

Savanna burning yesterday and today in Gabon's Bateke Plateaux: foraging-fires and ecosystem effects

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Abstract

Anthropogenic fire regimes and society are linked: social change modifies fire application which then impacts ecosystems. In the past 40 years, savanna burning has changed markedly around the world as policies, laws, and cultures change. This report explores the links between fire regime and culture represented by the fire-based Bateke land chief system in Gabon. Unlike other parts of sub-Saharan Africa where colonial anti-fire policies have been strict and punitive, fire policy in Gabon has been lax. As such, today's savanna fires are neither suppressed nor managed, and their value to the local economy and national conservation is not yet fully recognized. This report addresses the changing role of the Bateke savanna fires, the effects of their fire regimes on their savanna ecosystem, and the contribution of fire to biodiversity and present day fire-foraging. The effects of the fire regime on the ecosystem are explored through plant collection, participant observation, surveys, interviews, and vegetation plots analyzing the impacts of different fire treatments. The land chief's authority was part of a magico-religious system where land fertility was guaranteed by conducting rituals and proper burning procedures. This system effectively ended in the late 1960s during a tumultuous time in Bateke history, resulting in a change in fire culture and hence fire regime. The fires under the land chief system were regulated, annual, dry season occurrences conducted by the community and part of a land fertility rite. By contrast, today's fires are lit by individuals who are no longer under the land chief's authority. Hence, these fires are unregulated, occurring at all times of the year and often semi-annually. Generally, burning stimulates tree resprouting and clears mature grass. However annual and semi-annual fires have different levels of resprout survival based on resprout size, fire intensity, and patchiness. More frequent fires are less intense and patchy, favoring stem survival. In terms of plant diversity, the savannas maintain a flora that is unique for Gabon, though not rare worldwide. Dry-season burning seems to be important for maintaining this diversity. Anthropogenic fire is important for Bateke livelihoods where fire and foraging are related; 85% of survey respondents link fire and food. Today's foraging traditions make fire important for Bateke livelihoods, despite being less connected to land fertility rituals of the past. Taking a national view, most protected savannas in Gabon are not yet by fire and some managers do not recognize its importance to local livelihoods and culture. However, Gabon's parks are dedicated to managing protected savannas with fire. The land chief system, though probably not designed to protect resources, may offer lessons of fire control in a cultural context for contemporary management of protected areas (PAs). This report is a summary of a thesis on the subject (Walters 2009).

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Introduction

The Batéké Plateaux of Gabon begins at the edge of the major forest block of the Ogooué River Basin forests. After 500 kilometers of forest from the Atlantic coast, one stands at the edge of the plateaus: ancient sandy, grass-covered dunes with tropical rivers circulating at their bases. It is here that the River basins of the Ogooué and the Congo are separated by Kalahari sands and where the Ogooué finds its source.

Gabon is mostly a forested country, with the savannas accounting for less than 20% of the surface area. Most of the Gabonese people are forest people, with an understanding of forest resources such as timber. There is little economic value associated with savannas and little training in managing them. Savanna food resources are little known outside of the local populations, fire research has been limited in this ecosystem, and the link between foraging¹ and fire unexplored.

Yet, here, at the edge of the Gabonese forest is the largest interior savannas of Central Africa, housing the Bateke people, a group related to the *Roi Makoko* who signed a trade treaty long ago with the French. It is here that savanna culture still lives, with signature fire-foraging traditions: some still practiced, some in memory only. This report attempts to understand how and why savanna burning was conducted, how it has changed, and how it affects the ecosystem.

Study site and methods



This study took place in the Batéké Plateaux south of Lékoni, Gabon between June 2006 and January 2009. We surveyed 122 Batéké inhabitants of the following villages: Kebiri, Ekouyi, Mbouma, Lewou, and Saaye, Malundu I, Malundu II, Walla (see Fig. 1, left used with permission by J-P. Vande Weghe 2008), conducted recorded interviews with more than 35 people, conducted savanna vegetation surveys on tree structure and forb diversity, and finally interviewed managers of Gabon's protected savannas. This work represents a synthesis of a thesis written about this subject (Walters 2009).

Fire, people, vegetation and management

Organized and purposeful savanna burning is a disappearing heritage world-wide. In some places, only elders remain knowledgeable of past fire-setting practices. In some parts of the world, fire was once the primary tool used to subsist; used as a technique for hunting, grazing, gathering, and agriculture it was intimately linked to man's survival. However, while these practices remained part of southern economies, northern economies abandoned subsistence fires and came to consider fire as only a destroyer of vegetation. Policies banning fire or changing resource access have transformed landscapes, stigmatized local fire use, and led to unprecedented changes in fire regimes². This history and practice of indigenous fire-use and

¹ Foraging is defined as hunting, gathering, and fishing.

² Fire regime is a term used to describe the characteristic fires in a given site (Whelan 2002: 47). The classification of fire regimes includes variations in ignition, fire intensity and behavior, typical fire size, fire return intervals, and ecological effects (Goldammer and de Ronde 2004).

governmental fire-suppression makes some of the central issues in fire regime studies to be, “how and why anthropogenic fire regimes change and how this affects ecosystems”.

However, fire is an emotive topic often polarizing anthropologists, ecologists, conservationists, and policy-makers. This has led to disputes amongst these groups about the role of fire in West Africa, Madagascar, India, Brazil, and elsewhere. In some historical cases, researchers with fire experience in one context have unintentionally misused this experience in a new and different situation, causing a chain reaction of misinterpretation by policy-makers and land managers. The reasons that one fire experience does not fit all are numerous relating to the international context, customary fire-use, interactions of these fire regimes with local vegetation and climate, and national policy. Fire interacts differently in each of these complex cases. What is certain is that fire-use needs to be understood on a place-by-place basis taking into account these cited factors.

Former fire-setting and the land chief system

When most Bateke talk about their ancestors, inevitably, they discuss the land chief. These land chiefs were rulers of the land and directly connected to the ancestral spirits dwelling therein. The land chief was charged with maintaining land fertility and the contentment of the ancestors. If there was a problem with agricultural production, hunting success, or gathering, the land chief would appease the ancestors with ceremonies and sacrifices of wine and cola. In this sense, the land chief was spiritually tied to the land and responsible for all actions that occurred within (Vansina 1973).

The plateau area is separated into a series of land chief domains. In the past, almost all foraging was governed by the land chief. de Brazza first encountered land chiefs during his first passage through Bateke territory (de Brazza 1888). Numerous sources indicate, as did the majority of people surveyed in this study, that burning was strictly controlled. The Bateke were so serious about fire regulation that they stopped granting usage of their territories by the bordering Balali people, who had a tendency to burn hunting reserves (Sautter 1960). Hunting reserves were sections of savanna reserved exclusively for the annual hunt organized by the land chief. This area was well known. Adjacent to villages, burning for other uses was permitted, but never in the land chief’s hunting reserve. Serious penalties were exacted when burning was misapplied or uncontrolled; these actions were viewed as transgressions against the ancestors. According to our survey, villagers who had directly observed these fines made the following list (Table 1):

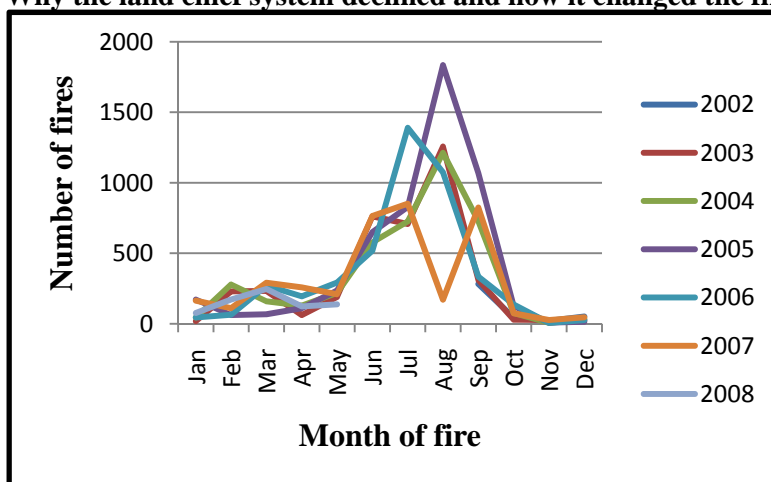
Fines
Payment in money or raphia to the land chief
Payment of daughter in marriage
Sacrifice of goats, chickens, red wine to ancestors as directed by the land chief
Consequences
Sickness
Death
Slavery
Loss of daughter in marriage
Loss of money
Wrath of the land chief
Wrath of other villagers

Today, there are still a few older women who were given in marriage for this reason. If payment was refused, it was certain that an illness would befall the accused. In order to avoid this, people were careful about their burning.

During the height of the dry season, the land chief would send out word that a communal hunt would take place in his domain. Specialists for each domain, the *otiugui*, were used to burn these areas. Essentially, these were some of the best runners in the area, requiring that the igniter run a quarter to half of the circumference of the area to be burned; one such area measured 12.9 km in circumference.

In the days before and during the hunt, rituals were conducted to ensure the hunt's success and safety. Burns on each domain would occur serially, one after the other, allowing the participation of inhabitants from multiple domains. As many as 50 hunters, each bringing their own net, might gather together. The larger game was driven by the flames towards the nets. Once burned, the women followed the flames, collecting the small quarry that the fire left behind including rodents and grasshoppers. Proceeds of the hunt were communally shared amongst all the participants. Historically, these fires occurred annually in the mid-dry season. However, today, burning is semi-annual.

Why the land chief system declined and how it changed the fire regime



Today, fires burn in nearly every season in the savanna of the Batéké Plateaux. Considering data from Lékoni, Gabon to Léfini, Congo (Univ. Maryland 2006), fires peak in the long-dry season, which is the season of hunting, grasshopper collection, and forest plantation burning. There is a very small secondary peak in the short-dry season (January to February), when fire may be used for hunting Abdim's

Stork. Despite the peaks, there is fire activity at all times of the year, though notably less in October and November, when little is left to burn and the beginning of the rainy season is stimulating growth after the many dry-season fires (Fig.2, above).

According to the testimony of numerous informants, the fire-drive ended in the study site some time in the late 1960s. When we asked these people born prior to 1960 why they thought the fire-drives had stopped, they indicated the following as important factors: gun introduction, changes in the post-independence law, and the rural exodus. Indeed, along with *regroupement*, these changes to Bateke society occurred in the 1960s and were co-incidental with the end of the fire-drive. The fire-drive was historically conducted with nets, spears, and clubs. However, when guns became readily available, hunting practices changed. Prior to 1960, guns were rare in the plateaus and illegal. However, political campaigns in the early 1960s in both Congo and Gabon made gun ownership legal and easy (Bernault 1996). Guns allowed individuals to hunt when desired and eradicated the community dependence on the nets of their neighbors.

Colonial laws on hunting, fire use (the fire-drive became illegal in 1904), and land tenure all challenged the land chief's authority. Furthermore, the government began favoring elites, rather than customary chiefs that had been appointed by the French (Gray 2002; Kinata 2001; Ongala 2005).

The rural exodus also contributed to a re-structuring of the village populations. Not only were there less men to conduct hunts, but also fewer people to be trained for the customary offices and ceremonies related to land fertility and burning.

The *Régroupement* policy emptied the countryside of its villages, estranging many from their domains. Villages that were once scattered throughout Gabon are now almost solely grouped along roads (Pourtier 1989)³ in what resulted in a cultural re-alignment (Gray 2002). Bateke who were regrouped to forested areas such as Boumango and Bongoville have lost many foraging traditions while those remaining near their savanna domains are more likely to practice burning.

While historic burning was a communal affair maintaining land fertility and organized by the land chief, today's burning is governed at the discretion of the individual (Fig. 3). In the Koukouya Plateau, Bonnafé (1978: 28) wrote that today's land chiefs work the fields, whereas in past they were political and spiritual leaders. This de-coupling of the political and spiritual realms deregulated burning which then impacted the ecosystem. This results in a dramatic difference in the way in which burning occurs. In the past, hunting fires used domain boundaries, however, today these domains are no longer respected with fires burning across the Plateaus (fig. 4a, 4b).

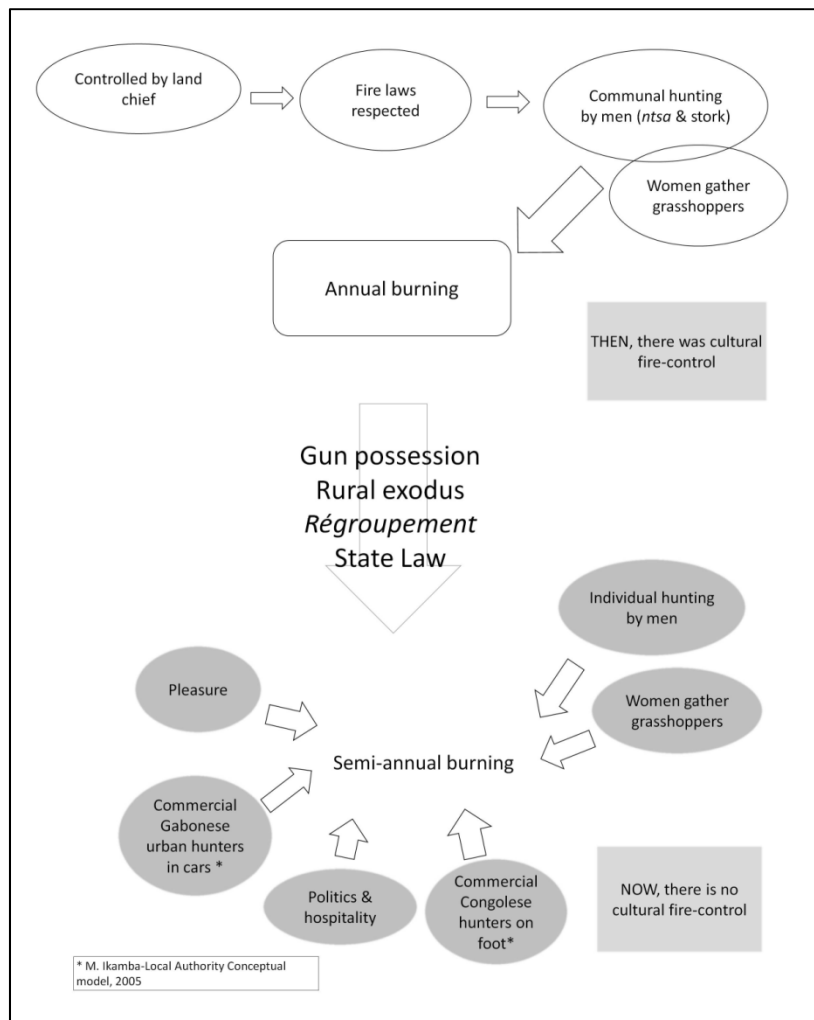


Figure 3. Evolution of the fire regime based on socio-political changes to the land chief's authority.

³ The exceptional cases of pygmy villages in the mountains of Central Gabon continue to remain off roads.

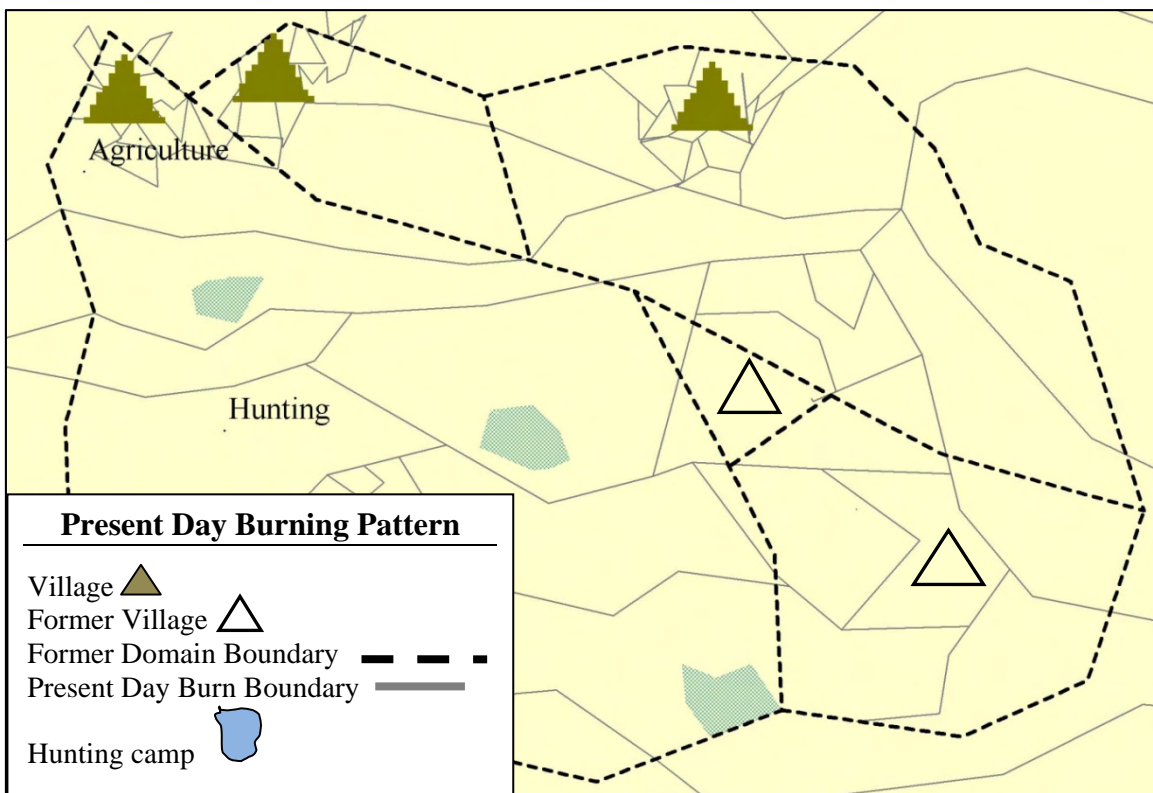
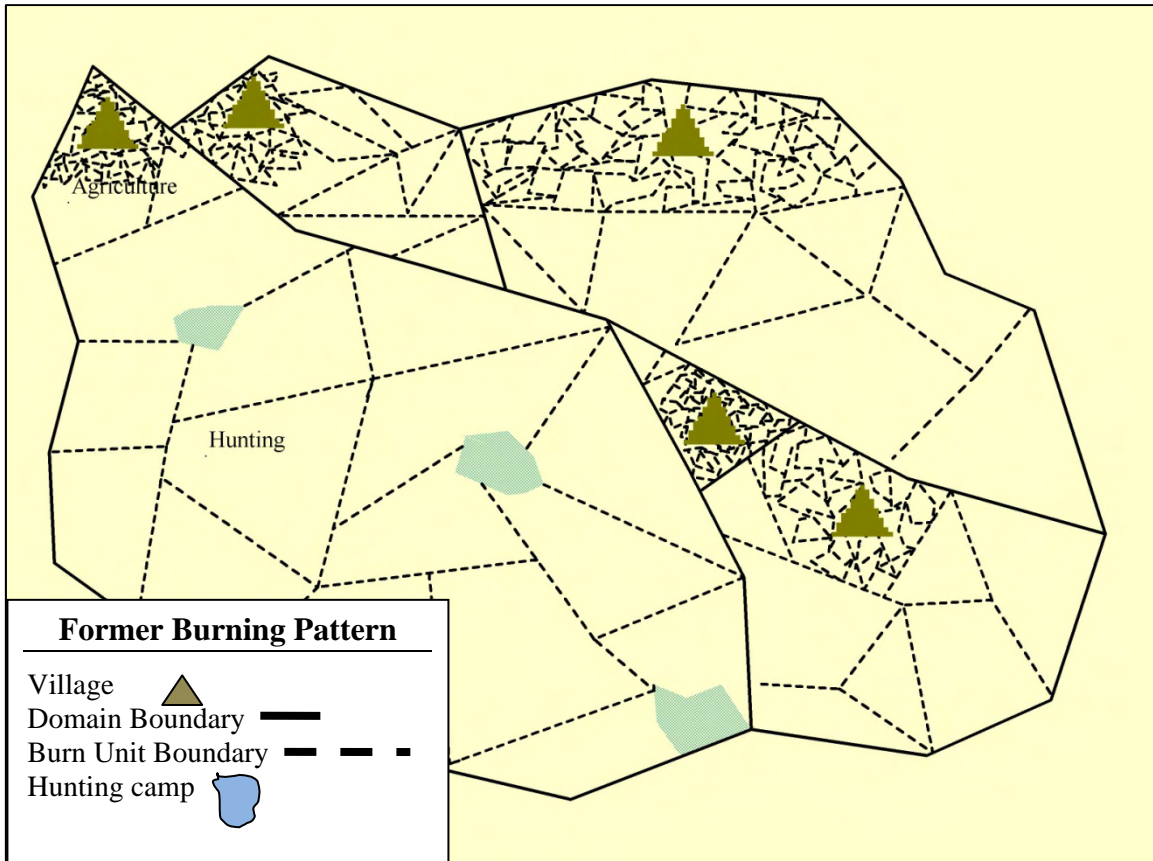


Fig. 4 a. Former burning pattern where fires were contained within domain boundaries and had prescribed *ewa* boundaries. Fig. 4 b. Present-day burning pattern where fires no longer conform to domain or *ewa* boundaries.

Fire and foraging in the Bateke Plateaux cultural landscape

Burning for foraging today, despite a decline in the land chief’s authority, is still conducted. However, our survey results indicate that while people burned strictly for livelihoods in the past, today’s burning may also include landscape beautification and what some call disorderly use of fire (Table 2).

Pre-independence burning rationale (informants born pre-1960)	Current rationale for burning (all respondents)
1. Grasshopper gathering	1. Clearing paths
2. Hunting (fire drive)	2. In disorder (negative)
3. Savanna plantation	3. Hunting (creating pasture)
4. Rodent gathering	4. Grasshopper gathering
5. Clearing paths	5. Savanna regeneration
6. To eat	6. Savanna plantation
7. Caterpillar gathering	7. To eat
8. Bird hunting	8. Caterpillar gathering
	9. Visibility
	10. Fun
	11. Protection from reptiles
	12. Mushroom gathering
	13. Dead grass removal/landscape beautification
	14. Rodent gathering
	15. Bird hunting

Table 2: Reasons in order of importance for past and present savanna burning.

However, 85% of informants link fire and food today and in the past, listing more than 25 savanna foods. In their own words:

If the savanna is burned, one can find *olu* (*Albizia adianthifolia*), *kankele* (caterpillars), and *ampari* (grasshoppers).

Bea Ongassia, age 55, my translation

Before, the mamas would burn the savanna to look for *ampari* (grasshoppers) and men [would burn] to hunt. After the *ampari*, the new grass growth would call the *ntsiensiele*.

Georgine Ngobuni, age 67, my translation

Particularly important are fires lit directly to gather grasshoppers and those lit in the long dry season to generate forage for caterpillars in November. Additionally, several gather plant species benefiting from fire including *Olu*, *mfuluru* (*Landolphia lanceolata*), and *ntundu* (*Aframomum alboviolaceum*). The traditions involving the fire-foraging practices of *kankele*, *ampari*, and others are emblematic of Bateke traditions; these fire practices are anchored in land tenure practices and subsistence traditions, previously ensuring land fertility. Today, these practices are conducted almost exclusively for subsistence. Historically and today, foraging with fire has been one of the largest forces impacting plateau area vegetation.

Fire and flora: herbaceous diversity and fire regime

What is the value of the Bateke Plateaux savanna flora to the national flora of Gabon and how do anthropogenic fires affect it? The Bateke Plateaux area was first proposed for conservation due to its unique landscape, its amenability to tourism, and the presence of unique animals (Wilks 1990). New

work suggests that many plateau savanna species share the same distribution as the animals for which the plateau area is protected. Many of these species, while not globally rare, are rare in Gabon making them potentially important to Gabonese conservation (vande Weghe 2009). One way to understand the value of a flora is to assess its uniqueness within the national flora of Gabon by understanding how many savanna species from the plateau area are found elsewhere within Gabonese savannas. When we compare the savanna diversity of areas where plant checklists have been completed (Loango NP (Harris et al. 2009), Pongara NP (Dauby et al. 2008), Lopé NP (McPherson and White 1995) and Plateaux Bateke NP (Walters et al. 2009), we see that these savannas are extremely dissimilar in composition, not having more than 15% of their species in common (see Table 3, below).

Site			
	Lopé (N = 222)	Bateke (N = 182)	Loango-Pongara (N = 133)
Lopé	--	15.0%	12.7%
Bateke	--	--	13.5%
Loango-Pongara	--	--	--

Table 3. Comparison of savanna floras from three sites using the Jaccard Similarity Index. Total species numbers per site are noted in parentheses.

Twenty-five per cent of the Bateke Plateaux savanna flora contains species which, despite wider global distributions, are only found in the Haut Ogooué province in Gabon⁴. Of these species, five are globally rare being endemic either to the Bateke Plateaux area or slightly wider in distribution: *Scleria baroni-clarkei*, *Syngonanthus ngoweensis*, *S. schlechteri*, *Eriosema* sp. nov. van der Maesen & G.M. Walters, and *Clerodendrum* sp. nov. P. Bamps & G.M. Walters. By contrast, the most gathered savanna species by the Bateke are common throughout their distribution including *Anisophyllea quangensis*, *Annona senegalensis*, *Landolphia lanceolata*, *Parinari capensis*, *Albizia adianthifolia*, and *Aframomum alboviolaceum*.

How does burning affect this savanna plant diversity? In a study using five sites each in burned and unburned areas with a survey constituting 270 plots across the four seasons, ANOVA results indicated that dry-season burning is the most important in maintaining forb diversity. However, there are species unique to every season in burned and unburned areas. The rarest of the plateau species in the surveyed sites, plateau endemics *Eriosema* sp. nov. and *Clerodendrum* sp. nov. are found in both treatments; therefore, regardless of burning, they are present.

Burning and vegetation structure

Fire is a major factor shaping savanna ecosystems including North America prairies, the Brazilian cerrado, and the Australia outback; all African savanna systems are affected by fire including those of Madagascar, South Africa, East Africa, and West Africa (Pyne 1995). Humans have inhabited African savannas for a long time, perhaps as long as two million years. The manipulation of fire is the factor that probably led to expanded use of these areas in Africa, first with the use of fire as a hunting and gathering tool (Harris 1980) and later as a pastoral and agricultural tool (Komarek 1972). Savanna fires in the Batéké Plateaux have occurred since at least 2100 BP (Schwartz 1988). The Bateke have been burning in the study site since the 1840s when they first arrived (Deschamps 1962).

⁴ Similar distributions are found for forest species (Walters, Wieringa, Bradley, Niangadouma, Nguema, and Stone 2009).

Although the Bateke are known for creating forests around their village sites (Guillot 1980)⁵ and therefore being ecosystem engineers, their use of fire to change the ecosystem is less explored.

The interaction between fire frequency and vegetation structure is primarily concerned with stems achieving a large enough size to escape fire. Fire that is too frequent encourages constant resprouting from savanna tree bases and prevents saplings from graduating into larger size classes; however a longer return period may allow saplings to grow beyond fire damage height to become trees (Enslin et al. 2000, 43:27-37). Variation in fire intensity may be one way which favors stem-escape. How Bateke burn today may have changed the historical fire dynamics once in place across the plateaus.

While informants do not acknowledge that savanna tree density has changed in their memory (becoming more open or more closed), they acknowledge that the small savannas, *kabala*, within the forest are closing. These are closing despite the use of fire, a phenomenon common elsewhere in Central Africa⁶. This closing has also been noted by transect work in the PBNP (Leal et al. 2007). As stated by one informant:

The *kabala* that no longer exist, this is the forest invading them. The forest is more powerful than grass.

M. Assieme, 2007, my translation

Today, as historically, peri-village burning and domain burning differs. Close to the village, patches are burned numerous times per year (three or more times in the same place); these fires are noticeably smaller than those lit further away in the domains (Fig. 5). The peri-village fires are lit for various reasons including village security (from destructive late season fires) and protection of savanna plantations. However, out in the domain, fire setting has become more frequent and occurs annually to semi-annually.

⁵ The Bateke in the study site, despite having created village forests that dot the landscape as far as the eye can see, do not like living in forest. This dislike of the forest has been explained many time by informants and also commented in the literature.

⁶ However, forest advance is common in Central Africa (Maley 1990). Recent scientific studies based on a variety of methods, all coming from the forest-savanna edge, attest to forest advance in Gabon, Republic of Congo, and Cameroon. There, forest gains on the savanna despite fire use; fire-resistant species at the forest edge may also protect the forest (Dowsett-Lemaire 1996; Koechlin 1961). Some coastal forest in Gabon is the result of recent expansion occurring in the past 500-1000 years (Delègue et al. 2001); forest expansion is also active in central Gabon's savannas (Nana 2005). Encroachment is active in southern and central Cameroon (Guillet et al. 2001; Mitchard et al. 2009; Vincens et al. 2008), in the coastal forest of Republic of Congo (Dowsett and Dowsett-Lemaire 1991; Favier et al. 2004), and in central Republic of Congo (Sautter 1966: 515). Forest advance into Congolese Mayombe savanna occurs at a rate as high as 50 m per century (Schwartz et al. 1996). Fire slows forest progression but does not stop it (de Foresta 1990) and active protection of the forest edge has been found to speed up colonization by forest (King et al. 1997).

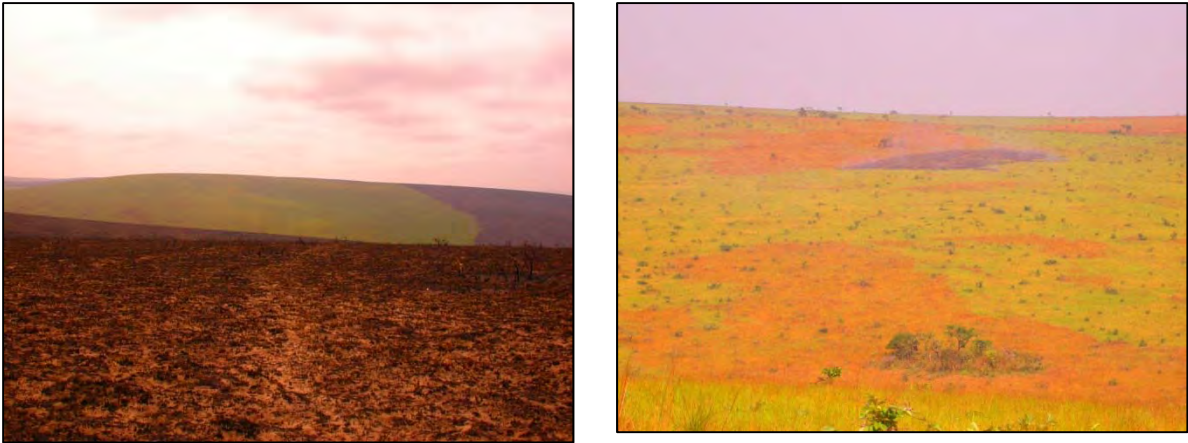


Figure 5. Domain and peri-village fires. The single large domain fire (left) is contrasted with the small peri-village fires not detected by Firemapper (right). Maximum colour saturation of the image is used to contrast the burned areas: the differences in green (burned a few weeks ago), rust-brown (unburned), and dark brown/black (most recently burned) signal the age of the burn.

In unburned Bateke savanna, the woody vegetation is crowded by high, dry grasses. Not only do dead grass tussocks accumulate, often obscuring the *H. acida* re-sprouts, but the resprouts themselves are abnormally thin and are not actively recruited in the absence of fire. Resprouting was low throughout the year with the average density of resprouts per plot not exceeding 20 per m². Once savannas are burned, *H. acida* displays intensive resprouting typical of fire-dependent species. Average resprout production two months post-fire was high at 60 per m². However, by month 12 there was no difference between areas that had not burned for 36 months and those that had not burned for 12 months. This pattern suggests that *H. acida* is a fire-dependent species (Fig. 6).

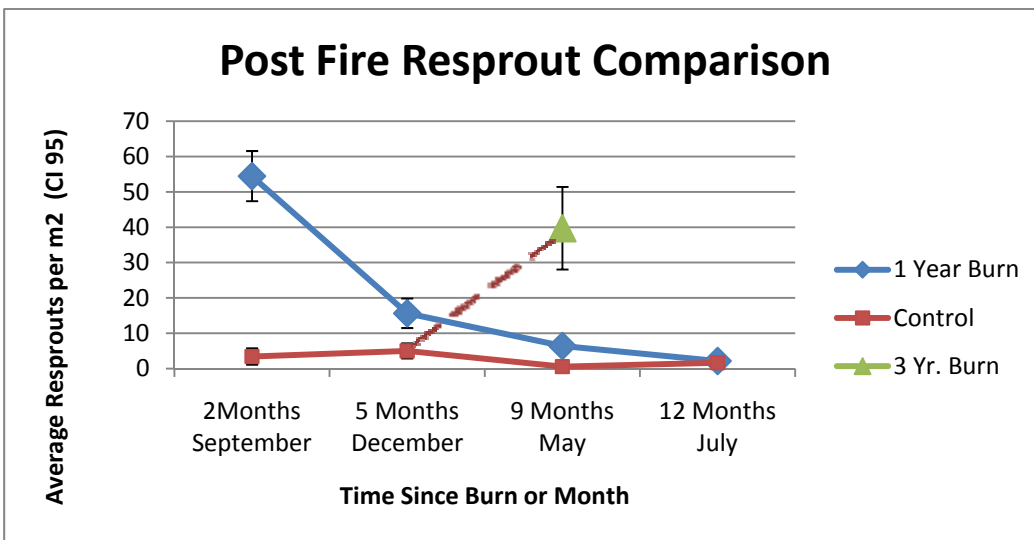
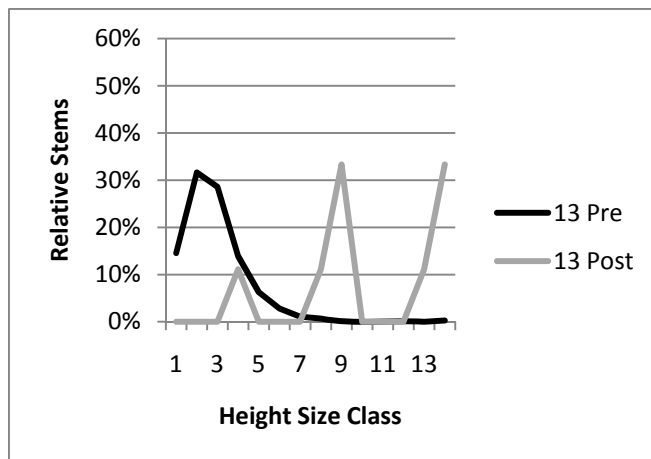


Fig. 6. Resprouting density per square metre compared across treatments. Significance is denoted by non-overlapping 95% Confidence Interval bars.

When these savannas are burned, the stem size-class distribution is interrupted, and transformed from one of near-continuous distribution of stem sizes to one composed of only post-fire survivors (see Fig. 7).



This trend was most pronounced in the annual fires where 100% of the grass and resprouts were burned. However, in the treatments burned semi-annually, fires were patchy and the structure was almost unaffected. In Fig. 8, the fires at 9 and 4 months were patchy and allowed many stems to escape fire damage.

Fig. 7. Pre- and post-fire relative distributions of stems are compared.

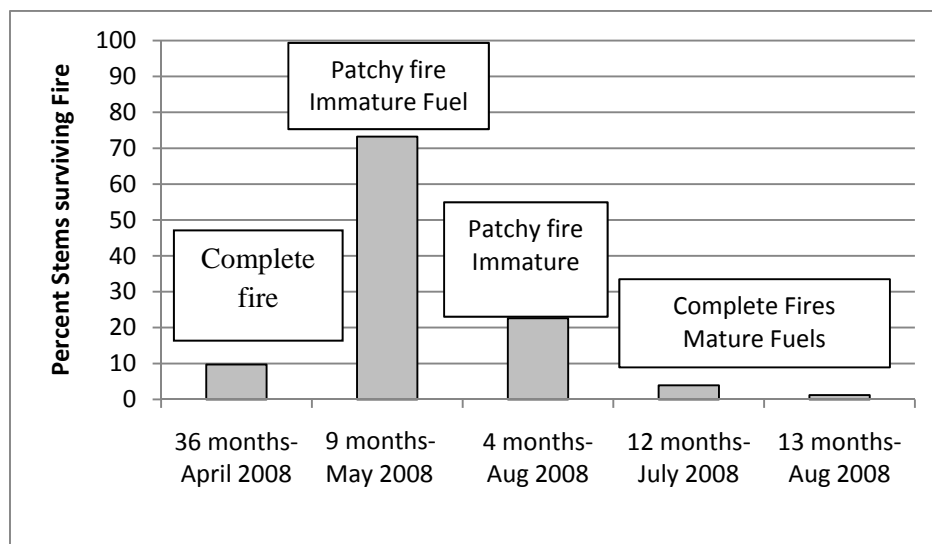


Figure 8. Comparison of post-fire stem survival, fuel maturity, and season.

There are several ways for stems to escape fire, including protection from fire by growing in savanna plantations (Laris 2008), fire suppression, termite activity, and high rainfall promoting rapid growth (Higgins et al. 2000). Patchy fires in the study burned incompletely either due to immature fuel or poor fire weather and may provide a new way for stems to escape fire damage. Patchiness in fires is not unknown and is generally attributed to irregular water distribution (Vetaas 1992, 3:337-344), variation in grass production (Chidumayo 1997), competition between trees and grass (Mordelet and Menaut 1995), fuel dynamics, and fire weather (Trollope et al. 2004). This study seems to indicate that the modern Bateke fire regime of semi-annual burning may result in increased tree survival. However, this should be verified by a study using historical aerial photographs.

The potential of modern fire management in Gabon’s protected savannas

In PA networks in developing countries savanna management may be poorly understood and under-financed. Despite overall advances in ecosystem management with fire, there is still a lack of technology and lack of information about fire effects. Noted fire ecologist, W. Trollope indicated that in Africa, fire-use knowledge may be higher amongst elders than western-trained managers and scientists:

Insights into the ecology and use of fire in these [developing] countries are very poorly developed at practitioner, scientific and government levels. A possible exception to this in both countries [Kenya and Namibia] is the conventional wisdom on fire ecology that still exists in the older members of tribal communities. However, virtually no effort is being made to capture this conventional wisdom about fire ecology and it is bound to disappear with time with the demise of these senior members of society.

(Trollope cited in FAO 2001, Working Paper 55: 35)

Studies have recently shown that local burning may be beneficial to resource management (Bird et al. 2008; Laris 2002; Mbow et al. 2000) and that burning can be a savanna management tool (du Toit et al. 2003). In Gabon, six out of 13 parks contain savanna habitats. What knowledge is required to manage these savannas? Information necessary for successful management of savannas in PAs includes knowledge of historic and present fire regimes, local burning rationales, clear management goals, and research on the specific effects of fire in a PA.

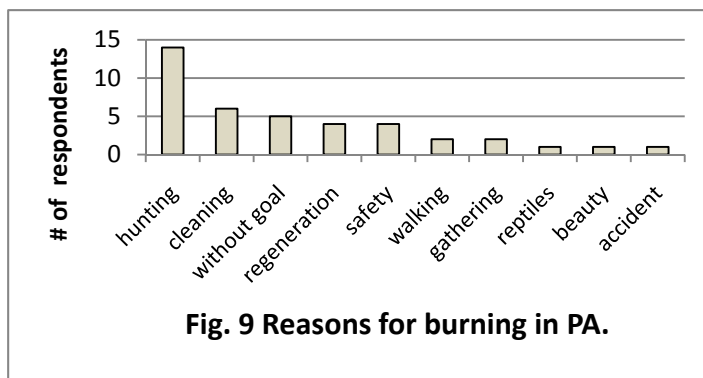


Fig. 9 Reasons for burning in PA.

All Gabon parks are incorporating fire into savanna management. Interviews were conducted with the managers and implicated NGOs to understand what training in savanna management had been received and if local burning around their PA was understood. The only park in Gabon to have a fire management plan is Lopé National Park⁷. However, all parks experience

fire in their borders and buffer zones. When asked why these areas were being burned, the answers in order of importance were: hunting and fishing, cleaning, without goal, regeneration, safety, ease of walking, gathering, clearing of reptiles, beautification, and by accident (Fig. 9). While many managers had grown up in savanna areas subject to burning, most had learned to burn through management training. If respondents had not grown up in a savanna, their fire experience was almost exclusively with management fire (Table 4). While nearly all NGO respondents had been trained in science, nearly all ANPN respondents had been trained in management. There was little cross-training. Formal savanna management training had not been received by most respondents. Respondents in the survey generally expressed goodwill towards using fire as a management tool. However, many expressed a need for studies to support fire for management.

In the case of PNPB there is a clear link between the structure of the savanna ecosystem and the way it has been burned. Interviewing elders resulted in understanding the cultural link between the Bateke people and their form of fire management. Using Firemapper data and interviews, we understand that a recent change in fire regime has occurred. Without this information, research on the flora and fauna would have been limited to basic effects of fire under today's regime, without understanding the context. Furthermore, the park's management objective of conserving Bateke cultural heritage would have been compromised. Clearly, PNPB will benefit from multi-disciplinary research oriented towards ecosystem ecology and its social context.

⁷ There, savannas have been found to be part of human and vegetation history; this is similar for other Gabon savanna areas such as the Bateke Plateaux.

In a recent comparison of two national parks renowned for their savannas it was found that management objectives (including fire) could only be obtained by having monitorable goals, baseline data, and sufficient resources (Parr et al. 2009). This is mirrored for the whole of the Australian park system, where adaptive management is stressed in a cultural context (Keith et al. 2002). Based on the experience provided in Bateke and Lopé NPs, we see that one needs a team of managers, conservationists, and researchers engaged in the process together. It requires a knowledge of the cultural context in which burning occurs and often requires a leader to organize and synthesize research and findings. Finally financing is required to enact the plan safely. Without any of these things, a fire plan may only exist on paper.

	Reasons for savanna burning near respondent's origin	Reasons for burning experience by savanna residents	Reasons for burning experience by savanna non-residents
Gathering	5 ⁸	1	
Plantations	4	1	
Snake removal	2		
Ease of walking	2	1	1
Hunting	2	2	
Management	1	7	3
By accident	1		1
Unspecified goal	1	2	1
Security			1
Subtotal of respondents	N = 8	N = 8	N = 4
Total burn experience		N = 12	

Table 4. Comparison of ordering of reasons savannas were burned in places of origin versus direct experience with burning. Respondents were able to list more than one response per category.

Conclusions

The proper use of fire was once the foundation of land fertility beliefs and fire-foraging practices amongst the Bateke. Today there are few middle-aged men to pass on the knowledge between youth and elders. As this knowledge diminishes, a portion of the culture is lost. The land chief's diminished authority can be viewed as one of the root causes for reducing community activities as well as regulation of burning and hunting. However, today's burning does not appear to be destructive, despite being more frequent; it favors tree growth and forb diversity.

One of the unknowns in this ecosystem is how grazing and fire once interacted to shape the ecosystem. In the past, European explorer's accounts indicate that grazing pressure in the Bateke savannas was high. Today's numbers are low (Bout 2006) owing to recent gun introduction, the

⁸ Many of these respondents had grown up in the Tchibanga area where savanna burning is linked to post-burn mushroom gathering.

commercial bush meat trade, and associated illegal hunting (Aczel 2006; Gami 2003). In savanna systems where grazing populations are higher, herbivores transform woody structure (Holdo 2007), break up the savanna grass cover resulting in fragmented fires, increase diversity, and create a more productive system (McNaughton 1979). One can only imagine what the ecosystem would be like if grazers were still a prominent part of it.

In recent years, UNESCO and others have recognized the link between biological and cultural diversity (Persic and Martin 2007). In recognition of this, many researchers have sought to reconcile both local and western forms of landscape management (Berkes et al. 2000; Sheuyange et al. 2005; Tipa and Nelson 2008). Including aspects of social and biological studies will place burning within a bio-cultural context, an appropriate approach to preserving savannas important to Gabon's human and vegetation history. Certainly understanding the social context of the savanna and its importance to local livelihoods and the area's fire history is important for conducting informed management and conservation.

Specific Recommendations

- While Gabon has the capacity to carry out fire research, direction of this research and knowledge on enacting a fire plan successfully is lacking. Gabon's parks should consider consulting with South Africa park personnel who have an experience in this domain.
- Gabonese students conduct fire research, thus increasing the national capacity within Gabon to manage savannas.
- Understanding the importance of savanna to local subsistence and the burn rationale of local populations is important for managing development and conservation projects. Savanna area projects are encouraged to conduct basic surveys about these issues.

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