

Western Gorilla (*Gorilla gorilla*)

Additional supporting information for *G. gorilla* assessment: Figures 1 & 2; Tables 1 & 2; and Appendix 1.

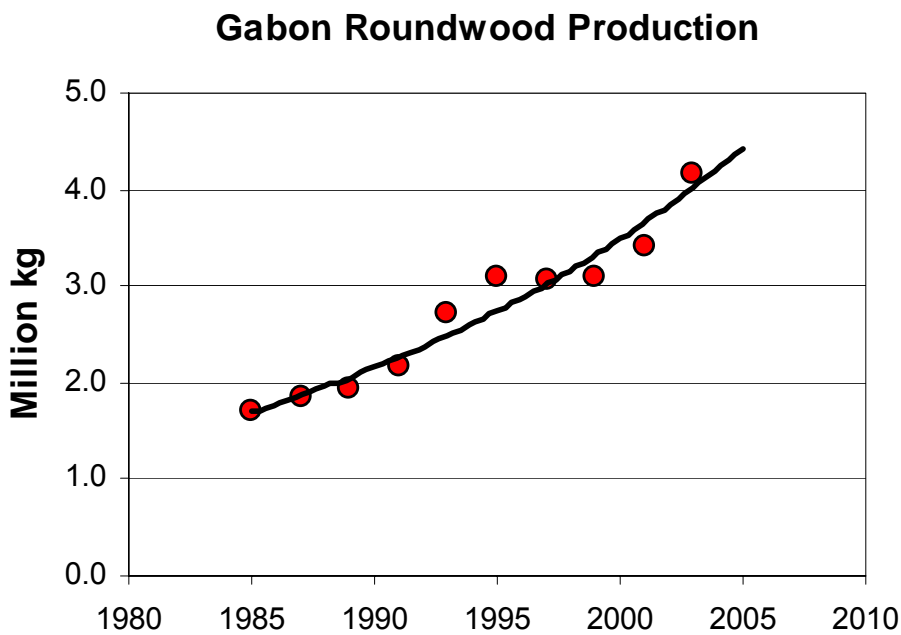


Figure 1. Roundwood production in Gabon (1980-2005). Source: <http://faostat.fao.org/>.

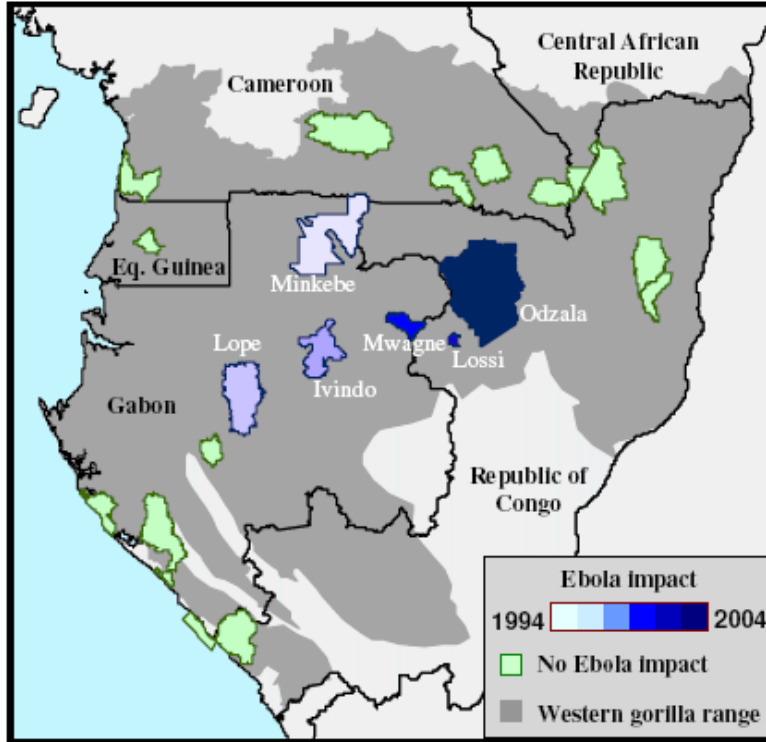


Figure 2. Protected areas with important western lowland gorilla populations.

Table 1a. Estimates of percent decline in gorilla abundance in six survey zones.

Site	Outbreak Date	Survey Area (km ²)	Survey Effort (km)		Nests per km		% zone affected	% Decline
			Pre-Ebola	Post-Ebola	Pre-Ebola	Post-Ebola		
Minkébé	1994-96	22,300	81	2,911	4.11	0.12		97.1
Lopé*	1996	2,000						0.0*
Ivindo	1996-8?	4,700	67	124	2.40	1.33		44.6
Mwagné	2001	3,600	23	289	1.85	0.03		98.2
			Non-Out	Outbrk	Non-Out	Outbrk		
Lossi	2002-3	4,300	267	332	1.98	0.081	62	59.0
Odzala	2003-5	13,100	61	62	8.34	0.38	58	55.6
Total		50,000	565	3,652	weighted mean % decline =			74.2

*A chimpanzee carcass testing positive for Ebola was found at Lopé National Park. However, because of inadequate sampling coverage and pre-Ebola logging at Lopé, no decline estimate has been attempted. Rather, the gorilla population in Lopé is arbitrarily assumed to have experienced zero impact from Ebola. This assumption of zero impact exerts a conservative influence on the combined estimate of population decline due to Ebola.

Table 1b. Estimates of percent decline in gorilla abundance in five survey zones.

Site	Outbreak Date	Survey Area (km ²)	Survey Effort (km)		Nests per km		% zone affected	% Decline
			Pre-Ebola	Post-Ebola	Pre-Ebola	Post-Ebola		
Minkébé **	1994-96	22,300	81	2,911	4.11	0.12		97.1
Ivindo	1996-8?	4,700	67	124	2.40	1.33		44.6
Mwagné	2001	3,600	23	289	1.85	0.03		98.2
			Non-Out	Outbrk	Non-Out	Outbrk		
Lossi	2002-3	4,300	267	332	1.98	0.081	62	59.0
Odzala	2003-5	13,100	61	62	8.34	0.38	58	55.6
	Total	50,000	565	3,652	weighted mean % decline =			73.1**

**Lopé has been removed since Ebola impact could not be discriminated from hunting impact. Decline rate estimates are based on relative abundance (function of nest encounter rates and surface area), rather than just park surface area. Using only surface area (no abundance), the estimate climbs to 77.3% decline.

Table 2. Protected areas holding significant pre-Ebola outbreak populations of western lowland gorilla, and Ebola-induced declines.

Protected Area	Country	Pre-Ebola Area (km ²)	Post-Ebola Area (km ²)
Protected areas with no documented Ebola impact (*areas in epizootic path)			
Monte Alen	Eq. Guinea	2,000	2,000
Campo	Cameroon	2,315	2,315
Ngotto	CAR	733	733
Moukalaba Doudou	Gabon	4,500	4,500
Loango	Gabon	1,550	1,550
Birougou	Gabon	690	690
Conkouati	Congo	3,465	3,465
Dja	Cameroon	5,260	5,260
*Nki	Cameroon	1,882	506
*Boumba Bek	Cameroon	2,501	672
*Lobéké	Cameroon	2,179	585
*Dzanga Sangha	CAR	959	258
*Dzanga Ndoki	CAR	190	51
*Nouabalé Ndoki	Congo	4,243	1,140
*Lac Télé	Congo	4,564	1,226
Total		37,031	24,951
% post-Ebola decline		32.6%	
Protected areas with documented Ebola impact			
Lopé (assumed to have zero impact)	Gabon	4,970	4,970
Ivindo	Gabon	3,000	806
Minkébé	Gabon	7,570	2,034
Mwagné	Gabon	1,160	312
Odzala	Congo	13,200	3,547
Lossi	Congo	320	86
Total PA area with documented Ebola impact (km²)		30,220	11,755
Total PA area (all PAs) (km²)		67,251	36,706
% post-Ebola decline (all PAs)		45.4%	

Appendix 1

Supplementary documentation for *Gorilla gorilla* Red List

Based on correspondence from Damien Caillaud to Liz Williamson (5th May 2007): **Generation length of *Gorilla gorilla gorilla* Maya Nord, Congo = 22 years**

A method to estimate the generation time of western lowland gorilla is outlined below.

The main issue is the lack of long-term data on this species. The longest, ongoing study is Mbeli Bai, launched in 1995. Some life history trait estimates from this population (and also from habituated groups and from Maya Nord population) were published in 2004 (Robbins *et al.*, Int. J. Prim.). Though this publication does not provide estimates of adult mortality, which would be necessary to estimate the mean generation time, it gives some interesting evidence that inter-birth interval could be longer in western gorilla than in mountain gorilla. As in mammals inter-birth interval is positively correlated with life expectancy, this observation could indicate that the generation time may be longer in western lowland gorilla than in mountain gorilla.

So, which available dataset may be useful to estimate western lowland gorilla adult survival and some other life history traits? Does longitudinal observation data constitute the only source of information? Under the main assumption that the few populations studied in clearings are demographically stable (i.e., their structure has reached an equilibrium and does not change with time anymore), we can imagine that population structure data conveys information concerning the life history traits they result from. D. Caillaud has developed a method to extract this (life history) information, using a Bayesian statistical method that has been developed in population genetics (which is not strange since one of the aims of population genetics is to infer historical events from cross sectional data, namely DNA sequences). The purpose of Caillaud's work was mainly to estimate age-specific migration parameters in western lowland gorilla, but it was also used to estimate age-specific survivals.

This work used the population structure data from Lokoué: 365 individuals observed from October 2003 to January 2004 (just before the Ebola outbreak). However, as a part of this dataset is useless to answer the question we are interested in here (composition of each group or number of adult males for example), Caillaud simplified it. The other published population structure data from Mbeli (Parnell 2002, Am. J. Prim.) and Maya Nord (Magliocca *et al.* 2002) was also included. Finally, the method was simplified, giving up the Bayesian algorithm as it is not necessary to estimate the generation time.

The assumptions made to estimate the adult female survival are:

- The populations are demographically stable.
- It is assumed initially that individuals could be assigned one of the following age classes: infant (< 3.5 years), juveniles (< 6 years), subadult (< 8 years) and adult (\geq 8 years). The infant age class is slightly extended.
- The annual survival of adult females varies according to their age (senescence). It is assumed that this variation follows the same pattern as that observed in mountain gorillas (Robbins and Robbins 2005, agent based model). This does not mean that the age specific survivals are assumed to be the same, but that the decrease of the annual survival is assumed to follow a similar pattern (notably with a max age of 40 years).
- The sex-ratio of immatures (namely, infants+juv+subadults) is 1.

- The survival of infants (to the age of 3) varies between 0.3 and 0.5 (following Robbins *et al.* 2004).
- The survival of juveniles equals the survival of subadults. This assumption would not be necessary if we knew exactly at what age juveniles become subadults. The 6 years transition age will probably be revised in a next future (or the morphological criteria it is based on).

Caillaud also first assumed that the transition age between infants and adults was 8 years old. However this assumption led to an important site-dependant variation of the adult survival estimates, which is interpreted as an effect of the observer (as this variation is very large, it is very unlikely to be a consequence of ecological difference). The morphological criteria currently used are probably not reproducible enough (i.e, they are too subjective). Basically, it seems that Caillaud's morphological criteria imply a transition age of 7 years rather than 8 years at Lokoué, and an inverse bias at Mbeli, where the subadult-adult transition age seems to be 9 years. Maya Nord seems somewhere between 8 and 9 year. So Caillaud chose to suppress the distinction between subadults and adults, and set the annual immature survival probability to an arbitrary but plausible value of 0.95 (0.98 was also tested). The results were as follows:

Case 1: Infant survival probability to the age of 3 equals 0.7, juv and sub annual survival probability both equal 0.98.

	infancy duration	
	3.5 years	4 years
model1	19.8	20.8
model2	20.1	21.1
model3	20.4	21.3

Case 2: Infant survival probability to the age of 3 equals 0.7, juv and sub annual survival probability both equal 0.95.

	infancy duration	
	3.5 years	4 years
model1	21.0	22.0
model2	21.2	22.1
model3	21.4	22.3

Case 3: Infant survival probability to the age of 3 equals 0.5, juv and sub annual survival probability both equal 0.98.

	infancy duration	
	3.5 years	4 years
model1	20.8	21.7
model2	21.4	22.2
model3	21.9	22.6

Case 4: Infant survival probability to the age of 3 equals 0.5, juv and sub annual survival probability both equal 0.95.

	infancy duration	
	3.5 years	4 years
model1	21.9	22.8
model2	22.4	23.2
model3	22.8	23.5

The above tables provide estimates of the mean age of females aged 10 years or more, obtained using population structure data from 3 sites (Lokoué, Mbeli, MayaN). The 3 models denoted model1, model2 and model3 correspond to three different ways to parameterize the survivals of the immature individuals. Caillaud also tested two durations for the infant age class (3.5 and 4 years). The generation time estimates, defined as the mean age of females aged 10+, range from 20.8 to 23.5 years.

Caillaud therefore advises using **22 years** as the (temporary) reference value for the generation time of western lowland gorilla.

It is important to note that that these estimates mainly rely on 3 assumptions. The first is that the populations are demographically stable. The second is that the decrease of adult female survival depends on their age in a similar pattern to that observed in *G. beringei beringei*. The third is that the duration of the infant age class varies between 3.5 and 4 years. Among these three assumptions, the second one is the most likely to be invalidated in the future. The maximum life duration is indeed likely to differ among the two gorilla species.