet primary and secondary forest.
8. Create map of current agricultural clearing & outer limits proposed by village elders and chiefs: After mapping the outer limits of the proposed agriculture zone and the limits of present-day agricultural clearing, the geo-referenced data collected during the field missions is transferred from GPS units to a computer at the main office for clean-up and analysis, first in Excel and Mapsource and then in ArcView or ArcGIS. WCS technicians make a poster-sized map of the proposed agriculture zone for presentation to community groups, translating the geographic waypoints collected in the field into angles and distances on the map.
9. Presentation of map and zoning results to community groups: Community members, representing different groups (Bantu men and women, Pygmy men and women, etc.), are trained to present zoning objectives and to use the map to explain the agriculture zone to their peers. They facilitate meetings on the new agriculture zone and its proposed limits and present the map to local communities for discussion.
10. Presentation of current extent of agricultural clearing and community proposal for agriculture zone to protected area managers: The proposed agriculture zone is presented to the reserve management committee for feedback and approval.

BOX 1, continued

11. Negotiation of zone to be delimited: After the proposed limits have been mapped and the results presented to representatives of different groups in the village, the official agriculture zone limits are negotiated. In some cases people may feel compelled to argue for more area based on fear that they are losing their land – or, in rare cases, WCS may advise them to extend the proposed limits based on estimated land clearing rates or population size. The final decision depends on approval from both the reserve management committee and village (clan) leaders.
12. Agreement reached between representatives of the village and OWR managers over zone limits: It may take several meetings before a final agreement on agriculture zone limits is reached, then a date is set for the ceremony to sign the zone protocol and place cement posts and information panels marking the limits of the agricultural zone along the road.
13. Ceremony to place boundary markers and sign posts and to sign the agriculture zone protocol: During the ceremony, the zoning process is reviewed and the protocol which states the area (ha) and geographic boundaries of the agriculture zone is read aloud before an audience of local authorities, reserve managers and other community members. Signature of the protocol by reserve and village representatives is followed by a shared meal.
14. Delimitation - clearing the perimeter of the agriculture zone: Where natural limits such as rivers do not exist, field teams clear a 3m band in the underbrush of the forest in order to make artificial agriculture zone limits visible. Small teams of village residents, led by a WCS technician, are hired to clear the perimeter when the zone is first created and conduct annual upkeep. This activity provides multiple benefits, including revenue for hired clearing teams, awareness of zone limits by villagers and OWR personnel and facilitated monitoring of zone limits by ICCN.
15. Validation of land use zones in management plan: Once the reserve land-use zoning plan is complete at the local territorial level, it will officially be considered part of the OWR management plan and validated by ICCN at the national level.

What happens after the zoning agreement is signed?

Since 2000, the OWR zoning team has worked intensively with local communities and political authorities to zone 15 agriculture zones, covering more than 48,000 ha. Signing an agriculture zone agreement with a village and erecting signposts and informational panels is a very important achievement, one that often comes after months of work. But it is really the beginning of a process of long-term land management to make certain that local livelihood needs are met with minimum levels of deforestation and biodiversity loss. Post-zoning, it is vital that agronomists work with farmers to enhance crop productivity, on less land and with improved use of fallows, which should reduce the pressure to clear forest for agriculture. Options to enhance local farming practices include providing farmers with improved crop varieties and farming tools, and training village outreach workers (both men and women) to extend enhanced farming practices to more communities.

As it is a minority of farmers, mostly recent immigrants, that clear the most land, targeting them to adopt improved farming practices may have the greatest impact on reducing forest clearing for agriculture. This would lead to more equitable use of the agriculture zone, and

might also reduce conflicts within the OWR, as long-term residents often perceive that it is recent immigrants who are “using up” their agriculture lands.

It is important to note that there is variability in every agriculture zone, and that, therefore, blanket policies that dictate field size are not the answer. Some households do not even have the capacity (e.g. labor force) to farm a 0.5 ha plot. Some people may not want to farm their own land, preferring instead to serve as day laborers on neighboring farms. Ideally, it is up to each village to determine which households will cultivate how many plots of what size each year, so that the total agricultural area remains within the target level that the zoning plan specifies for the village. This allows some stronger, or more skilled, farmers to pool their efforts and clear larger fields with the help of day laborers while others simply plant small gardens around their house and work for their more economically powerful neighbors.

Implementation Concerns

Human-wildlife conflict

Crop raiding by wildlife is a reality in OWR and one of the challenges of having wildlife and farmers in such close proximity. In the villages along the main road (RN4), crop raiding by species such as birds, forest hogs, monkeys and elephants is one of the most common complaints from farmers. Farmers sometimes use crop raiding as an example of how they perceive that OWR staff (ICCN) have prioritized the needs of wildlife over those of people.

To address the problem of crop raiding, farmers are encouraged to plant fields in clusters or blocks to reduce the number of isolated fields, which are more difficult to protect and thus more vulnerable to crop raiding. In fact, in villages that have participated in agricultural zoning, access to benefits such as improved seed varieties, tools and technical advice is conditional on planting fields together in blocks. Additionally, ICCN guards only respond to crop raiding complaints in those fields where multiple farmers are situated together, by chasing away wildlife with noise (e.g., for elephants) or, on occasion, shooting crop-raiding species (e.g., monkeys).

Intra-community dynamics: immigrants and indigenous groups

Currently, land is not perceived as a scarce resource in most parts of the reserve; village chiefs and elders sell land for a low price, in exchange for a symbolic gift, or even give the land away for free. This can cause conflict between the community (the general population of farmers) and village elders and chiefs (i.e. land owners). The younger generation and the population of village dwellers sometimes feel betrayed by chiefs and village elders who gain personal profit from land which is considered to be village or clan property. Part of

the challenge, therefore, is to convince the local chiefs of the valuable and finite nature of the land in the reserve, so that they will not continue to give it away to immigrants. Instead, the hope is that they will consider zoning as a long-term plan to conserve the forest and secure their livelihoods.

In addition to the payments and tribute that they make to chiefs and landowners, immigrants provide another source of income through day labor. Immigrants tend to be more economically powerful and can recruit laborers from indigenous ethnic groups to clear the forest and work in their fields; in contrast to indigenous farmers, they are thereby able to clear multiple large fields per year. In this sense, in exchange for access to land and natural resources, immigrants may be seen as providing immediate benefits to the local economy, whereas ICCN's zoning system may be seen as a hindrance to these short-term gains.

This process of land-use zoning, because it requires local land owners to discuss and document their land claims, can provoke conflicts with immigrant groups who wish to have easy access to land without oversight by protected area authorities. In some cases, when immigrants felt threatened by the zoning program, they advised indigenous landowners to refuse to cooperate with the OWR management team.

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Elephant kill

Therefore, the OWR team must proactively implement community education so that the resident population understands and accepts that zoning is a management tool whose goal is to ensure their long-term access to, and use of, their local natural resources. Thus far, zoning in the OWR has been effective in this sense; in some villages where locals have already determined agricultural zone limits, immigrant communities have decided to look elsewhere for farmland.

Maintaining the respect and trust of people throughout the long-term management of zones requires active participation by OWR staff in village livelihoods issues; for instance, supporting village conservation committees to serve as a platform for airing grievances and communicating with reserve managers. Community relations are also helped by the fact that ICCN and the conservation NGOs contribute to community development projects and assist with various needs ranging from health and education to transportation and funeral costs.

Bargaining: Using zoning to gain benefits or challenge restrictions

It is not uncommon for village representatives, especially chiefs, to change their positions more than once during the zoning process. Even on the eve of an inauguration ceremony for a new agriculture zone, letters have been received threatening to call off the ceremony if certain demands are not met; for example the construction of a school, medical care for village elders or transportation assistance for the village chief. ICCN recognizes that it is important not to respond to this kind of political maneuvering with false promises, finding that the appropriate response to such demands is to assure local communities that OWR representatives are not in a hurry to sign the protocol creating the zone, and emphasizing that it is a document that should be signed when both parties are ready.

Communities have commonly misinterpreted the purpose of zoning, believing it to be a way of losing all claims to the land. OWR staff have worked hard to allay these fears, noting repeatedly that signing agriculture zone agreements does not mean that villagers have signed away their land to the OWR. Rather, by signing, communities are formally documenting their customary rights over the land and acknowledging that, because they live in a protected area where agricultural expansion needs to be planned and monitored, some of these rights are modestly circumscribed. Another misinterpretation is that, by mapping agricultural land and negotiating the limits of an agriculture zone, reserve managers are, in effect, ceding that land back to the community to be used how they see fit. This is also erroneous, as agricultural zones within the OWR are still under the mandate of ICCN and are subject to the regulations of a protected area. One of the most sensitive topics is gold mining. Even though gold mining is illegal in protected areas in DRC, people sometimes try to interpret the zoning process to imply that, if a zone is “ceded back” to them, they would be free to mine there.

Hunting Zones

The overall goal of the OWR zoning program has been to spatially delimit different activities such as agriculture, hunting and conservation. More fluid and, therefore, more frequently disputed than agriculture zones, the hunting zones (zones de chasse) are forest territories where a variety of activities take place, including not only hunting, but also the gathering of non-timber forest products (NTFPs), fishing and residence in temporary camps.

The OWR is one of the few remaining landscapes where Mbuti and Efe Pygmies are able to continue traditional hunting practices (Tshombe et al. 2000). Zoning provides maps of the traditional claims that acknowledge hunters' customary rights as well as their potential roles in the sustainable management of wildlife and forest habitat. Mapping the forest territories and hunting zones used by local villagers is useful for estimating the amount of forest area being used and understanding how different hunting groups use these territories. If agricultural expansion was allowed to proceed unchecked, forest loss would, over time, cause a decrease in the area available for hunting. Therefore, recognizing the customary rights of indigenous people to forest hunting territories offers to them a level of tenure security they previously lacked, and promotes land-use practices that result in retention, rather than conversion of the forest.

Hunting methods

The 1992 decree that created the OWR states that ICCN can grant permits for activities undertaken to meet subsistence needs, provided that these activities do not include the hunting of strictly protected animals or the use of prohibited technology (Tshombe et al. 2000). If fully enforced, this policy would mean that only Pygmy hunter-gatherers could legally hunt in the reserve as they typically only use nets, spears or bows and arrows. While hunting with guns is illegal and quite rare in the reserve (with the exception of armed soldiers who target elephants and monkeys), snare hunting, though also illegal, is more widespread and provides an important source of protein and revenue for many

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Snare in the forest

reserve inhabitants. In fact, along the east-west road that bisects the OWR, the dominant hunting methods are nets and snares. Leg-hold snares are widely used and are the most common hunting method in some areas of the reserve. A snare ban is difficult to implement, both institutionally and socially, because of the size of the reserve, the low capacity of ICCN to control this activity and the fact that alternative hunting methods and livelihood options are limited.

Mbuti hunt with nets they make from a forest vine. These nets measure one meter in height and average about 60 meters in length (Hart 2000). Net drives are a group activity in which men attach their nets to bushes and saplings end-to-end, forming a semi-circle with an average perimeter of ~900 meters. Women and children congregate at the open side of the circle to drive game toward the nets, targeting predominately forest antelopes (duikers) and other small mammals, though occasionally birds and monkeys are also caught (Hart 2000). As one travels northeast, net hunting progressively disappears as one moves into sectors of the reserve long inhabited by Efe archers and their Bantu and Sudanic snare-hunting neighbors. Both nets and snares target forest antelopes, which are the most commonly consumed bushmeat species in the reserve. Archers are opportunistic hunters who will kill any small game encountered on the ground, and also use poison-tipped wooden arrows to target arboreal primates.

The majority of snares used by local groups are nylon or plastic. There are two categories of snare hunters in the reserve: 1) hunters who hunt for their own subsistence and who have ancestral (clan) claims to hunting territories; and 2) immigrants or “visitors” without legitimate clan-based claims to forest territories whose main objective is to capture as many animals as possible to sell to external markets. These “temporary” hunters are more likely to use metal-wire snares and often violate hunting territories by entering and placing snares without gaining permission from those with ancestral claims to the forest.

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Focus group discussion, Wamba Territory

Economic and social importance of bushmeat

Bushmeat is used for household consumption, sale, and trade. In many cases meat is sold to earn money for basic needs such as salt, cooking oil, soap, cloth, medicine, and school fees. Meat may also be sold to roadside restaurant owners who sell it to their clients for a small profit. Bushmeat is usually consumed within the reserve and often within the same village territory where it was hunted. However, growing external demand encourages longer distance trade with large towns on the reserve's periphery where bushmeat is scarce and fetches a relatively high price. Intrinsically low production levels of most forest wildlife species, declining wildlife populations due to hunting, a growing human population, and increased market access as roads are repaired, make it necessary to manage hunting, secure local residents' traditional claims, and control access to the forest by people with only short-term commercial interests.

Considering forest territories in the zoning framework

Pygmy hunter-gatherers utilize well-established clan-based territories, sometimes sharing access rights with neighboring clans. Recognizing that forest territories are dynamic source-sink spaces, hunter-gatherers manage their territories through rotations in time and space, staying at a hunting camp for one to two months before moving to a new location within their territory, and rarely returning to a given location within a year. Factors such as trust, social cohesion, economic benefits and family ties influence the way that they decide to share information, such as the location of honey trees or edible plants, game distribution, and even the presence of dangerous poachers.

Local snare hunters (for example the Ndaka and Lese) use a similar rotation system to manage their snare-hunting territories. As snare hunting is illegal, it has been difficult to officially map hunters' territories, but that does not mean they are not well-known to local communities; for example, the density of snares is often highest near farms where crop raiding is a problem. Some progress has been made in making sketch maps with certain snare hunters who are willing to explain to OWR zoning staff how they use the forest. Hunting territories have been mapped most successfully when done in mixed teams of zoning staff, Pygmy net hunters and Bantu snare hunters.

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Repairing nets

The process used for delineating hunting territories or zones is similar to that used for agricultural zoning, and includes a series of meetings, participatory mapping, negotiation and communication with community groups to reach consensus on zone limits (see Box 2). However, land and resource tenure differ for agriculture and hunting zones. Hunting zones are typically larger and territories are claimed by a clan rather than an individual family or household (as is common with agricultural zones).

Unlike agriculture zones where one of the first steps is to map the extent of agricultural clearing around a village, for hunting zones, the aim is to document the forest territory claimed as common property by clans in one village or localité (group of small villages which share a common forest). Mapping of forest territories generally follows extensive work with villages in their agriculture zones, so that villagers are already familiar with the process of land-use zoning; in addition, a village population census usually has already been conducted.

BOX 2: Hunting Territory Zoning Steps

1. Contact village authorities (chief and clan leaders): Village authorities are contacted to organize the meeting(s) necessary for discussing their forest territory and conducting a participatory mapping exercise.
2. Census of hunters and participatory mapping: Many people in the village may hunt at various times of the year as part of a wider livelihoods strategy, but for this exercise zoning staff are interested in people who identify themselves as hunters and who have detailed knowledge of the forest and clan limits. The mapping exercise can be done with markers and paper, or using sticks to draw in the dirt, whatever people feel comfortable with.
3. Plan for mapping mission: Once information is collected on the general size and shape of a village's forest territory and the distance of outer limits from the road, a forest mapping mission is planned. The mapping team is composed of OWR staff (usually 2 people) and a small group of hunters and clan leaders. To keep field teams small (5-10 people) and to ensure that several people in the village are able to participate, mapping missions are broken up into two or more outings of approximately 5-7 days each. During the missions, teams use GPS units to document forest territory boundaries.
4. Create map of forest territory: Geo-referenced data collected during the forest missions is transferred from GPS units to a computer at the main office for clean-up and analysis, first in Excel and Mapsource and then in ArcView. Zoning technicians make a poster-sized map of the territory using the geographic waypoints collected in the field and translating them into hunting territory polygons, for presentation to the community.
5. Validation of forest claims in Management Plan: Once all forest territories have been mapped in the OWR at the localité level, the map is officially considered part of the OWR management plan and must then be recognized by ICCN at the national level.
6. Zone Management: As with agriculture zones, effective management of forest zones requires a set of enforceable regulations that have been mutually agreed upon, as well as periodic monitoring of wildlife populations and updates of clan limits. Though data are available on bushmeat hunting, little is known about the harvest rates of most NTFPs in the reserve. NTFPs such as honey, mushrooms, insects, medicinal plants, nuts and lianas used to weave hunting nets are important resources for these communities but few data are available to evaluate the sustainability of their exploitation.

Table 4. Estimated number of times households in 3 villages can consume duiker bushmeat per month in various scenarios of production and recommended offtake levels (5, 10, or 25% of total production).

Village	Number of house-holds	Forest territory (ha)	Annual duiker production levels kg (min-max) for territory	Annual rec-ommended sustainable offtake 5% (min-max)	Annual rec-ommended sustainable offtake 10% (min-max)	Annual rec-ommended sustainable offtake 25% (min-max)	Number of times per month each household could eat duiker (min-max)
Bandisende	124	44,300	8,417 - 31,010	420 - 1550	841 - 3,101	2,104 - 7,752	.28 - 5.21
Epulu	267	66,000	12,540 - 46,200	627 - 2310	1,254 - 4,620	3,135 - 11,550	.20 - 3.6
Salate	99	54,000	10,260 - 37,800	513 - 1890	1,026 - 3,780	2,565 - 9,450	.43 - 7.95

By mapping forest territories for each village, one can calculate the area of each territory and the number of people who may have access to its forest resources. In the case of bushmeat hunting, the sustainability of hunting levels and the capacity of forest territories to provide enough protein for local populations can be assessed.

Table 4 presents information that can be used to help OWR managers determine whether traditionally claimed forest territories or hunting zones are large enough to provide bushmeat protein or revenue to resident households. One major challenge in judging whether or not hunting levels are sustainable is that levels of production can vary greatly from site to site, even for the same species. For example, production levels for an assemblage of duikers[5] in the Ituri forest have ranged from 0.19 to 0.70 duikers/ha/yr (Wilkie et al. 1998). However, if the production level is known or can be reasonably estimated, the guidelines presented in Robinson and Bennett (2000) can be used to calculate the amount of harvestable biomass available within each hunting territory for scenarios where the sustainable hunting level is either 5, 10 or 25% of total production. Translating sustainable harvest quantities into the number of times per month that a household can eat a duiker helps to engage local hunters in discussions about territory size and harvest levels.

The type of scenarios seen in Table 4 are not meant to provide rigid offtake rates or household duiker consumption recommendations; rather, much like the agriculture zone formula above, the process may be used to stimulate discussion among hunters, bushmeat consumers and the OWR management committee. Comparing hypothetical predictions such as those presented in Table 4 with actual socioeconomic data collected during household surveys helps OWR staff and local communities better understand the likely impacts of hunting on wildlife

5 Duikers includes: *Neotragus batesi*, *Hyemoschus aquaticus*, *Cephalophus monticola*, *C. nigrifrons*, *C. leucogaster*, *C. callipygus*, *C. dorsalis*, and *C. sylvicutor*

populations, the sustainability of protein consumption and trends in income derived from the bushmeat trade. Collection of six months of daily records on the consumption of forest products, including bushmeat, in 70 households from three villages showed that the actual rates of consumption fall somewhere between the 5% and the 25% offtake levels (see Table 5), suggesting that present rates of hunting may be sustainable. However, because bushmeat from duikers is only consumed a few times per month, it seems certain that it does not provide 100% of household protein needs; it is therefore important to determine the other sources of protein that local people are using to supplement their diets.

OWR staff have been cautioned not to place too much weight in these numbers as household consumption surveys are prone to error. That said, data like these do help promote discussion with local people on the sustainability of hunting practices. As with that for the agriculture zone, this sort of scenario exercise can include future projections of population growth, can be repeated for other game species, and can also be used to help estimate the potential and actual monetary value from sales of duiker bushmeat.

Variations in forest common property management: Experience from mapping

To date, OWR staff have conducted participatory mapping of approximately 300,000 ha of forest hunting territories, for a total of 10 villages. This mapping experience has illustrated the diversity and flexibility of how hunting territories are organized and used. Understanding how the hunting territories of different clans overlap and how hunters who use different hunting methods divide their territories is critical for creating appropriate management guidelines for the zones that specify who is authorized to hunt where, and with what method.

For example, in one village, hunting territories are generally only for Mbuti net hunters; groups of Bantu or Sudanic snare hunters are not recognized and the Mbuti tend to destroy any snares found in their hunting territories. These hunting territories run perpendicular to the main road and are defined by different clans, with the boundaries well-known by the hunters. Because of family ties and affinities between different clans there is movement between territories, although some neighboring clans with more conflictual relationships move in parallel

Table 5. Estimates of duiker bushmeat consumption recorded from household surveys conducted in 70 households in 3 villages (Bandisende, Epulu and Salate) from June to December 2007.

Village	Estimated duikers per household per year	Estimated duikers per household per month
Bandisende	12.7	1.06
Epulu	20	1.67
Salate	45.5	3.79

up and down their forest territories to police one other. In contrast, in a different pair of neighboring villages (Salate and Molokay) there are no clan-specific hunting territories, but rather a single hunting territory that belongs to all residents of both villages. Within this territory, net hunters hunt closer to the road and snare hunters go further into the forest.

Since forest territories are more fluid than agriculture zones, their outer boundaries are more likely to be disputed. The model developed for defining agriculture zones may therefore not be appropriate for all hunting zones because of this dynamic nature. The size of a hunting territory can depend on the power of a clan; for example, the number of adult male hunters and the leadership abilities of its chief, which may change over time. Due to the fluidity inherent in hunting territory boundaries, each village's forest territory is mapped before delimiting the hunting zone, sometimes resolving boundary disputes in the process. The hunting zones that OWR staff have mapped thus far have not been officially signed in ceremonies that document their area and limits. Rather than focusing on creating a definitive map of hunting zones, the aim was instead to document each village's forest territory and understand more about who has access to which forest resources. In doing so, the zoning system provides the first documentation of the clan-level claims of both Pygmy and Bantu/Sudanic forest dwellers. By documenting their claims and officially recognizing them in the reserve management plan, the State (represented by ICCN) and the international community (represented by conservation NGOs) recognize and support their claims to forest tenure.

There are no artificial physical boundaries, such as informational signs or cement posts, for hunting zones at present. Instead, in most cases, each village is well aware of their limits, and the areas are managed as common property with certain clans having permission to harvest NTFPs and hunt. However, there are incursions by outsiders, especially snare hunters and poachers with firearms. In the agriculture zones, people may actually benefit from outsiders coming in to use the resource, as with immigrants paying village chiefs for farming rights. A major difference, then, is that people do not generally benefit when outsiders use the hunting territories. Instead, hunters lament a reduction in wildlife and, in the case of poachers, the potential danger and instability created in nearby villages.

Conservation Zones

In addition to subsistence zones, the long-term land-use plan for the OWR calls for fully-protected conservation zones where all subsistence activities would be prohibited. These fully-protected zones are crucial to the survival of OWR wildlife populations, particularly those that are rare or susceptible to overhunting or human disturbance.

Biological surveys of key large mammal populations and human activities were conducted in the OWR in 2005-2007. They were the first surveys conducted in the OWR since the civil war in 1996, and the

results permitted managers to evaluate changes in faunal densities over the 10 years of conflict. These surveys found that significant populations of the OWR's flagship species remain, including forest elephant, okapi and chimpanzee. Most faunal populations were found to be significantly more abundant in the center of the reserve, in a zone proposed for strict conservation, than in the zones designated for traditional hunting and agricultural settlement. There are also several important sites known as edos, or clearings in the forest, where wildlife congregate for water and minerals. Some edos are protected from hunting by cultural taboos, which could provide a natural starting point for conservation zones.

The majority of the proposed conservation zone overlaps with one particular *collectivité*[6], whose inhabitants practice small-scale farming, fishing, hunting (with snares or bow and arrow) and gathering. Multiple groups currently use the forest in the proposed conservation zone; because of these significant overlaps between the conservation zone and traditional hunting territories, it is necessary to conduct a social impact assessment of the proposed conservation zone as well as mapping missions which map forest claims (to demonstrate the extent of overlap between the hunting territories and the proposed conservation zone). The map, and the results of the social and biological assessment, will be presented to stakeholders before negotiating a management agreement for the conservation zone.

In addition to the large northern conservation zone, a second zone has been proposed in a southern section of the reserve. However, setting aside this second zone may prove impossible in the near future due to encroachment by new settlements and the regular presence of armed poachers. It is currently proposed that human activities will not be permitted within the conservation zone, with the likely exception of honey gathering or cultural rites, especially certain customary use by whichever clan(s)' territories are most affected.

Conclusions

Since the zoning program began in 2000, the first priority has been delimiting the agriculture zones in order to limit agricultural expansion into the forest and to secure local rights in the face of growing immigration. It is only since 2004 that hunting territories also started to be mapped in the forest. While the conservation zone, especially in the north, is recognized as a priority for OWR management, the low population density in the core section of the reserve and the fact that it is not located on the main national road (RN4) means that wildlife there are relatively abundant and human-caused threats are less intense. Therefore, for the moment, OWR's limited time and resources are first directed towards securing the subsistence zones.

6 A political unit that includes several villages, which are usually dominated by one or two ethnic groups with their own languages.

It is important to stress that zoning in DRC is, in many ways, experimental and that results monitoring and adaptive management are necessary to evaluate the capacity of the described zones to support livelihood needs and conservation goals into the future. The reserve management committee, headed by ICCN, strives to make decisions based on the most complete information presently available and to consider possible demographic, ecological, and social changes. For instance, once an agreement is signed with village representatives establishing the outer limits of an agricultural zone, monitoring how people use this zone becomes very important. Trust between local communities and reserve managers is equally important; communities must be convinced that OWR zoning teams will work with them to find solutions to any zone management problems that arise and that zone limits may be re-evaluated in the future as necessary.

Like agriculture, hunting in a human-inhabited protected area requires considerations of both biodiversity conservation and livelihood options. Bushmeat hunting is an important source of protein and revenue for people in the OWR, but the way in which people gain access to bushmeat differs for different sectors of the reserve: access to bushmeat can be affected by patron-client relationships, which may determine how meat is sold, traded or purchased; clan territories can influence the range of movement and access rights to different parts of the forest; and, finally, hunting methods will affect which bushmeat species are able to be captured.

The intent of this zoning work was to document and validate local claims to resources – namely by the Mbuti and Efe Pygmies and indigenous shifting cultivators – in such a manner that immigrants arriving at this settlement frontier find that local populations are empowered with tenure security and the capacity to assist ICCN with the co-management of their natural resources.

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Mbuti boy with net

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