Gorilla reintroduction to the Batéké Plateau National Park, Gabon:

An analysis of the preparations and initial results with reference to the IUCN guidelines for the re-introduction of Great Apes

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1. Introduction

The western gorilla *Gorilla gorilla* continues to decline in the wild, and has recently been moved to the 'Critically Endangered' class of the IUCN 'red list' of species threatened with extinction (IUCN 2007). The principle reasons contributing to this decline have been acknowledged by the international community within the 'Kinshasa Declaration on Great Apes' (GRASP 2005a) as 'the destruction of forests and other habitat; threats from human activities, including increasing encroachments by human populations on their habitat; civil disturbances and wars; poaching for bushmeat and for the live animal trade; and diseases such as ebola'. Key national level actions within range-state countries have been identified within the 'Global strategy for the survival of great apes and their habitat' (GRASP 2005b), and include 'ensuring effective management of existing protected areas [containing great ape habitat]' and 'in areas where great apes have recently been extirpated, supporting viable wild reintroduction programmes in accordance with IUCN guidelines'.

To date, the only programme concerning the reintroduction of gorillas is that of the UK-based charity The Aspinall Foundation, which runs two western gorilla reintroduction projects in the neighbouring Republics of Congo and Gabon in collaboration with the respective national governments (PPG 1998, Chamberlan & Maurois 1998, McRae 2000, Calaque 2003, Courage *et al.* 2001, King *et al.* 2006a, 2006b, Mahé 2006a, Farmer & Courage 2007). The Congo project was the first to be initiated, and initial post-release results are very encouraging, with released gorillas adapting well to the release site, ranging and behaving in similar ways to wild gorillas, and reproducing successfully (Courage *et al.* 2001, King 2004, 2005, King & Courage 2007, King & Chamberlan 2007, King *et al.* 2005b, 2006a, Farmer & Courage 2007). The Gabon project is ten years younger, and has benefited in many ways from learning from the pioneering experiences in Congo (PPG 1998, 2003, King 2000, Calaque 2003), and subsequently differs from the Congo project in several ways. One factor unique to the Gabon project is the incorporation of *ex-situ* captive-bred gorillas within the release stock (the Congo stock includes one *in-situ* captive-bred), which otherwise consists of rehabilitated wild-born orphans of the illegal in-country bush-meat trade. A rigorous process was undertaken to acquire the CITES permits for the export of the *ex-situ* captive-bred stock, which included examination of the reintroduction proposal (PPG 2003) and information provided by the CITES Gabon Management Authority. When the 2003 permit was issued, it was noted that 'the science of reintroduction is relatively new, particularly in regard to apes… We strongly encourage [The Aspinall Foundation] to share the results of this project with the wider conservation community… Such dissemination of information may ensure that other primate reintroduction projects may benefit from the lessons learned…' (DEFRA, in litt). Several reports and articles have since been published or are available on request (eg. Mahé 2006a, 2006b, King *et al.* 2006b, King & Chamberlan 2007, Farmer & Courage 2007), and the project has been presented at various conferences and workshops (eg the Francophone Primatological Society Meetings 2004 and 2005 (Mahé 2004c, 2005), the PASA/IUCN African primate reintroduction workshop 2006, and the International Primatological Society Congress 2006 (King *et al.* 2006b)). However, in this report we present the most complete analysis to date of the preparations, release and initial results of the western gorilla reintroduction programme to the Batéké Plateau National Park in Gabon. The analysis is structured largely with reference to the recently published 'Best Practice Guidelines for the Re-

introduction of Great Apes' (Beck *et al.* 2007) of the World Conservation Union (IUCN), although we also refer to the Guidelines for non-human primate reintroductions (IUCN 2002), as these were guidelines used in the preparation of the reintroduction proposal (PPG 2003).

Goal and activities of PPG

The Aspinall Foundation (TAF, formerly the Howletts and Port Lympne Foundation), a British charity founded by the late John Aspinall (Courage & Harvey 2003), in cooperation with the governments of the Republic of Congo (since 1987) and of Gabon (since 1998), set up the Projet Protection des Gorilles (PPG) for the overall goal to work with local partners for the conservation of indigenous endangered species in general, and of gorillas in particular (*Accord de Coopération en matière de protection des gorilles entre le Gouvernement de la République du Congo et la Fondation de Howletts et Port Lympne*, 7/4/1993).

To achieve this goal, PPG is involved in several distinct but related activities in the two range countries (King *et al.* 2006a):

- The reduction of the trade in orphan gorillas, and consequently the illegal bush-meat trade, by repression (facilitating confiscation of illegally held gorillas by the national governments) and by prevention (information, awareness, education).
- The rehabilitation of confiscated orphan gorillas into a natural forest habitat, for the conservation and individual welfare of these 'ambassadors' of their species.
- The reintroduction of gorillas into protected areas within the former range of the species.
- The management of these areas for the restoration and the protection of their natural resources.
- The promotion of local, national and international awareness of the threats facing the species.
- The development of sustainable conservation-minded activities which provide economic benefits on a local and national scale.

This report will concentrate on the third of these activities (reintroduction), and specifically the reintroduction in Gabon, although aspects of the other activities will be summarised where they have direct links to the reintroduction programme.

History of PPG-Gabon

PPG-Congo was created in 1987, through a collaboration agreement between The Aspinall Foundation and the Congolese government, and in 1989 a gorilla orphanage constructed within the grounds of the Brazzaville Zoo began accepting gorilla (and bonobo) bush-meat orphans (Attwater 1990a, King *et al.* 2005a). In 1994, some of the gorillas were transferred to the Lesio-Louna Reserve, 140 km north of Brazzaville, and the first releases occurred in 1996 (Attwater 1994, Courage 1996, King *et al.* 2004, 2006a). However, a year later civil war erupted, and PPG evacuated all the apes at the Brazzaville Zoo, and all but the six oldest gorillas in the Lesio-Louna Reserve, to the Tchimpounga and HELP-Congo chimpanzee sanctuaries near Pointe-Noire on

the Congolese coast (Courage 1997). With the future of PPG-Congo uncertain, The Aspinall Foundation began negotiations to create a similar project in Gabon (PPG 1998, Calaque 2003, Chronopoulous 1997, 1998). Following a meeting between John Aspinall and the President of the Senate and the Minister of Water & Forests and Reforestation on 20 October 1997 (PPG 1998), an agreement was signed between The Aspinall Foundation and the Gabonese government to allow the relocation of the gorillas under the care of PPG-Congo to Gabon (Calaque 2003). While the relocation plans were abandoned in January 1998, following the withdrawal by the new Congolese government of the permission to export the gorillas (PPG 1998, Chronopolous 1998, Courage 1998, Calaque 2003), a new proposal (PPG 1998) to create a project in Gabon for the conservation of the gorilla through confiscation, rehabilitation and reintroduction of orphan gorillas was accepted by the Gabonese government. This led to the official creation of PPG-Gabon in July 1998 through the signing of a 'Cahier de Charges' between The Aspinall Foundation and the Ministry of Water & Forests and Reforestation of the Government of Gabon. Several orphan gorillas that had been identified in-country during 1997 were then transferred to the agreed site, the Mpassa area of SE Gabon, as were subsequent gorillas confiscated by the Gabonese authorities, and nine *ex-situ* captive-borns from the UK. In August 2002, through a Presidential Decree, the Mpassa reintroduction site was included within the limits of the newly-created Batéké Plateau National Park (PNPB). In November 2004, PPG-Gabon became recognised by the Ministry of the Interior as a Gabonese Association, with the stated goal of "the protection of the endangered western gorilla and its habitat, and the valorisation of Gabon's natural heritage".

Aim of reintroduction programme

As stated earlier, the overall goal of PPG is to work with local partners for the conservation of indigenous endangered species in general, and of gorillas in particular, and gorilla reintroduction is one of several activities carried out by PPG in Congo and Gabon to achieve this goal. The principal aim of the reintroduction programme, following IUCN (2002) and Beck *et al.* (2007), is to re-establish viable, self-sustaining populations of the western gorilla in the wild, within the former range of the species (PPG 1998, 2003, King *et al.* 2006a).

Precautionary Principle

The precautionary principle, as given by Beck *et al.* (2007), states that the 'protection of wild populations is always the priority', and that 'with the re-introduction of great apes, there is always a level of risk to the released individuals, indigenous wild populations if they exist, and their habitats'. These risks have been fully recognised by PPG since its conception in Congo in 1987 (see Attwater 1990b) and in Gabon in 1998 (see PPG 1998, 2003), and the reintroduction programme has been designed and managed accordingly:

- Risks to released individuals were minimised through soft-release strategies and intensive post-release monitoring.
- Risks to wild populations were virtually eliminated by selecting reintroduction sites where great apes had been locally extirpated in living memory, and other primates were at low densities, and by long-term medical

assessments of release stock (Attwater 1990b, 1994, PPG 1998, 2003, King *et al.* 2004, 2006a, Mahé 2006a).

- Site selection has naturally concentrated on relatively degraded ecosystems, for which the reintroduction of gorillas was considered beneficial, both in terms of the significant ecological role that the species has been shown to fulfil in central African forests (Tutin *et al.* 1991, Voysey *et al.* 1999a, 1999b, Poulsen *et al.* 2001), and through the associated habitat management activities (Attwater 1994, King 2005, Calaque 2005a, 2005b).

Summary of PPG-Gabon reintroduction programme

- The PPG-Gabon reintroduction programme is considered a true 'reintroduction' as defined by Beck *et al.* (2007), as it aims to re-establish the western gorilla 'in an area which was once part of its historic range, but from which it has been extirpated or become extinct' (PPG 2003). It is not considered a 'welfare reintroduction', as species conservation is the primary reason behind the reintroduction programme, not individual welfare (see PPG 1998). Conversely, welfare is one of the primary reasons for excluding individuals from the programme should release be deemed detrimental to the long-term welfare of the individual. (Other reasons to exclude individuals from the programme include threats to the reintroduced population or the ecosystem of the release site).
- The PPG-Gabon release strategy is 'soft', in that during an initial pre-release rehabilitation phase the gorillas return to a night enclosure, allowing them to gradually adjust to their new environment, are accompanied by staff throughout the day everyday, and receive supplementary feeding and veterinary follow-ups (PPG 2003). This phase can take several years.
- The PPG-Gabon release stock is primarily wild-born, made up of orphans of the national bush-meat trade in Gabon that have been illegally detained in captivity for varying durations from only a few days to several years. The wild-born stock is supplemented by a smaller number of *ex-situ* captive-borns abandoned by their mothers, provided through the captive breeding programme of the Howletts and Port Lympne Wild Animal Parks in UK (PPG 2003, Mahé 2006a).

Reintroduction approach

Beck *et al.* (2007) recognise that reintroduction requires a 'multidisciplinary approach involving a team of specialists from various backgrounds and areas of expertise'. Over the past twenty years, the two PPG projects have benefited from such a multidisciplinary approach, with major contributions from specialists from a wide-range of organisations, including amongst others: The Aspinall Foundation, Howletts and Port Lympne Wild Animal Parks, the Government of Congo, the Government of Gabon, the Wildlife Conservation Society, the Global Environment Facility, the Centre International de Recherches Medicales de Franceville (CIRMF, Gabon), the Centre d'Etudes sur les Ressources Vegetales (Congo), the Libreville Herbarium (Gabon), HELP-Congo, Ami Chaucer Hospital (UK), the University of Edinburgh (UK), the University of Kyoto (Japan), Edinburgh Botanical Gardens (UK), Missouri Botanical Gardens (USA), the Alliance National pour la Nature (ANN, Congo), the

Association pour la Protection des Primates au Congo (APPC, Congo), and the Association des Techniciens de Santé Publique (ATSP, Congo).

The two PPG projects are founder members of the Pan-African Sanctuary Alliance (PASA), which has greatly helped communication between African sanctuaries, reintroduction projects, and external interested parties (Farmer 2002, Cress 2006). Both PASA and The Aspinall Foundation are members of the Great Apes Survival Project (GRASP), which provides a unified global strategy amongst many partners, including range-state governments, for the long-term survival of great apes (GRASP 2005a, 2005b, King *et al.* in prep.).

Various reintroduction proposals have been prepared by PPG and widely debated over the years (Attwater *et al.* 1992, PPG 1998, 2003), and many progress reports and articles are available. Never-the-less, while 15 articles regarding PPG are included in the bibliography of Beck *et al.* (2007), many reports remain fairly unknown in the wider conservation community, although most are available on request from The Aspinall Foundation.

2. Species socioecology and behaviour

Studies of the western gorilla in the wild were reviewed in 2002 to aid understanding of the needs of a reintroduced population, and to help predict and assess the future progress of the populations (King *et al.* 2004, 2006a). Some data reviewed in 2002 of particular relevance to western gorilla reintroduction planning and assessment are summarised below. Since 2002 many more studies have been published in a wide variety of journals and books, many of which have recently been conveniently summarised and synthesised by Harcourt & Stewart (2007).

- At Mbeli Bai, Congo, excluding solitary males, mean group size was found to be 8.4 (sd 4.3), of which 6.6 (sd 3.2) were weaned, results not significantly different to most other gorilla studies (Parnell 2002).
- Stable groups generally consist of one adult male with several adult females (median = 3.0), with a variable number of immatures (Parnell 2002).
- Limits on group size may be imposed by intra-group feeding competition due to relatively low density of herbaceous vegetation (Parnell 2002).
- Non-dominant males usually leave group at 14-15 years old (Tutin 1996).
- Groups are often formed by an adult female joining a solitary male (Parnell 2002).
- Solitary males generally do not form all-male groups (Parnell 2002).
- Most contact between solitary males is characterised by mutual avoidance or agonistic display (Parnell & Buchan-Smith 2001, Parnell 2002).
- In a day, groups in Lopé, Gabon, were reported to travel between 220 m and 2.8 km, although longer distances may have been overlooked (Tutin 1996).
- Groups travel further when fruit is abundant than when scarce (Tutin 1996).
- One group in Lopé had a core home range of about 10 km², but covered 21 km² during a 10 year period (Tutin 1996).
- There is extensive over-lap between the home ranges of different groups (Tutin 1996).
- Solitary males may track groups for several days (Tutin 1996).
- Encounters between two groups often occurred near concentrations of ripe fruit; usually one group would leave following vocal or chest-beating interaction (Tutin 1996).
- 64% of nest sites were on the ground (Tutin *et al.* 1995).
- Ground nests predominate in areas with high densities of herbaceous plants (Tutin *et al.* 1995).
- Tree nests were more frequent in areas where herbaceous plants were rare and during wet months (Tutin *et al.* 1995).
- Several plant species of Marantaceae and Zingiberaceae are consumed more when other food sources are scarce, and therefore may be considered 'keystone foods' (White *et al.* 1995, Kuroda *et al.* 1996).

3. Habitat and release site

Site selection process

The process of site selection for the Gabon reintroduction project is described in the original project proposal (PPG 1998). Eight conditions were considered during site assessment: a) habitat; b) surface area; c) legal status & management potential; d) isolation from human populations; e) isolation from wild gorillas; f) access; g) presence of an indigenous fauna; and h) the possibility of the project to survive national unrest. The final category was clearly influenced by the experience of PPG-Congo during and following the civil war.

Three areas of Gabon were prospected by air and ground surveys: a) the Mandji region; b) the Ndendé region; and c) the Mpassa region of the Batéké Plateau. The prospection team included an expert in gorilla rehabilitation and reintroduction from PPG-Congo (Despina Chronopolous), and an expert in western gorilla ecology and central African conservation from the Wildlife Conservation Society (Mike Fay).

Of the three areas, the Mpassa region was found to be the most appropriate for the proposed reintroduction project, fulfilling all the identified criteria (PPG 1998). The site is located in the unique Batéké Plateau region of south-east Gabon (fig 1), and has subsequently been incorporated into the Batéké Plateau National Park (PNPB, fig 2), created in 2002. Access is by 4x4 vehicle from the town of Léconi, 60 km to the north, while transport within the PBNP is mainly by boat along the Mpassa river (fig 2).

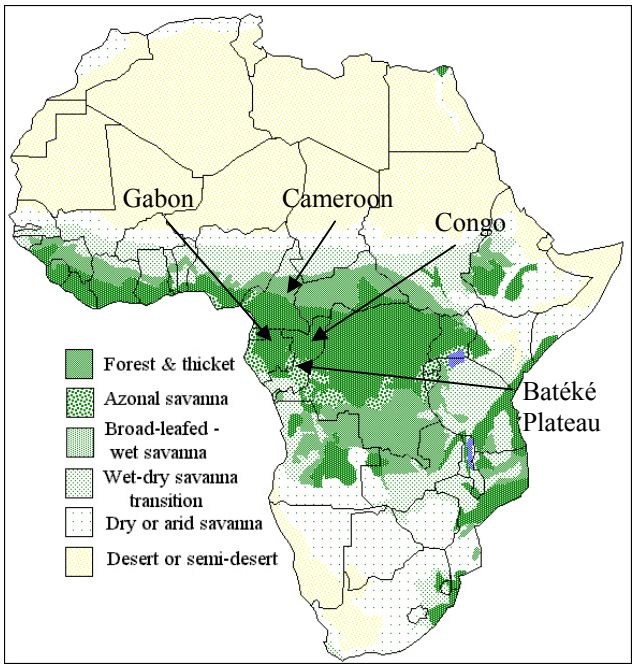

Fig 1. Simplified and generalised distribution of major vegetation types in Africa, adapted from NASA (undated) (after King & Chamberlan 2006), with location of Batéké Plateau, Gabon & Congo.

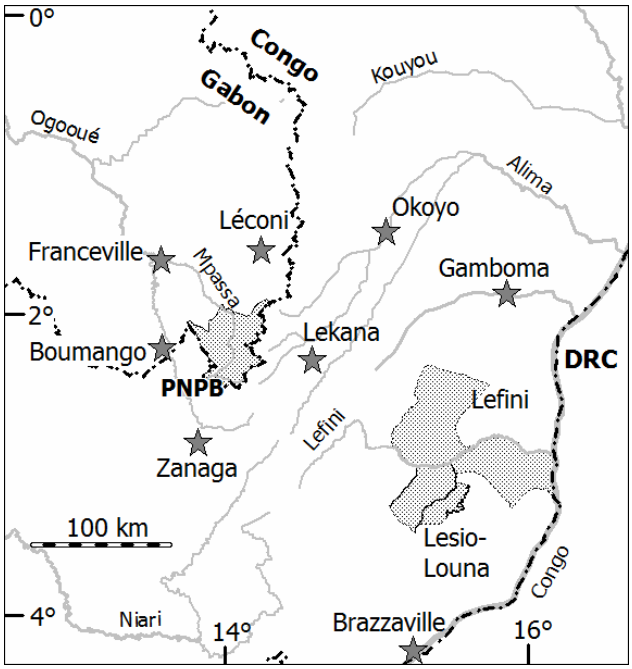

Fig 2. The Batéké Plateau region of Gabon & Congo, showing major rivers, towns, and protected areas (shaded), including the location of the PNPB in SE Gabon.

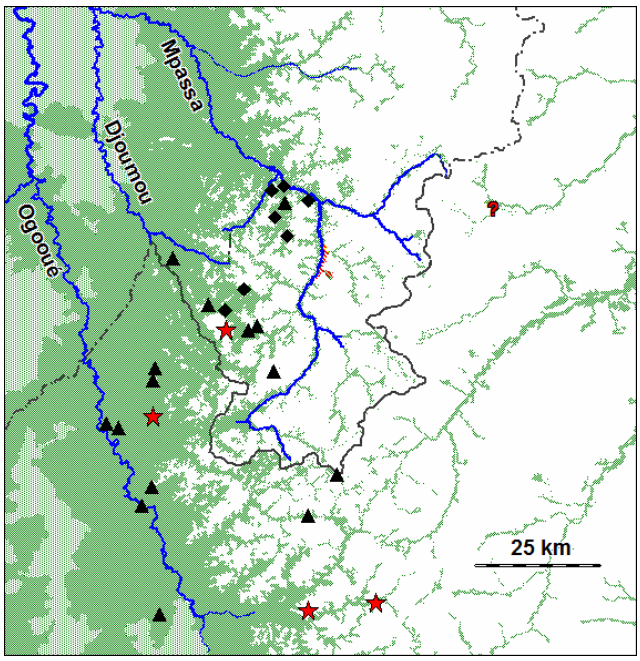

Fig 3. Recent records (2002 to 2007) of gorillas (red stars) and chimpanzees (black triangles and diamonds) in and around the PNPB, the range of the reintroduced gorilla population as of April 2007 (forest area in red), and an unconfirmed record of a gorilla shot in 2002 (red question mark). (Data from Inkamba Nkulu & Diahouakou 2005 (triangles and stars outside PNPB), Aczel 2002 & unpubl. data (diamonds), Bout 2006 (triangles and star inside PNPB), Gami 2002 (red question mark); undetermined chimp or gorilla nest records are excluded, but all nest records within the PNPB have been west of the Mpassa river).

Historic range of western gorilla & isolation from current populations

The specific release site, along the Mpassa river, was chosen as no signs of wild gorillas were found during ground surveys (PPG 1998). Almost ten years on, there has still been no observation of wild gorillas in the reintroduction zone. Hunters working in the north of the park confirmed never encountering gorilla sign (Aczel 2002), while local people talk of the gorilla having been extirpated from the region around ten or twenty years ago (ie 1980s or early 1990s) (Bout 2006). However, tracks of a small group of wild gorillas, thought to contain one silverback, three other adults, and one infant, were found within the PNPB in September 2004 (Bout 2006), near the western boundary of the park, where the main Gabonese forest block extends slightly within the park (fig 3). Tracks have also been found just outside the park, to the south and south-west, in neighbouring Congo in 2004 (Inkamba Nkulu & Diahouakou 2005). These wild gorillas are separated from the reintroduced population by over 20 km, and by several ecological barriers (rivers, extensive grassland) (fig 3). No gorilla sign was found in Congo bordering the east of the park in 2004 (Inkamba Nkulu & Diahouakou 2005), although Gami (2002) reported a claim that a gorilla had recently been shot in the zone of the abandoned village of Otana (fig 3).

Isolation from human activity

The experience of PPG-Congo demonstrated that while the general area for a gorilla reintroduction may be identified through consideration of several ecological, sociological and political criteria, the presence of effective ecological barriers between the released gorillas and human activity should define the specific site for release (King *et al.* 2004, 2005b, 2006a, King & Chamberlan 2007). Isolation from human activity was therefore one of the principal criteria during the site selection process (PPG 1998). There are no permanent human settlements within the PNPB, and illegal infiltration is minimised through an organised anti-poaching programme in partnership with the Gabonese Government and the Wildlife Conservation Society

(Aczel 2002, 2003a, 2003b, 2004, 2005, 2006). This is especially effective for the reintroduction site itself, with only a handful of known infiltrations within the range of the gorillas in almost ten years. The nearest villages are 30 to 40 km away, and separated from the release site by major ecological barriers (rivers, extensive grassland) which ensure that the released gorillas can not arrive in the villages or the surrounding agricultural areas (figs 3 & 15 (page 22). Project camps within the park are also separated from the released gorillas by a major river (fig 4). Despite this significant isolation, options are never-the-less available for intervention measures should one or more individuals find themselves in areas of human activity in the future (King 2007c).

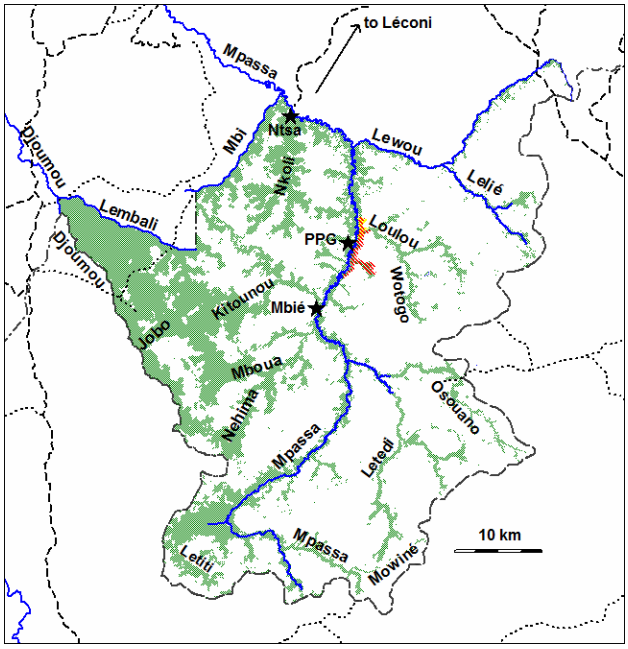

Fig 4. Forest cover, major watercourses and project camps (stars) within the PNPB, Gabon, and the home ranges of the two reintroduced gorilla groups in red (group 1) and yellow (group 2), as of April 2007.

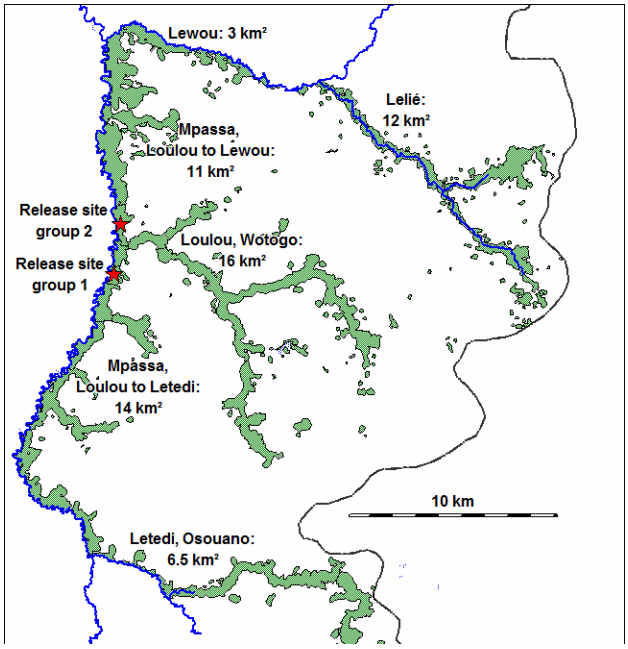

Fig 5. Forest cover within the proposed gorilla 'sanctuary' of PPG (1998), located in the north-east portion of the PNPB, Gabon.

Spatial analysis and carrying capacity

The original spatial analysis of the reintroduction site, and the PNPB, was based primarily on the 1:200,000 maps of IGN (1961), plus various GPS data (PPG 1998, 2003, Aczel 2006). Satellite images were incorporated into the project GIS (Geographic Information System) in 2007 (King 2007c). The use of the digitised satellite images allowed a more precise estimation of spatial variables than was previously available, in particular the extent of forest cover. The revised analysis illustrated that the PNPB covered a total of 2,044 km² (= 204,400 ha), including 606 km² of forest (= 60,600 ha). Most forest cover is concentrated to the west of the park, while the east of the park is principally savanna with gallery forests along watercourses (fig 4). Forest cover within the principle reintroduction site itself, including all forest within the proposed 'sanctuary' of PPG (1998) east of the Mpassa river, totals 62 km² (= 6,200 ha). This includes 25 km² (= 2,500 ha) of forest along or

within 3 to 4 km of the Mpassa, while the remainder follows its major tributaries including the Lewou/Lelié, Loulou/Wotogo, Letedi and Osouano (fig 5).

The highest estimated densities of western gorillas reported in the wild are in the region of 5.5 individuals per km², although the majority of studies give densities between 0.5 and 2.5 per km² (see summaries in Rogers *et al.* 2004 & Morgan *et al.* 2006). Therefore, a rough estimate of carrying capacity of a suitable forest area of 62 km² would be 31 to 155 individuals, and for a forest area of 25 km² from 12 to 62 individuals (using 0.5 to 2.5 per km²). The true carrying capacity of any zone is likely only to become apparent with experience, and very little is known about the influence of the linear nature of gallery forest on carrying capacity. Current knowledge of wild and reintroduced gorillas suggests that a figure of around 1.5 individuals per km² might be a reasonable expectation in the long-term. If the entire PNPB were to be considered, the 606 km² of forest could theoretically support a population of well over 500 gorillas.

Geology

The PNPB is situated at the north-west limit of the vast Batéké Plateau that extends from SE Gabon, through central Congo and southern DRC to northern Angola (Christy 2001 IBA). The Plateau consists of sandstone and deep Kalahari sands, which date from the Eocene period, around 50 million years ago, and extend south in a fairly narrow strip through western central Africa and Botswana to northern South Africa (PPG 2003, Calaque 2005, Haddon 2000 in Walters 2007a, see map in Walters *et al.* 2006). In gallery forest, the underlying sand is covered with a very thin litter layer (fig 7, Walters *et al.* 2006). Much of the Plateau has been eroded away, leaving a mosaic of remaining smaller plateaus, often delimited by dramatic sandstone escarpments, separated by watercourses and extensive areas of gently rolling grassy sand dunes (fig 7). The extreme western portion of the PNPB traverses the abrupt transition between the Batéké Plateau and the older laterite soils of the Franceville basin, which date from the Precambrian period (PPG 2003).

Hydrology

The eastern boundary of the PNPB follows the national boundary between Gabon and Congo (fig 2). This boundary also represents the boundary between two major watersheds, with the watercourses to the east flowing generally eastwards to feed the tributaries of the Congo river, and those to the south and west flowing north-west to feed the Ogooué river. Within the PNPB, most watercourses feed the Mpassa, which runs from south to north almost bisecting the park, and then continues northwards to join the Ogooué just north of the provincial capital of Franceville (figs 2 & 4).

Weather

Rainfall data from the PPG base-camp in the PNPB is given in table 1 and fig 6. Annual rainfall is in the region of 2,500 mm, with a short dry season from mid-June to late September. Dry season temperatures can be up to 2°C cooler than in the wet season (fig 6). Maximum daily temperatures rarely exceed 33°C, and minimum rarely lower than 18°C. Humidity is generally in the mid to high 90s, but drops to around 90% during the dry season.

Table 1. Rainfall (mm) recorded at the PPG base-camp in the PNPB, 2005 to 2007.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	**Total**
2005										191	276	240	
2006	280	275	359	213	316	193	1	64	82	185	408	276	**2650**
2007	120	410	220	306	394	17	1	34	134	290	277	254	**2456**
Mean	200	342	289	260	355	105	1	49	108	222	321	257	**2507**

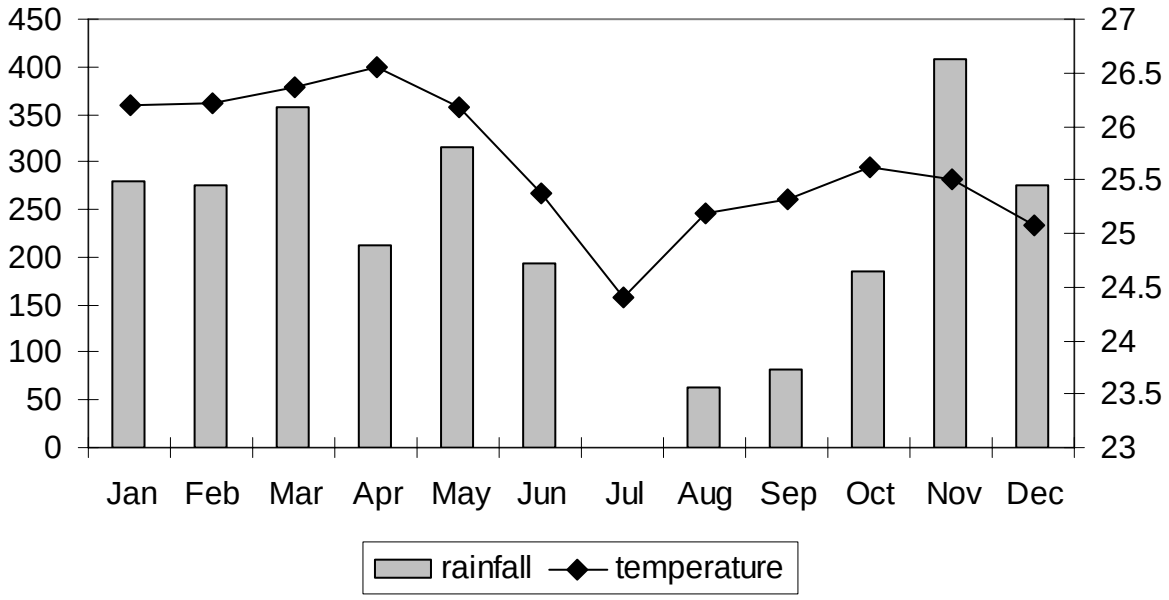

Fig 6. Monthly rainfall (mm, left axis) and average temperature (°C, right axis) at the PPG base-camp in the PNPB, 2006.

Habitats and flora

The major habitats of the PNPB are related to the variety of underlying soils. As elsewhere on the Batéké Plateau, the PNPB is dominated by rolling grassland, interspersed by gallery forest along the watercourses, and some small forest patches on higher ground (fig 7). An exception to this is the western portion of the park, which supports the south-eastern limit of the lowland forest block that covers the majority of the country (figs 1, 3 & 4). The role of grassland fires in the ecological dynamics of this forest-grassland mosaic is discussed by Walters (2007a).

The Mpassa gallery forest is connected directly to the main Gabonese forest block, and consequently includes many species of typical lowland forest. Low-lying areas can be permanently flooded, supporting *Xylopia* swamp with a fairly bare understorey. Seasonally swampy areas are more diverse, supporting a wide variety of forest trees, and an understorey often densely packed with *Sarcophrynium* (Marantaceae). All swampy areas are also characterised by abundant *Ancistrophyllum* and *Eremospatha* spp. (Arecaceae). *Raphia* swamps appear rare or absent from the area. Slightly higher areas are consequently drier, and support an even more diverse tree community, and an understorey often dominated by *Palisota* spp.

(Commelinaceae), plus various species of Marantaceae. Extensive hydrophilic communities are often found along the river edge, particularly on the inside of river meanders, often dominated by *Aframomum* sp. (Zingiberaceae) and various grasses and sedges. Another *Aframomum* sp. often lines the gallery forest/grassland border.

Several grassland habitats are present within the PNPB, the most widespread being lightly wooded *Loudetia* grassland, with *Hymenocardia acida* generally the dominant woody species, although numerous other woody and herbaceous species are also present, in varying proportions. The *Loudetia-Hymenocardia* wooded grassland extends from the gallery forest edge up the majority of the hill slopes of the park. Other grassland habitats characteristic of the Batéké Plateau are also represented within the park, but are less widespread, such as non-wooded *Loudetia* grassland, and lightly-wooded *Loudetia-Annona senegalensis* grassland. Various moist grassland habitats are also present, either in low-lying areas near watercourses, or in depressions between hills. Several grass and sedge species colonise recently-burnt areas.

Over 50% of the flora initially identified in the PNPB is classified as Guineo-Congolian, while another 20% of the species have extended distributions into the Zambesian or Sudanian phytochoria (Walters *et al.* 2006).The most recent plant list for the PNPB and surrounding area gives 522 species from 88 families, including three species new to science (Walters 2007b). Most of these species have been collected in gallery forest and grassland, while the major forest block to the west of the PNPB has been inadequately sampled. Walters (2007b) suggests that the number of species present in the area could be double that currently known.

Fig 7. Gallery forest intersects the extensive wooded grassland of much of the PNPB (a), supported by only a thin litter layer covering the deep Kalahari sands (b). (Photos: T. King)

Indigenous fauna

The diversity of forest and grassland habitats within the PNPB supports an associated diversity of forest and grassland fauna. For example, 255 species of bird are currently known from the park, of which over 75 occur mainly in savanna, including a *Cisticola* sp. as yet undescribed scientifically and so far only known from the Batéké Plateau region of Gabon, and over 120 mainly in forest (Christy 2001a, King 2007a, 2007b). This mix of two major avifaunas across the entirety of the Batéké Plateau, including various near-endemics of south-central African grasslands and woodlands (such as Miombo Pied Barbet *Tricholaema frontata*, Sousa's Shrike *Lanius souzae* and Tinkling Cisticola *Cisticola rufilatus*), has prompted the classification of the area as part of the Guinea-Congolian/Zambezian transition zone of White (1983) (Dowsett-

Lemaire 2001, King & Chamberlan 2007, King 2007a, 2007d). The PNPB is located at the extreme north-west of the Batéké Plateau, as it merges into the Gabonese rainforest block (fig 1), and consequently has a richer forest avifauna but a slightly poorer savanna avifauna than elsewhere on the Plateau (Christy 2001a, King 2007a). Never-the-less, it is the savanna avifauna that is of higher ornithological interest, and coupled with the diverse mix of species present (fig 12), was one of the principal attributes leading to the creation of the National Park (Christy 2001a).

Fig 8. Elephants are regularly seen along the Mpassa river. (Photo: P. Aczel)

In a similar manner, the mammal fauna is also made up of both forest and savanna components (fig 11). Bout (2006) undertook a systematic monitoring of the large mammals of the PNPB, and recorded direct or indirect observations of 29 species, including forest elephant *Loxodonta africana cyclotis* (fig 8), forest buffalo *Syncerus caffer nanus*, water chevrotain *Hyemoschus aquaticus,* red river hog *Potamochoerus porcus*, sitatunga *Tragelaphus spekei*, bushbuck *Tragelaphus scriptus,* bush (or Grimm's) duiker *Sylvicapra grimmia*, seven species of forest duiker *Cephalophus* spp. (table 2), leopard *Panthera pardus*, golden cat *Felis aurata*, serval cat *Felis serval* (unconfirmed), side-striped jackal *Canis adustus*, African civet *Civettictis civetta*, genet *Genetta servaline* or *G. tigrina* (both species may be present), African palm civet *Nandinia binotata*, giant pangolin *Smutsia gigantea*, aardvark *Orycteropus afer*, and six species of primate (to be discussed below). Various other large mammal species are also present within the park (table 2), but were not surveyed by Bout (2006). Two species appear to have been extirpated within living memory: the hippopotamus *Hippopotamus amphibius* around twenty years ago, and the southern reedbuck *Redunca arundinum* around fifty years ago (Bout 2006). The current status of the lion *Panthera leo* remains debatable (Henschel 2006), with some evidence indicating that a small number may continue to exist within and around the PNPB (Gami 2002, Bout 2006).

Of the primate species recorded within the PNPB by Bout (2006), the western gorilla *Gorilla gorilla* was thought to have been extirpated from the park in living memory, although tracks of a small group have recently been found towards the western limit of the park (Bout 2006, see above, fig 3). The chimpanzee *Pan troglodytes* was also originally thought to be absent from the area (PPG 1998), but occasional direct sightings and other observations have since shown that a small number remain in the north-west (Aczel 2002, Henschel 2003a, Bout 2006) and west (Aczel 2004, Bout 2006) of the park, and outside the park to the north-west (Bout 2006), south and south-west (Inkamba Nkulu & Diahouakou 2005) (fig 3). One or two chimpanzee nests were observed in the western gallery forest of the Mpassa, south of the confluence with the Lewou river, in Feb 2007, but Bout (2006) found no sign of the species anywhere east of the Mpassa and south of the Lewou rivers. This area includes the gorilla reintroduction site, from which chimp sign had never been recorded (PPG 1998, 2003) until a recent unconfirmed sighting of a singleton in 2006 by the post-release monitoring team (S. Ognele pers. comm., trail 'W').

Of the smaller diurnal primates within the PNPB, the most abundant and visible is the moustached monkey *Cercopithecus cephus* (fig 9), which is widely distributed throughout the west of the park and also present in the east (Bout 2006). The de Brazza's monkey *C. neglectus* and the crowned monkey *C. pogonias* have been observed directly within the park on only five and one occasions respectively (Bout 2006), and are so rare as to be virtually unknown by local populations and hunters (Bout 2006, Maisels *et al.* 2007). The northern talapoin *Miopithecus ogouensis* appears to be distributed throughout the major gallery forests of the park (Bout 2006), and is fairly frequently observed directly. At least three small nocturnal primates have also been recorded within the PNPB, potto *Perodicticus potto,* Demidoff's galago *Galagoides demidoff* and an unidentified larger galago (table 2).

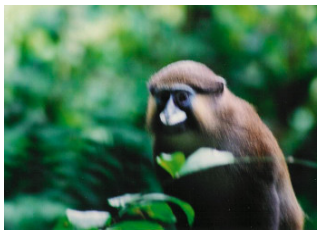

Fig 9. Moustached monkey *Cercopithecus cephus.* (Photo: L. Pearson)

Fig 10. Fruit bat, probably *Epomops franqueti.* (Photo: T. King)

Small or discrete mammals have not been adequately surveyed within the PNPB, although several species have been noted through opportunistic observations (table 2), including giant otter shrew *Potamogale velox*, brush-tailed porcupine *Atherurus africanus*, swamp otter *Aonyx congica*, and ratel *Mellivora capensis*. An epauletted fruit bat was photographed while roosting in overhanging gallery forest along the Mpassa river in August 2007 (fig 10), and although identification to species level requires assessment of the pattern of ridges on the upper palate inside the mouth (Bergmans 1997), this is most likely to be *Epomops franqueti*, a widespread species in Central Africa (Malbrant & Maclatchy 1949, Bergmans 1997, Kingdon 2001). Elsewhere on the Batéké Plateau, a mist-net study of fruit bats in the Lesio-Louna Reserve in Congo recorded five species, *E. franqueti*, *Hypsignathus monstrosus*, *Megaloglossus woermanni, Micropteropus pusillus* and *Myonycteris torquata* (King 2003), all of which are likely to also occur in the PNPB. The little-known golden mole *Calcochloris leucorhinus* has also been recorded in the park (Kitchener *et al.* in prep.).

Reptiles and amphibians have not been surveyed in the PNPB, but some of the more visible species include African slender-snouted crocodile *Crocodylus cataphractus* (we know of no confirmed observations of Nile crocodile *C. niloticus* or African dwarf crocodile *Osteolaemus tetraspis*), monitor lizard *Varanus* sp. (probably *V. niloticus*), rainbow lizard *Agama agama*, rock python *Python sebae*, spitting cobra *Naja* sp. (probably *N. nigricollis*), bush viper (possibly *Atheris squamigera* or *A. chlorechis*), Gabon viper *Bitis gabonica* (N. Bout pers. comm.), terrapins Pelomedusidae spp., toads *Bufo* spp. and treefrogs Hyperoliidae spp (figs 13 & 14).

Fish have not been surveyed, while the results of some invertebrate studies are not yet available.

Table 2. Notes on the status of the principle mammals of the PNPB, Gabon. (PA = P. Aczel, LP = Liz Pearson).

Primates		
Western gorilla	*Gorilla gorilla gorilla*	tracks of one group found in west (Bout 2006, fig 3); reintroduced population east of Mpassa
Chimpanzee	*Pan troglodytes*	seen several times & heard regularly, esp. west of Mpassa (Aczel 2002, 2004, Bout 2006, fig 3); photographed with camera traps (Henschel 2003a, fig 11)
Moustached monkey	*Cercopithecus cephus*	common in forest (fig 9, PA, LP pers. obs., Bout 2006), sometimes with *M. talapoin* (Bout 2006)
De Brazza's monkey	*Cercopithecus neglectus*	seen 4 or 5 times & heard several times (Bout 2006, Maisels *et al.* 2007)
Crowned guenon	*Cercopithecus pogonias*	seen once (group of c20 by Bout 2006) & heard (F. Maisels & P. Henschel in Bout 2006)
Talapoin	*Miopithecus talapoin*	frequent in forest (PA, LP pers. obs., Bout 2006)
Potto	*Perodicticus potto*	LP pers. obs., H. Ontsana in Maisels 2005
Demidoff's galago	*Galagoides demidoff*	PA, LP pers. obs., Maisels 2005
Galago unidentified	Galagonidae sp.	larger galago (white tail): LP pers. obs., H. Ontsana in Maisels 2005
Chiroptera		
Singing fruit bat	*Epomops* sp.	one photographed along Mpassa river, Aug 2007, probably *E. franqueti* (fig 10)
Insectivora		
Giant otter shrew	*Potamogale velox*	H. Ontsana in Maisels 2005, N. Bout (pers. comm.)
Golden mole	*Calcochloris leucorhinus*	one specimen (Kitchener *et al.* in prep.)
Rodentia		
Brush-tailed porcupine	*Atherurus africanus*	PA pers. obs., H. Ontsana in Maisels 2005
Pygmy squirrel	*Myosciurus pumilio*	unconfirmed, but recognised by H. Ontsana in Maisels 2005
Giant forest squirrel	*Protoxerus stangeri*	unconfirmed, but recognised by H. Ontsana in Maisels 2005
Giant Gambian rat	*Cricetomys gambianus*	unconfirmed, but recognised by H. Ontsana in Maisels 2005
Cane rats	*Thryonomys sp.*	*T. swinderianus* or *T. gregorianus* or both; unconfirmed, but recognised by H. Ontsana in Maisels 2005
Carnivora		
Side-striped jackal	*Canis adustus*	savanna (PPG 1998, PA, LP pers. obs.), esp south & north-east (Bout 2006)
Serval	*Felis serval*	unconfirmed, but local people consider it rare in savanna (Bout 2006)
Lion	*Panthera leo*	possible tracks in north-west (Bout 2006)
Leopard	*Panthera pardus*	forest west of Mpassa, rare (Bout 2006); also present east of Mpassa (PA, LP pers. obs.) & just north of the PNPB (Henschel 2003a, fig 11)

Golden Cat	*Profelis aurata*	rare, forest in north-west (Bout 2006); one seen near PPG camp (PA pers. obs.)
Swamp Otter	*Aonyx congica*	PA pers. obs., H. Ontsana in Maisels 2005
Spot necked otter	*Lutra maculicollis*	unconfirmed, but given by Mouzinga 2005 & by H. Ontsana in Maisels 2005
Civet	*Civettictis civetta*	throughout, but quite rare (Bout 2006)
Palm civet	*Nandinia binotata*	rare (Bout 2006)
Genets	*Genetta sp.*	rare (Bout 2006); *G. tigrina* or *G. servalina* or both
Marsh mongoose	*Atilax paludinosus*	PA, LP pers. obs.
Ratel	*Mellivora capensis*	PA pers. obs., H. Ontsana in Maisels 2005
Pholidota		
Giant pangolin	*Smutsia gigantea*	rare (Bout 2006); PA, LP pers. obs., H. Ontsana in Maisels 2005
Long-tailed pangolin	*Uromanis tetradactyla*	H. Ontsana in Maisels 2005; also PPG staff (pers. comm.)
Tree pangolin	*Phataginus tricuspis*	H. Ontsana in Maisels 2005, N. Bout (pers. comm.)
Tubulidentata		
Aardvaark	*Orycteropus afer*	common in north; rare in south (Bout 2006)
Proboscidea		
Forest elephant	*Loxodonta africana cyclotis*	frequent along Mpassa river (fig 8, PA, LP pers. obs., PPG 1998); mainly west & north-west (Bout 2006)
Artiodactyla		
Hippopotamus	*Hippopotamus amphibius*	last group killed 20 years ago (Bout 2006)
Red river hog	*Potamochoerus porcus*	widespread (PA, LP pers. obs.); abundant in centre of PNPB (Bout 2006)
Water chevrotain	*Hyemoschus aquaticus*	Mpassa river (PA, LP pers. obs.); rare (Bout 2006)
Forest buffalo	*Syncerus caffer nanus*	low densities throughout (PPG 1998, Bout 2006, PA, LP pers. obs.)
Sitatunga	*Tragelaphus spekii*	swamp, esp Mpassa river, Bai Jobo (Bout 2006); often seen in Mpassa (PA, LP pers. obs.)
Bushbuck	*Tragelaphus scriptus*	savanna, infrequent (Bout 2006)
Reedbuck	*Redunca arundinum*	one killed 60 years ago (Bout 2006)
Blue duiker	*Cephalophus monticola*	forest, mainly west of Mpassa (Bout 2006), also east of Mpassa (PA, LP pers. obs.)
Bay duiker	*Cephalophus dorsalis*	forest, v common (Bout 2006)
White bellied duiker	*Cephalophus leucogaster*	gallery forest (Bout 2006)
Black-fronted duiker	*Cephalophus nigrifrons*	forest, rare (Bout 2006)
Ogilbyi's duiker	*Cephalophus ogilbyi*	forest, common (Bout 2006)
Peter's duiker	*Cephalophus callipygus*	gallery forest, enters savanna to feed (Bout 2006), identification unclear (Maisels 2005)
Yellow-backed duiker	*Cephalophus silvicultor*	forest-savanna mosaic (Bout 2006)
Bush (or Grimm's) duiker	*Sylvicapra grimmia*	savanna, esp south-east (Bout 2006)

Fig 11. Several of the large mammals of the PNPB, photographed with the use of camera-traps by Henschel (2003a): a) Chimpanzee *Pan troglodytes*; b) Leopard *Panthera pardus*; c) Aardvark *Orycteropus afer*; d, e & f) Forest elephant *Loxodonta africana cyclotis*; g) Red river hog *Potamochoerus porcus*; h) Forest buffalo *Syncerus caffer nanus*; i) Yellow-backed duiker *Cephalophus silvicultor*; j) Bush (or Grimm's) duiker *Sylvicapra grimmia*; k) Blue duiker *Cephalophus monticola*; l) m) n) & o) red forest duikers *Cephalophus* spp.: l) possibly *C. callipygus*; m) probably *C. nigrifrons*; n) unknown; o) probably *C. ogilbyi*. (Photos: P. Henschel)

Fig 12. The PNPB supports a diverse avifauna, including species associated with forest (eg. Chocolate-backed Kingfisher *Halcyon badia* (a)), savanna (eg. White-fronted Bee-eater *Merops bullockoides* (c)) and aquatic habitats (eg. Rock Pratincole *Glareola nuchalis* (d)), migrants (eg. White-throated Bee-eater *Merops albicollis* (b)) and numerous birds of prey (eg. Palm-nut Vulture *Gypohierax angolensis* (e)). (Photos: T. King)

Fig 13. The reptiles of the PNPB remain fairly unknown, but species present include a) African slender-snouted crocodile *Crocodylus cataphractus*; b) monitor lizard *Varanus* sp. (probably *V. niloticus*); c) rock python *Python sebae*; d) spitting cobra *Naja* sp. (probably *N. nigricollis*); e) bush viper (possibly *Atheris squamigera* or *A. chlorechis*). (Photos: T. King (a), M. Charboneau (b), P. Aczel (c, e), H. Quetier (d))

Fig 14. The amphibians of the PNPB have not been studied, but include toads *Bufo* sp. (a) and tree frogs Hyperoliidae spp. (b). (Photos: T. King)

4. Socioeconomic, financial and legal requirements

Legal and financial aspects

Relations with the Gabonese government were built during the initial stages of the project proposal in 1997 (see PPG 1998), which facilitated the rapid creation of PPG in Gabon through the signing of a 'Cahier de Charges' in 1998. Since 2004, PPG is recognised as a Gabonese association. PPG (in both Gabon and Congo) benefits from a long-term technical and financial commitment from the UK-based charity The Aspinall Foundation, founded by the late John Aspinall (Courage & Harvey 2003). John Aspinall created and financed two Zoological Parks in Great Britain in 1957 and 1975, which support the largest and most successful breeding colony of western gorillas in captivity (Brieu 2000).

The 'Cahier de Charges' signed in July 1998 between The Aspinall Foundation and the Ministry of Water & Forests and Reforestation of the Government of Gabon, with a validity of ten years, outlined the conditions related to the use of the reintroduction zone by PPG-Gabon, under the responsibility of The Aspinall Foundation. This contract included an article permitting the use of illegally held gorillas in Gabon as part of the release stock, although all wild animals in Gabon are the property of the government (Chamberlan 2007). The document also required PPG-Gabon to provide regular activity reports to the government, and to help the government classify the zone as a legally protected area.

The presence of the project in the area led to the inclusion of the zone as one of 13 National Parks created in 2002 by Presidential decrees. The limits of the resulting Batéké Plateau National Park (*Decrét n° 609/PR/MEFEPEPN du 30 août 2002 portant classement du parc national des plateaux Batéké*) are almost identical to those in the 1998 'Cahier de Charges' defining the zone under the responsibility of PPG-Gabon, although include a small supplementary area to north-east of the original zone. The decree states that the management of the national park falls under the tutelage of the Ministry of Water and Forests (Eaux et Forêts), defined through an 'Interior Reglementation' document and a 'Management Plan'. An associated governmental ordinance (*Ordonnance n° 6/2002 du 22 août 2002*) states that each national park is managed by a 'Conservateur' and one or more assistants, nominated by the President.

In April 2004, the Wildlife Conservation Society (WCS) created a project to assist the PNPB Conservateur in particular, and the government in general, to manage the national park (Calaque 2005a). The WCS project falls within the framework of the Congo Basin Forest Partnership (CBFP), and aids the PNPB in five principle activities (Calaque 2005a): a) technical support to the Conservateur; b) park surveillance to deter illegal hunters, through a small team managed by WCS, financed by The Aspinall Foundation and supervised by PPG; c) monitoring of biodiversity and of natural resource utilisation by local populations; d) developing education and awareness programmes in the local communities; and e) supporting efforts to develop tourism in the PNPB to contribute to socioeconomic objectives.

While the reintroduction programme remains entirely financed by The Aspinall Foundation, the other aspects of the management of the PNPB are now or have been supported by various organisations, including the government of Gabon, The Aspinall

Foundation, WCS, USAID, USFWS, CIRMF, RARE, Missouri Botanical Gardens, and the National Geographic Society.

With the original 1998 'Cahier de Charges' between The Aspinall Foundation and the Gabonese government expiring in 2008, a new document is being discussed to revise the conditions relative to the limits and management of the specific reintroduction zone, which now falls within the national park. The Aspinall Foundation also works in close collaboration with the government of neighbouring Congo, through it's related projects PPG-Congo and Projet Lesio-Louna (see King *et al.* 2006a for details), and also through trans-boundary collaboration concerning PPG-Gabon and the protection of the PNPB (eg Gami 2002, Calaque 2005b, Projet Plateaux Batékés 2006, Ampolo in prep.).

Socioeconomic aspects

During the site prospection phase (PPG 1998), representatives of the local communities between Léconi and the reintroduction site indicated that the proposed zone (south of the Mpassa-Lewou confluence) was not controlled locally, and that the majority of the population considered the zone to be part of Congo (PPG 1998). Indeed, the region has a confusing history in the late 19th and first half of the 20th century, while the national boundary was debated and revised on several occasions. It was only in 1946 that the region became finally and officially Gabonese, and apparently not until 1950 that the Batéké population in the area accepted the decision, due to the newly found mining potential of the area (Calaque 2005a). The area of the PNPB itself appears not to have mining potential, and is not utilised by the local populations, which may explain why in 1998 much of the population remained confused by the exact location of the national boundary.

While there is little, if any, use of the PNPB by the Batéké villages located in Gabon, hunting pressure remains the principal threat to the park (Calaque 2005a). Since 2000, the vast majority of hunters identified directly or indirectly within the park come in fact from Congo, many from the Koukouya Plateau (region of Lekana) and nearby Leketi valley, but also from the region of Zanaga (Aczel 2002, 2003a, 2003b, 2005, 2006, Henschel 2003a, Calaque 2005a, Mouzinga 2005). The principal paths arrive at the east of the park, then split to join the gallery forests and the forest block in the north-west of the park (Aczel 2002, 2003a, 2003b, 2005, 2006, Henschel 2003a, fig 15). Other paths cross the south of the PNPB, linking Lekana and Zanaga, while paths in the west and south-west may also link with the Boumango region of Gabon (Aczel 2003a, 2005, 2006, Bout 2006, fig 15). Many of these hunters paths within the PNPB, particularly those west of the Mpassa, have gradually been abandoned since the installation of the reintroduction project in 1998 and the start of an organised park monitoring and anti-poaching programme in 2000 (Aczel 2002, 2005, 2006). Hunting intensity throughout the park (especially by the Koukouya people arriving from the east) decreased dramatically between 2000 and 2004, and has since been maintained at a fairly stable level (Aczel 2005, 2006), estimated at 20% to 40% of levels pre-2000 (P. Aczel, pers. obs.). This decrease has been due to three major factors: a) the presence of the PPG camp and activities in the heart of the PNPB; b) the monitoring and anti-poaching programme initiated by PPG which has developed into a joint programme between PPG, the Gabonese Government, and WCS; and c) repeated awareness missions within the Koukouya villages in Congo.

One of these awareness missions was incorporated into a study of hunting practices and the overall socioeconomic situation of the Koukouya Plateau in Congo, which confirmed the high pressure coming from the region (Gami 2002). Along with the zone of the abandoned village of Otana, located approximately half way between the closest villages in Gabon (Akou) and Congo (Impini) (see fig 15), the PNPB is one of the two preferred hunting zones by the Koukouya villages, due to the apparent abundance of mammals which have become increasingly rare elsewhere (Gami 2002). Koukouya hunters arrive in the PNPB by foot, which takes two days from Lekana (Gami 2002). They work in teams of one or two hunters plus two or three assistants each to help smoke and transport the meat, during missions of around nine days, with meat being smoked progressively for up to three days (Gami 2002). Hunting by the Koukouya is now almost exclusively with guns (metal cable snares are also used by the inhabitants of Ontourou village), although the guns are rarely owned by the hunters themselves, and so are rotated between teams; as soon as one team returns to the village to rest and sell their meat, another team takes the gun and leaves (Gami 2002). The meat is therefore shared between the hunter, the owner of the gun, and the assistants (Gami 2002). In 2000, 212 guns were registered in nine villages by the regional Water and Forest officer in Lekana, which suggests the presence of over 600 hunters in the area if each gun is used by two or three hunters (Gami 2002). The most common gun is the calibre 12 (fabricated in France or Russia, often modified locally), although Kalashnikovs are occasionally also used (Aczel 2003b, Bout 2006). The type of ammunition may be modified for the species being hunted (Calaque 2005a). Medium-sized mammals (duikers, red river hog, pangolin, monkeys) make up the majority of the meat hunted (Aczel 2003a, Henschel 2003a, Bout 2006), although elephants killed for their tusks have been found fairly regularly (Henschel 2003a, Aczel 2004, Bout 2006). The meat is generally sold in Congo within local markets, although some is sent to Brazzaville (easily accessible from Lekana and Djambala), or even to Gabon (hunters from Zanaga sell meat at the border to Gabonese coming along the route from Boumango) (Calaque 2005a). The hunting appears somewhat seasonal, focussed in two principle periods, one in December to serve the end of year celebrations, another during the dry season, probably due to the ease of burning the grassland which facilitates hunting, and perhaps due to an increased local demand during the annual holiday season (Calaque 2005a).

Hunters within the PNPB originating from Gabon are less numerous than those from Congo. However, their impact is considerable as some use 4x4 vehicles, often at night with strong spotlights, and can therefore kill and transport a large number of animals in a short period of time. This hunting method concerns the north-east of the park, both inside and outside, in the region of the Lewou river (Aczel 2002, 2003b, 2005, Henschel 2003a, Mouzinga 2005). Vehicles arrive in this zone by a route from Léconi or Akou, passing by the Congo (fig 15). This is principally commercial hunting (for selling in towns) and hunting ‘to command’ (hunters financed by a rich client to provide status food for an important occasion), but also includes ‘sport’ hunting by towns-people during their weekends (Henschel 2003a, Calaque 2005a). Other Gabonese hunters work in the forest areas in and around the west of the park, including hunting for elephants (Mouzinga 2005, Bout 2006), coming by foot from the Boumango area, or from further north towards Kessala (Aczel 2002, 2003b, 2004, fig 15).

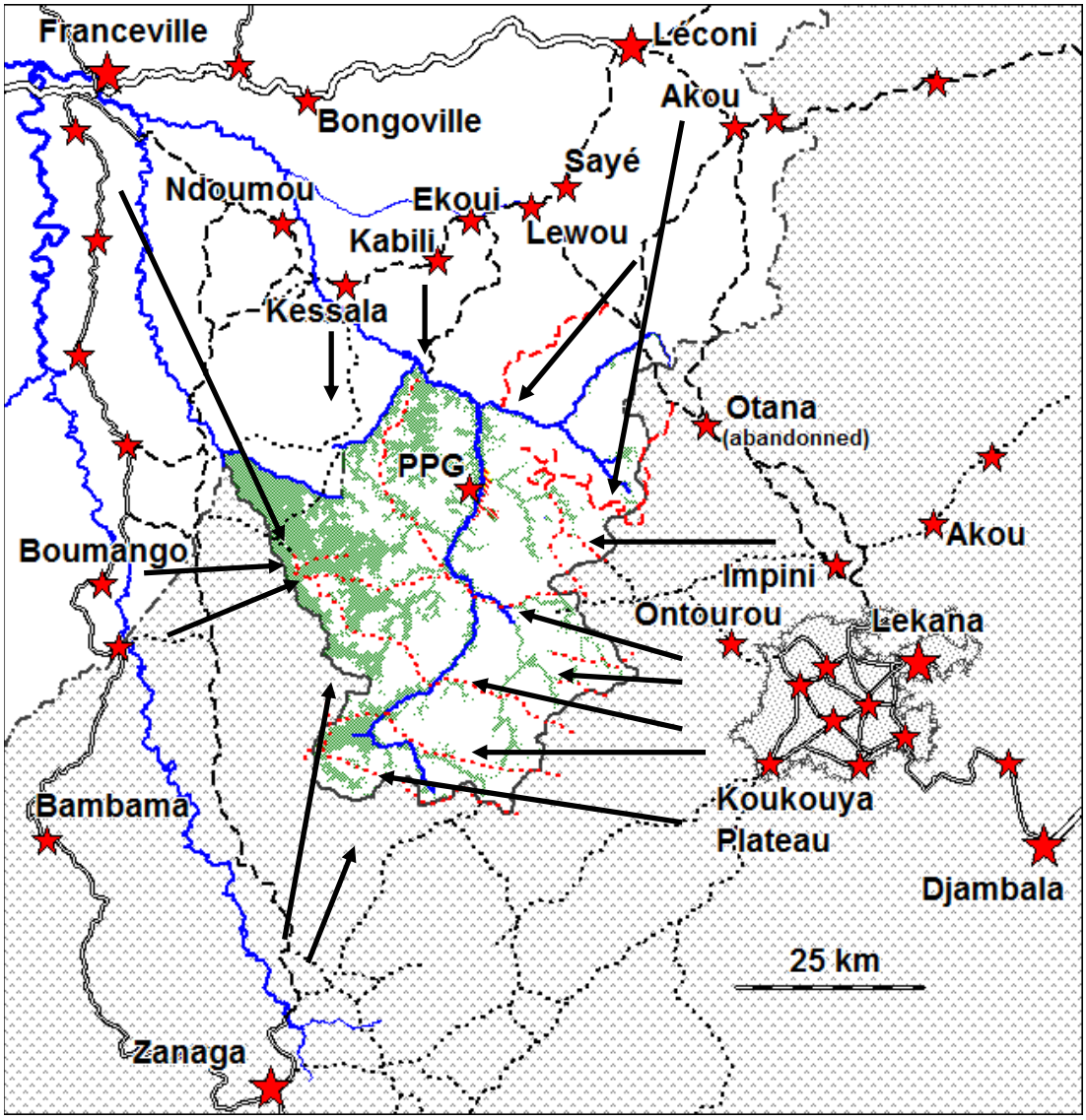

Fig 15. The reintroduction site (in red opposite the PPG camp) within the PNPB is separated from villages (red stars) by major ecological barriers such as rivers and extensive savanna. However, the socioeconomic situation of the PNPB is complex, with hunting pressure by 4x4 vehicles (dashed lines) from major Gabonese towns to the north and east of the park, but also by foot (dotted lines), especially from neighbouring Congo (shaded), including the large population of the Koukouya Plateau. The paths in red within the PNPB represent the situation in 2001; many have since been abandoned (especially those west of the Mpassa river) due to the combined efforts of PPG and the PNPB management project (see text).

The practice of large-scale hunting by vehicles by certain Gabonese, in both Gabon and Congo, coupled with the traditional ownership of some Gabonese territory by villages located in Congo, has naturally led to trans-boundary disagreements. Several Congolese villagers are therefore reluctant to respect Gabonese laws protecting the PNPB, especially as there is little effort to prevent commercial Gabonese hunters operating in Congo and leading to the decimation of the local fauna (Gami 2002, Aczel 2003a, 2005). Proposals to create a protected area in Congo surrounding the PNPB would help this issue, but progress is slow. Never-the-less, WCS and the Congolese government have increased their activities in the area since Gami's study, working closely with the local communities, and in collaboration with the PNPB

management project (Calaque 2005b, Projet Plateaux Batékés 2006, Ampolo in prep.).

Okoundzi (2004) spent three weeks in nine villages to the north of the PNPB, discussing their perceptions of the evolution of hunting practices and the abundance of mammals to hunt. As in Congo, the use of guns has completely replaced traditional hunting methods, and mammal populations have become increasingly difficult to hunt in most areas. Again, commercial or sport hunting with vehicles, and even with helicopters, was regularly deplored, and one village had constructed barriers to prevent vehicle incursions into their hunting zones. The importance of hunting within their culture and for their survival was stressed, and the need to avoid exterminating the animals to maintain their way of life was recognised. Several complained of crop destruction by elephants and especially red river hogs. Many villagers echoed the sentiments of 1997 and 1998 (PPG 1998) saying that the PNPB was so far from their villages that they didn't use the area themselves, some saying that it was located in the territory of the Koukouya (from Congo), others saying it remained part of their ancient territories.

Improved communication between the PNPB/PPG and the local communities is a recurrent recommendation (Gami 2002, Okoundzi 2004), echoing the sentiments of communities around the Lesio-Louna and Lefini Reserves in Congo (PPG-Congo 2003, Cartwright 2006). Another common recommendation is that of the 'reintroduction' of large savanna-dwelling antelopes or even buffalo, to facilitate hunting outside of protected areas (Gami 2002, Okoundzi 2004). In Gabon, almost all the populations complained about the lack of a tarmac route to their villages, which has economic implications as they struggle to transport agricultural or hunted produce to larger markets than their own villages (André 2003, Okoundzi 2004).

Since 2004, an environmental education programme within the local communities in Gabon has been developed in collaboration with a local NGO (Ikamba 2004). While communication and education have different objectives (Cartwright 2006), a structured education programme could help improve communication and dispel misconceptions about the goals of the PNPB and PPG.

The socioeconomic situation is highly complicated, and requires constant attention. However, there is little potential for conflict between the project and the local Gabonese village communities as they have not used the PNPB area for many years. The villages benefit from recruitment of project staff, and from occasional assistance with transport of people, medications or material (Calaque 2003). Tourism is often cited as having the potential to make a major contribution to the local populations, especially focussed on the impressive landscape and diverse avifauna as large mammals are scarce and better seen elsewhere in Gabon (Henschel 2003b, Calaque 2005c, Roger 2005, Roger *et al.* 2006), but to date expectations generally exceed benefits. The development of an integrated and participatory approach to sustainable development and natural resource management across the whole region therefore remains a major challenge, but this is widely understood by all stakeholders, including the local populations, and progress is being made on both sides of the Gabon-Congo border (Calaque 2005b, Projet Plateaux Batékés 2006).

5. Release stock

Source populations

The release stock for the PPG-Gabon reintroduction programme consists primarily of wild born orphans of the illegal bush-meat trade in Gabon, supplemented by *ex-situ* captive-borns abandoned by their mothers. During the initial investigations of the need for the project in Gabon, the Gabonese government expressed frustration that while it was clear that numerous gorillas were being held illegally within the country, there was no official facility to take responsibility for these animals, a factor limiting their capacity to deal with the situation (PPG 1998). Ten captive gorillas were identified in 1997, aged between 6 months and 12 years, and on the 25 February 1998 a meeting was held with the Minister for Water & Forests and Reforestation to discuss the modalities of possible confiscations (PPG 1998). Once agreed, and following the signing of the 'Cahier de Charges' between the government and The Aspinall Foundation in July, four gorillas were transferred to the reintroduction site in August 1998 (Chronopolous 1998, Pearson 1999). Efforts to repatriate three female gorillas of Gabonese origin that were identified in Nigeria in 1998 were unsuccessful. Nine adult and juvenile gorillas in stable groups held in captivity at the Centre International de Recherches Medicales de Franceville (CIRMF) were not considered suitable candidates for reintroduction principally for welfare reasons, but also as PPG release strategies have always been based on long-term rehabilitation in a forest environment from a young age. A captive 8 year-old male identified in Libreville in 1998 was also considered unsuitable for reintroduction for similar reasons, and so was transferred to the private wildlife park at Bakoumba in SE Gabon (PPG 2003). Between 1998 and 2003 a total of 24 wild born orphan gorillas were received by the project, of which all but one were transferred to the PPG base-camp in the PNPB (table 3, fig 16). Apart from PPG & CIRMF, less than ten other wild born gorillas are currently held in captivity in Gabon with permission from the government (Chamberlan 2007), although the use of illegally-held captive apes as attractions in some hotels remains a problem in the country (Cress 2007, King & Chamberlan 2007).

The wild born release stock has been supplemented by *ex-situ* captive borns abandoned by their mothers within the breeding colony housed at Howletts & Port Lympne Wild Animal Parks in the UK (King 2000, Calaque 2003, PPG 2003, Mahé 2006a). Two groups have so far been transferred, in 1999 and 2003, totalling 9 individuals aged between 1.5 and 5 years at the time of transfer. Both transfers were conducted within the strict regulations of the Convention on the International Trade in Endangered Species (CITES) framework. The choice of young gorillas abandoned by their mothers, and so effectively orphans, to supplement the release stock, rather than mother-raised captive-borns, was made primarily for welfare and ethical reasons: it was regarded as unethical to forcibly remove a young gorilla from its natal group, while successful adaptation to the wild was considered less likely for older captive gorillas, or for mother-reared youngsters who lacked confidence in human support. Ethical and welfare decisions remain somewhat subjective, with a scarcity of appropriate empirical data to aid decision-making. However, experience shows that older gorillas are often more severely affected by stressful situations than younger gorillas (eg King *et al.* 2005a), although if intensive long-term management strategies reduce stress to a minimum, even adult gorillas have been successfully transferred from one captive location to another.

While Beck *et al.* (2007) suggest that the relocation of threatened wild apes should be given priority over the reintroduction of captive-borns, there appears to be little justification for the relocation of wild gorillas to the reintroduction project in Gabon, as we are unaware of specific threatened wild gorillas that might benefit from a relocation, and especially given the high post-release survival success of orphan and hand-reared gorillas and the associated opportunities for raising awareness of gorilla conservation on a national and international level (Seddon *et al.* 2007). Bearing in mind that suitable habitat may decrease across Gabon, a relocation attempt might be envisioned in the future, perhaps if two (or more) non-viable populations could be merged to ensure long-term viability.

Stabilisation and rehabilitation

Rehabilitation is defined by Beck *et al.* (2007) as 'the process by which captive great apes are treated for medical and physical disabilities until they regain health, are helped to acquire natural social and ecological skills, and are weaned from human contact and dependence, such that they can survive independently (or with greater independence) in the wild'. We find it most useful to separate theoretically the initial period of quarantine and stabilisation from the rehabilitation phase, as the primary aim of that first period is simply to ensure survival of the captive gorilla, through a combination of medical and psychological treatments (PPG 1998). Data from PPG Congo show that this critical initial period of stabilisation generally lasts up to two months following arrival, after which probability of survival is greatly increased and rehabilitation to independence can become the priority (King *et al.* 2005a). Data from PPG-Gabon shows a similar trend, with a 17% mortality of wild-borns during the initial two months following arrival, accounting for half of all mortalities of wild-borns over a nine-year period (tables 3 & 4). Only those individuals that survive the initial two-month stabilisation phase are then considered for inclusion in the long rehabilitation and reintroduction process, which follows methods developed by PPG through years of experience in both Gabon and Congo (PPG 1998, 2003, Calaque 2003, King *et al.* 2005a), and is described in detail later.

Table 3. Gorilla survival following arrival at PPG Gabon, 1998 to 2007.

	Total arrivals	Mortality (time after arrival)			Still alive
		<2 mo	2-12 mo	>12 mo	(> 4 yrs)
wild-born	24	17%	8%	8%	67%
captive-born	9	0	22%	11%	67%

Table 4. Mortality of wild-born gorillas during the stabilisation phase (first two months following arrival) at PPG-Gabon.

Name	Sex	Date of arrival	Age at arrival	Survival	Cause of death
Sebe	m	19/11/1999	5 mo	29 days	pneumonia since arrival
Okondja	f	28/12/1999	1 yr 1 mo	14 days	bad health on arrival
Ossou	m	15/01/2000	2 mo	41 days	pneumonia
Mounana	m	02/07/2000	6 mo	6 days	dehydration & malnutrition

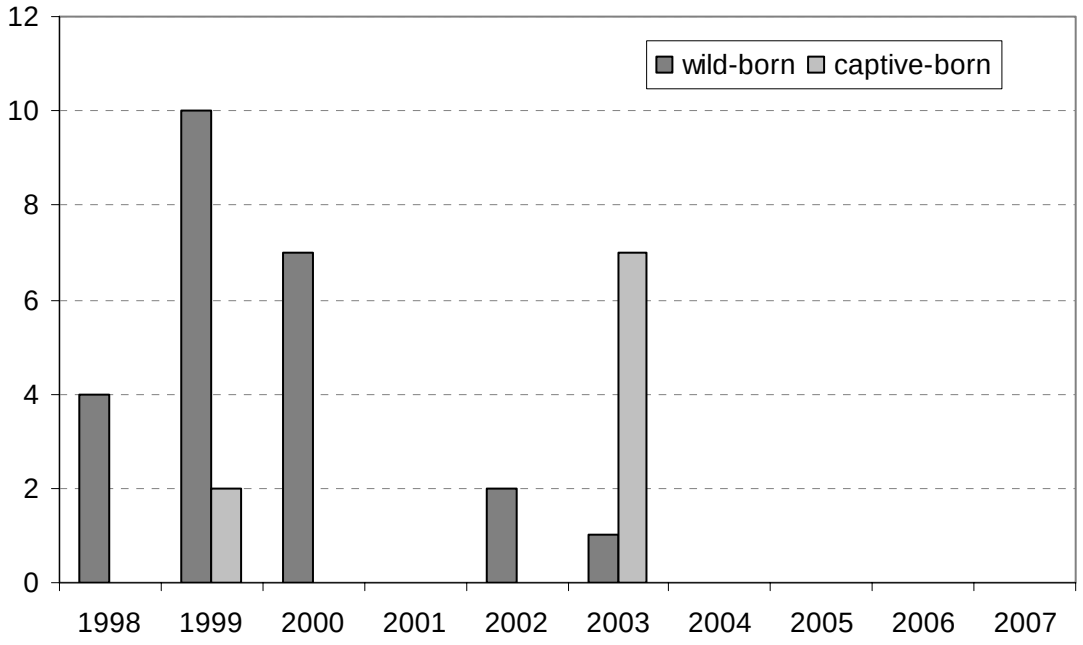

Fig 16. Annual arrival of wild-born and captive-born gorillas at PPG-Gabon.

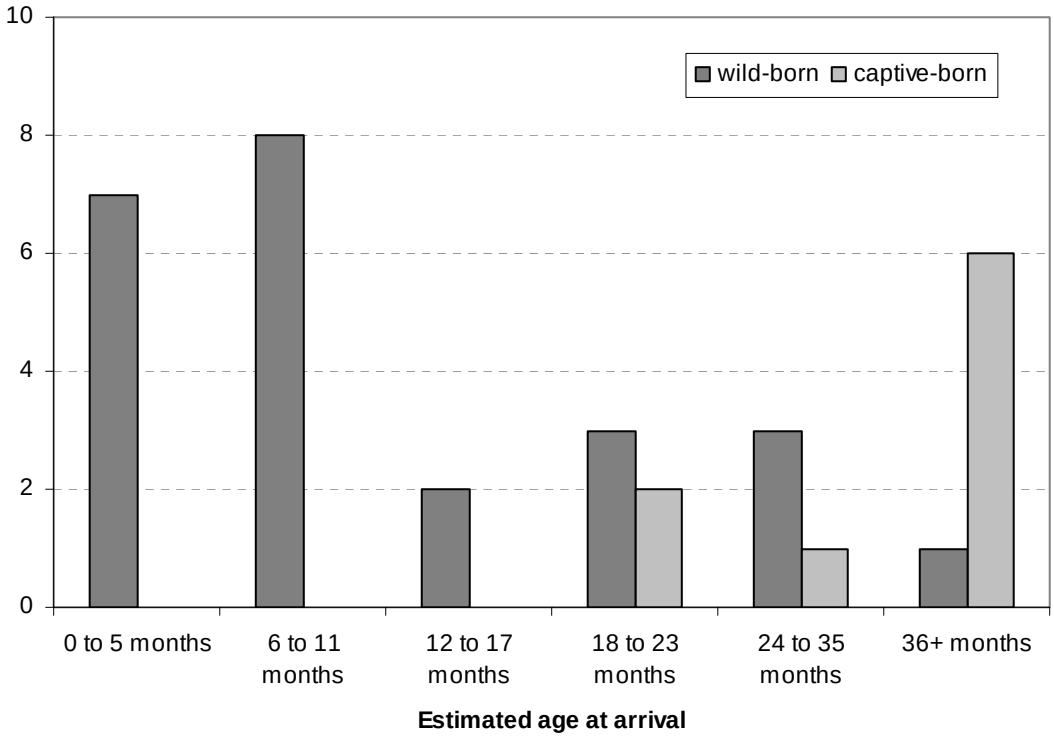

Fig 17. Age at arrival of wild-born (estimated) and captive-born gorillas at PPG-Gabon, 1998 to 2007.

Genetic assessment

The taxonomy of gorillas is debatable, with the traditional view of one species (*Gorilla gorilla*) containing three subspecies (*G. g. gorilla* in the west, *G. g. beringei* and *G. g. graueri* in the east) being challenged by recent suggestions to split the genus into two species (*G. gorilla* in the west and *G. beringei* in the east), while still recognising the two eastern subspecies (*G. b. beringei* and *G. b. graueri*), and possibly recognising a second western subspecies (*G. g. diehli*) represented by a small isolated population at the extreme north-west of the gorilla's total range, on the border of Cameroon and Nigeria (see Harcourt & Stewart 2007 for a recent review). In all of these scenarios, the species present across Gabon and Congo, and formerly within the reintroduction site, is *Gorilla gorilla*, and if this species has distinct subspecies, the one present was *G. g. gorilla*.

All of the wild-born release stock for the reintroduction originate from Gabon (fig 18), and are therefore of the same species (and subspecies if recognised) that was originally present. The *ex-situ* captive-borns are provided by a captive-breeding population originating from Gabon, Congo and Cameroon, and are therefore also of the same species (*G. gorilla*), and subspecies following most scenarios (*G. g. gorilla*). If the extralimital subspecies *G. g. diehli* is eventually officially recognised, it is highly unlikely that it is represented in the captive-breeding founders. However, mitochondrial DNA analysis suggests that the proposed *G. g. diehli* population is part of a more widespread haplogroup of western gorillas, extending across most of inland Cameroon (referred to as haplogroup C), while a second haplogroup (D) is represented from coastal Cameroon through most of Gabon and Congo (Wickings *et al.* 2004). These two major haplogroups probably originated through population fragmentation within forest refugia during periodic climatic changes in the Pleistocene (Wickings *et al.* 2004). Subsequent post-glacial forest expansion has led to the two haplogroups coming into contact again, with evidence for recent gene flow between the adjacent haplogroups in south-east Cameroon and north-east Gabon (Wickings *et al.* 2004). Following this categorisation, it is clear from the geographic origins of the release stock that the current reintroduced population in the PNPB is genetically predominantly of the 'D' haplogroup, and is likely to contain a small percentage of the 'C' haplogroup. A similar genetic make-up would be expected in the wild population of eastern Gabon, based on the samples analysed by Wickings *et al.* (2004).

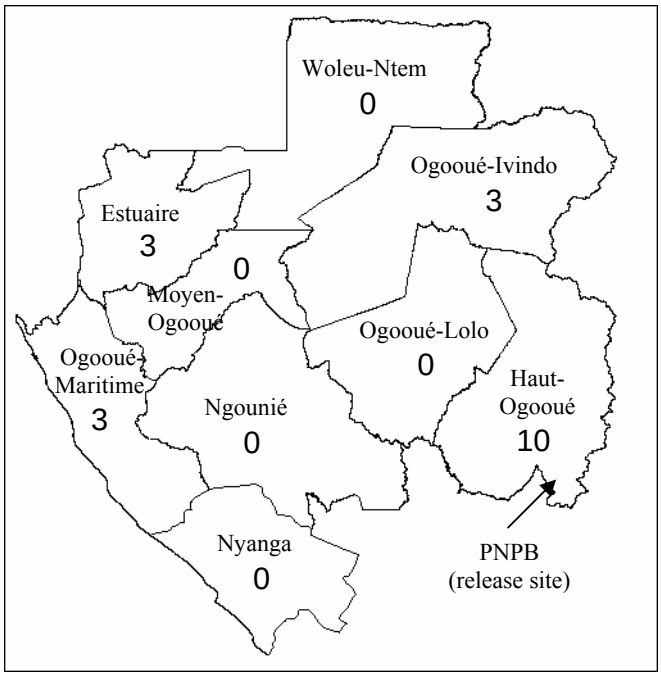

Fig 18. Provinces of Gabon, with the origins of wild-born gorillas released in the PNPB.

A further consideration with regards reintroduction is to ensure the long-term genetic viability of the population, by maintaining adequate heterozygosity (Beck *et al.* 2007). The release stock of the reintroduced population is made up principally of individuals from eastern Gabon (fig 18), and is completed by individuals from elsewhere in Gabon and the captive-bred stock with more diverse origins (see above). The initial founding stock is therefore likely to be more genetically diverse than a similar number of gorillas taken from a single location, so future problems are only likely to occur through severe inbreeding depression. Population modelling using software such as ZooRisk or Vortex will aid in long-term management decisions to reduce the risks of inbreeding depression, while the proposed reinforcement of the current reintroduced population with further rehabilitated individuals will clearly add to the genetic variation within the population. In the long-term, there may also be gene flow between the reintroduced population and the wild populations to the west and south of the reintroduction site (fig 3).

Population assessment

Beck *et al.* (2007) note that inter-population differences in behaviours acquired by social transmission have been observed in great apes, and such differences should be another consideration for reintroduction programmes. Unfortunately, no behavioural studies of the gorilla population previously present across the Batéké Plateau are available, so we will never fully understand these differences at the local scale. However, the majority of the release stock originates from geographical areas relatively close to the release site, and therefore we expect the reintroduced population to exhibit behaviours to a large extent similar to those populations in the general region, rather than those in distant isolated populations, if indeed there are differences. It is unclear whether this theory can be experimentally tested, but it is an aspect worth bearing in mind during decision-making processes regarding the composition of the release stock.

6. Disease Risk and Veterinary Requirements

Risk analysis and health management plans

Beck *et al.* (2007) introduce the concept of 'health risk analysis' as a qualitative or quantitative summary of the health risks involved in a reintroduction, which would then help define the health management plan. This concept is absent from previous guidelines (IUCN 2002), although the formulation of any health plan requires a certain level of risk analysis, whether described as such or not. The risk analysis process is therefore defined simply as 'a logical framework focussed on answering basic questions' (Beck *et al.* 2007), although whether this process can be truly quantitative depends on the nature of information available, and perhaps even more so on the information unavailable.

Health risk assessments within the PPG projects have historically been qualitative (Attwater 1990a, PPG-Congo 1993, 1994, Furley 1996, King *et al.* 2005a), although the relative importance of different diseases identified through such assessments has naturally impacted the evolution of the related health management plans. These plans are summarised for wild-born orphans by PPG (1998) and PPG-Congo (1993, 1994), and for *ex-situ* captive-borns by PPG (2003). Mahé (2004a) refined these health protocols based on updated information available at that time (particularly PICG 1999, IUCN 2002 and PASA 2004), and describes the implementation of the health plan for the specific case of the transfer of 7 *ex-situ* captive-borns from UK to Gabon in 2003 (Mahé 2006a). A simplified summary of the general strategic health plan employed by PPG in the past for most significant diseases is given in table 5.

Table 5. Simplified and generalised summary of past PPG health management plans (Significance to apes or staff is a subjective combined assessment of severity, probability and ease of testing and treatment: H = high, M = medium and L = lower).

Disease	Significance		PPG management plan
	Apes	Staff	
Ebola/Marburg	H	H	mortality so high and rapid that living apes highly unlikely to have been exposed, plus collaboration with CIRMF and WCS for awareness and testing
Tuberculosis	H	H	test apes during quarantine and pre-release, isolate positive apes; test and treat or vaccinate staff; refuse access by positive or untested humans (eg local populations, visitors)
EMCV	M	L	pest control & disinfection of stored foods before feeding to apes
Anthrax *Bacillus anthracis*	M	M	isolation of apes showing clinical signs during quarantine, smears from suspicious carcass found in the forest
Malaria	M	H	preventative testing; preventative medication (malarone) for *ex-situ* release stock; free treatment of clinical signs for staff; preventative medication advised for short-term overseas visitors
Filariosis	M	H	preventative testing, treatment of clinical signs for staff and apes

Disease	Significance		PPG management plan
	Apes	Staff	
Streptococcus pneumoniae	L	L	quarantine affected animals
Measles	H	H	vaccination of staff (and apes at PPG Congo)
Mumps	L	H	vaccination of staff (and apes at PPG Congo)
Rubella	L	L	vaccination of staff (and apes at PPG Congo)
Diptheria	L	L	vaccination of apes and staff
Tetanus	M	H	vaccination of apes and staff
Polio	H	H	vaccination of apes and staff
Rabies	M	L	vaccination of apes from UK if transiting through Europe
HIV/SIV	M	H	test apes during quarantine, and staff regularly; refuse direct contact between positive staff and apes (for the well being of the staff)
HTLV/STLV	L	L	test apes and staff if possible
Hepatitis A	L	H	test apes; vaccination of staff
Hepatitis B	L	H	test apes & staff; vaccination of staff
Hepatitis C	L	M	
Herpes simplex	L	M	
RSV	L	L	
Yellow fever	L	M	vaccination of staff
Adenovirus	L	L	
Influenza orthomyxovirus	M	M	
Shigellosis	H	M	test apes & staff during quarantine (if possible)
Salmonellosis (typed)	H	M	test apes & staff during quarantine (if possible)
Camplyobacter spp.	H	M	test apes & staff during quarantine (if possible)
Enteropathogenic *E. coli*	M	M	test if symptoms
Yersinia sp.	M	M	test if symptoms
Klebsiella sp.	M	M	test if symptoms
Oesophagostomum	H	M	daily disinfection of cage floor; regular stool testing of apes; treatment of entire group if one positive result (pre-release); hygiene rules for staff
Ankylostomiasis	M	M	regular stool testing of staff and apes; treatment if positive result; hygiene rules for staff
Strongyloidiasis	M	M	regular stool testing of staff and apes; treatment if positive result
Anguillules hookworm	M	M	regular stool testing of apes; treatment of entire group if one positive result (pre-release); hygiene rules for staff
Ascaris	M	M	regular stool testing of apes; treatment of entire group if one positive result (pre-release); hygiene rules for staff

Disease	Significance		PPG management plan
	Apes	Staff	
Whipworm *Trichuris*	M	M	regular stool testing of staff and apes; treatment if positive result; hygiene rules for staff
Hydatids/ *Taenia*	L	L	regular stool testing; treatment if positive result; pest control
Pinworm *Enterobius*	M	M	regular stool testing of staff and apes; treatment if positive result; hygiene rules for staff
Balantidium coli	M	M	regular stool testing of staff and apes; treat if heavy load or symptomatic
Entamoeba hystolytica	M	M	regular stool testing of apes and staff; treatment of group when symptomatic; hygiene rules for staff
Giardia intestinalis	M	M	regular stool testing of staff and apes; treat if heavy load or symptomatic
Cryptosporidium	M	M	regular stool testing of staff and apes; treat
Candidiasis	M	L	antifungal treatment to accompany antibiotic treatments in weak apes, especially during quarantine
Sarcoptes spp. (scabies)	M	L	treat apes and staff; avoid spread as very difficult to eradicate once established in a large group

In addition to the diseases listed in table 5, a major risk to the health of the gorillas has been identified as psychological stress or depression, and in combination with other health issues has often led to mortality (Furley 1996, Attwater 1999, King *et al.* 2005a). Helen Attwater, a trained nurse who worked at the PPG Brazzaville orphanage from its beginnings in 1989 until 1995, during which time 64 gorilla orphans arrived, concluded: 'a pathologist from Kyoto University… confirmed the conclusions we had drawn from our experiences to date: that the gorilla's two main areas of vulnerability were his complex, finely tuned digestive system, that could be easily and fatally disrupted, and his fragile emotional make-up… Emotional stress, exposure to human disease and malnutrition that resulted in the breakdown of a fine balance of intestinal parasites held in check under natural conditions, made the survival of newly arrived orphans unlikely' (Attwater 1999). Having recognised stress as one of the major health risks to the species, the management of stress has since become an integral part of PPG health management planning.

Health management major results

The generalised PPG health management that has been used in recent years is summarised in table 5. Specifically, different management plans have been implemented for different groups at different periods of time, with lessons learned during earlier experiences impacting later strategies. There have also been important differences between the strategies for wild-born and captive-born individuals.

Wild-born individuals were screened for all major diseases by CIRMF prior to transfer to PPG, except in some cases where individuals were so dehydrated not to allow blood samples to be taken immediately. In these cases, the tests were carried out during the initial stabilisation phase post-transfer. Tuberculosis was tested for using Mammalian Old Tuberculin injected subcutaneously in an eyelid, while serum

samples were used to test for a variety of viruses, principally SIV/HIV, HTLV I/II, hepatitis B and hepatitis C (AgB, AcC B, Ac HCV). The only positive results were for hepatitis B, which is not considered contra-indicative for release. Post-release virus monitoring has been generally through faecal virology analysis, although occasional blood samples have been taken and analysed post-release.

Ex-situ captive-borns underwent serology exams in the UK pre-transfer (Mahé 2006a). Serology analysis has not been repeated post-release, although haematology and biochemistry exams were undertaken at every opportunity to take blood samples (results in Mahé 2006a).

Wild-born individuals have been vaccinated against tetanus and polio, using the DTPolio vaccine (tables 6 & 7). It is worth noting that although the diphtheria vaccine is not useful, this triple vaccine is used as it is easily available in Africa, and the diphtheria is harmless (Mahé 2004a). This vaccine should not be confused with the DTPertussis vaccine (also called DTP but with Pertussis replacing Polio), or with Tetracoq (which includes both polio and pertussis, in addition to diphtheria and tetanus), especially as the pertussis vaccine often provokes severe negative reactions in apes (Mahé 2004a, PASA 2004). Wild-born individuals at PPG Gabon have not been vaccinated against measles, mumps and rubella (MMR vaccine), although they usually are at PPG Congo (King *et al.* 2006a). It is debatable how necessary this vaccine is for gorillas awaiting reintroduction (PASA 2004), especially if they are isolated from high risk humans, and indeed there was a time when some considered the use of vaccinations as contra-indicative for release.

Ex-situ captive-borns have also been vaccinated against tetanus and polio, either with DTPolio post-transfer (group 1), or with a combination of vaccines pre- and post-transfer (group 2, table 8). In addition, they were all vaccinated pre-transfer against rabies (to fulfil French transit requirements), and measles, mumps and rubella (MMR), while the first group were vaccinated against hepatitis A and B, and the second group against influenza (table 8).

The second group of captive-borns were given a 7-month malaria prophylaxis treatment, starting one day prior to transfer, using malarone (Mahé 2006a). This was decided because one of the previous *ex-situ* captive-borns that had died post-transfer was found to have been infected with *Plasmodium falciparum*, although it is unknown whether this contributed to his death (Mahé 2006a). Wild-borns have never been given preventative malaria treatment, although have occasionally been treated for malaria during the rehabilitation phase if they exhibited malaria-like symptoms. In one case, recovery from severe illness coincided with nivaquine treatment in a young hand-reared wild-born orphan (Moanda). In other cases, it was not clear whether malaria treatment was necessary or useful, but at the least should have been harmless.

Ex-situ captive-borns were dewormed pre-transfer, and continued regular preventative and curative deworming post-transfer with a variety of medications (further details in Mahé 2006a). Some wild-borns were dewormed pre-transfer, particularly those held in relatively good captive conditions pre-PPG, and all were regularly dewormed during their stabilisation and rehabilitation phases. Regular preventative deworming has also been carried out post-release for both wild-borns and captive-borns while feasible, and also when appropriate following positive parasitology results during

routine post-release faecal sampling. Endoparasite control has been one of the major challenges faced by PPG-Gabon, particularly pre-release, with *Oesophagostomum stephanostomum* being found responsible for one mortality pre-release and suspected to be the underlying cause of several long-term health problems. Oesophagostomes have proved particularly hard to treat compared to other nematode worms due to their unique lifestyle with the larvae forming nodules within the intestinal wall (fig 19). These nodules appear to protect them to some extent from several standard deworming treatments, with albendazole the most effective, and can develop into small abscesses resulting in intestinal inflammation and oedema. Future groups will be shown food-plant species in the release site that can be used as self-medication against oesophagostomes and other internal parasites, such as *Aspilia* and *Vernonia* spp.

Vitamin supplements have been given when symptoms have indicated possible vitamin deficiency, such as feeding on soil or sand. They were also given as post-transfer support for one year for the second group of *ex-situ* captive-borns (Mahé 2006a).

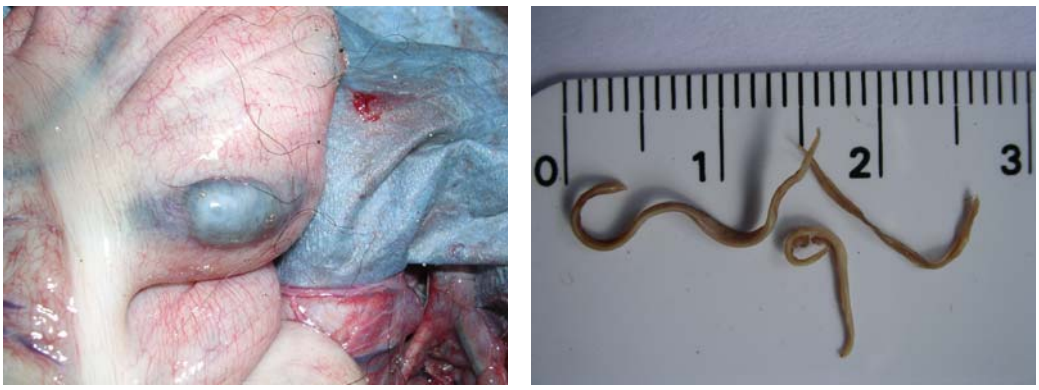

Fig 19. Nodule on the serosa of the colon, and larvae of *Oesophagostomum stephanostomum* removed from the nodule, which led to peritonitis, septicaemia and mortality of a young male western gorilla pre-release at PPG Gabon (from Paredes 2004).

Staff screening and health

The staff medical screening programme occurs in the town of Franceville, initially pre-employment, and then during time-off. A specific doctor in Franceville has been chosen by PPG to manage staff health issues, and PPG pays all medical expenses for project staff (Mahé 2006a). Pre-employment screening includes tuberculosis testing (intra-dermal reaction, sputum exam and thoracic x-ray), viral serology (HIV, hepatitis B), and faecal parasitology (Mahé 2006a). Positive results are treated appropriately pre-employment. HIV-positive staff would not work directly with the gorillas as they would be at higher risk of contracting disease (Mahé 2004a, Beck *et al.* 2007). Project staff are vaccinated for yellow fever, tuberculosis (BCG), diphtheria, tetanus, polio (DTPolio), hepatitis B, hepatitis A, measles, mumps and rubella (MMR) (Mahé 2006a). Staff are dewormed on a regular three-month cycle, and faecal parasitology exams are conducted as indicated by symptoms (Mahé 2006a).

Table 6. Vaccination dates for wild-born members of group 1.

	DTPolio 1	DTPolio 2	DTPolio 3	DTPolio 4
Sophie	01/05/98	01/06/98	01/07/98	16/09/99
Marco	16/09/99	25/10/99	09/12/99	04/12/00
Lekedi	16/09/99	25/10/99	09/12/99	04/12/00
Moanda	16/09/99	25/10/99	09/12/99	04/12/00
Choupette	16/09/99	25/10/99	09/12/99	04/12/00
Tonga	16/09/99	25/10/99	09/12/99	04/12/00
Kongo	16/09/99	25/10/99	09/12/99	04/12/00
Ndjima	16/09/99	25/10/99	09/12/99	04/12/00
Otala	16/09/99	25/10/99	09/12/99	04/12/00
Ngoma	16/09/99	25/10/99	09/12/99	04/12/00
Miyandza	16/09/99	25/10/99	09/12/99	04/12/00
Ivindo	16/09/00	29/10/00	04/12/00	04/12/01
Boumango	16/09/00	29/10/00	04/12/00	04/12/01
Mboundou	16/09/00	25/10/00	04/12/00	04/12/01
Belinga	16/09/00	29/10/00	04/12/00	04/12/01
Opoungou	16/09/00	25/10/00	04/12/00	-

Table 7. Vaccination dates for wild-born members of group 2 (further details in Mahé 2006a)

	DTPolio 1	DTPolio 2	DTPolio 3	DTPolio 4
Zora	27/08/04	28/09/04	29/10/04	
Souba	27/08/04	28/09/04	29/10/04	
Tchimbele	27/08/04	28/09/04	29/10/04	

Table 8. Vaccination dates for captive-born members of group 2 (arrival in Gabon 8/08/2003; further details in Mahé 2006a).

	Djalta	Kwibi	Djaltam	Kiba	Ama	Ima	Kido
Rabies	10/07/03	10/07/03	10/07/03	10/07/03	10/07/03	10/07/03	10/07/03
Influenza	24/07/03	24/07/03	24/07/03	24/07/03	24/07/03	24/07/03	24/07/03
MMR 1	30/04/03	30/04/03	30/04/03	30/04/03	30/04/03	30/04/03	30/04/03
MMR 2	30/06/03	30/06/03	30/06/03	30/06/03	30/06/03	30/06/03	30/06/03
MMR 3	24/07/03	24/07/03	24/07/03	24/07/03	24/07/03	24/07/03	24/07/03
Polio oral 1	18/04/03	18/04/03	18/04/03	18/04/03	18/04/03	18/04/03	18/04/03
Polio oral 2	25/06/03	25/06/03	25/06/03	25/06/03	25/06/03	25/06/03	25/06/03
DTPertussis	24/07/03	24/07/03	24/07/03	24/07/03	24/07/03	24/07/03	24/07/03
Tetanus 2	04/09/03	04/09/03	04/09/03	04/09/03	04/09/03	04/09/03	04/09/03
Tetanus 3	19/10/03	19/10/03	19/10/03	19/10/03	19/10/03	19/10/03	19/10/03
DTPolio	27/08/04	27/08/04	27/08/04	27/08/04	27/08/04	27/08/04	-

7. Transport

Wild-borns arriving 1998

The first four wild-born gorillas to arrive at the PNPB were transported together by helicopter on the 1 August 1998. The four gorillas were each monitored or cared for by PPG staff for between three and ten months pre-transfer, and underwent medical tests and treatments pre- and post-transfer. The three females were transported from the capital city of Libreville, where they had been in the care of PPG, while the male was picked up on the way in Franceville, after he had been driven from his previous home at the wildlife park at Bakoumba, where he had spent one year with good captive care. The two older gorillas were transported in crates (Marco 2.3 years and Sophie 1.8 years), and the two younger ones (Lekedi 1 year and Moanda 3 months) were held by PPG staff. Calmivet® (acepromazin) was used to keep Sophie and Lekedi calm during the journey. On arrival, the two older gorillas were held in a wooden night-cage constructed within the release site, while the two younger ones were kept on the opposite side of the river. All four were accompanied daily in the forest, with Lekedi and Moanda being transported daily across the river, and adapted well to the habitat (Chronopolous 1998, Pearson 1999). Within days, Lekedi joined the two older gorillas in the night cage within the release site, while Moanda joined them almost six months later, at the age of nine months.

Wild-borns arriving 1999 to 2000

Seventeen wild-born orphans were received by PPG Gabon between January 1999 and July 2000, some in fairly good health, but others in very poor health (Pearson 1999, 2000), and sixteen of these were transported to the PNPB. All but two were under two years old, and so could be transported without sedation or crating, by vehicle and boat. As with Moanda, all these young orphans spent a period of time sleeping on the opposite side of the Mpassa river to the release site, for up to 8 months in the case of Mboundou who arrived at only one month old (table 14). The two older individuals (Choupette 4.5 years and Tonga 2.5 years) had spent a considerable time together in captivity in the coastal town of Port Gentil, and underwent long-term health monitoring prior to arrival. In February 1999 they were anaesthetised with a ketamine/rompun combination and transported in the same crate by plane, vehicle and boat, and were placed in a separate compartment of the communal night cage at the release site.

Wild-borns arriving 2002 to 2003

The second group of gorillas to be reintroduced to the PNPB was started with the arrival at PPG Gabon of an 11-month-old female in June 2002 (Souba), almost two years after the arrival of the last members of the first group in July 2000 (table 14). To ensure social contact with conspecifics, she was accompanied daily in the forest with the first reintroduced group for several months (Holzman 2004), until the arrival of two more wild-born females, in December 2002 (Zora) and May 2003 (Tchimbele). This group of three young females was initially rehabilitated on the western bank of the Mpassa river, the opposite side to the reintroduction site, sleeping in a wooden night cage near the PPG camp (fig 4) and being accompanied by PPG staff in the surrounding forest on a daily basis. This continued until the group transfer to the

release site on 21 September 2003, which consisted of a short boat ride down and across the Mpassa river. The oldest of the three (Zora 3.5 years) was anesthetised to be crated for the transfer, using oral medetomidine (2 mg) followed by IM ketamine (80 mg), and reversed with IM atipamezole (7.5 mg). The other two (Souba 2 years and Tchimbele 1 year) were simply held in the arms of staff members, although Souba was calmed with oral diazepam (10 mg). At the release site, they were provided with a separate compartment of the wooden night-cage already being used by the seven captive-born gorillas that had been transferred the previous month (see below), to allow non-physical contact between them before social integration.

Captive-borns arriving 1999

The first *ex-situ* captive-borns to be included in the release stock were two young males aged 3.8 and 2.6 years who had been born within the captive-breeding programme at the Howletts and Port Lympne Wild Animal Parks in UK, but had been abandoned by their mothers and therefore hand-reared. They were accompanied during the transfer by the head gorilla keeper from Howletts who they knew well (Angus 2000, Pearson 2000). The two gorillas were sedated with Valium® (diazepam) at Howletts and transported in a single crate to Gatwick Airport for an overnight flight to Libreville, during which time they were fed and watered regularly (Angus 2000). In Libreville, they were transferred to a smaller transport crate to be flown by a single-engine Cessna to the Mpassa site; however, the larger plane accompanying them, with an international film crew aboard, crashed on landing on the sandy airstrip, forcing the second plane with the two gorillas to land in Franceville (Angus 2000). The gorillas and their keeper therefore had to spend a night in Franceville before completing the journey by pick-up and boat the following day, finally arriving late in the afternoon on 1 November 1999, when they were placed in their separate compartment of the communal overnight cage at the release site. The following morning they were accompanied in the forest with the group of rehabilitating wild-borns, and their integration to the group began (Angus 2000).

Captive-borns arriving 2003

The second group of *ex-situ* captive-borns to be incorporated into the release stock consisted of seven (5.2) young gorillas, aged between 1.5 and 5.2 years at transfer (table 9), who had been abandoned by their mothers within the captive-breeding programme at Howletts and Port Lympne Wild Animal Parks in UK, and had consequently been hand-raised. The full details of the preparations and implementation of the transfer are given by Mahé (2006a), an experienced veterinarian who spent two months with the group pre-transfer, accompanied them during the transfer, and spent a further eight months with them post-transfer. The head gorilla keeper from Howletts also undertook the voyage, adding another reassuring presence to the gorillas to reduce stress to a minimum. The transfer took a total of three days, starting at 20h00 on 6 August 2003 with the placing of the seven gorillas in six transport crates built following ATA regulations, with the two youngest gorillas sharing a single cage (Mahé 2006a). To place them in the crates, the five oldest gorillas were anaesthetised using oral medetomidine followed by intramuscular (IM) ketamine, while the two youngest were simply sedated with oral medetomidine (table 9, Mahé 2006a). However, once in the crates, the gorillas recovered from the anaesthesia prior to transport, and during the journey were given a mild sedative

(diazepam) only when they appeared overly excited or during particularly stressful periods (Mahé 2006a). The transport cages were designed to allow the gorillas to see and smell each other, but with removable wooden covers to enable complete closure when necessary (Mahé 2006a).

Table 9. Dosages used for the sedation and anaesthesia of seven captive-born gorillas on 6 Aug 2003, to place them in transport cages for transfer to Gabon (after Mahé 2006a).

	Age	Weight	Medetomidine (oral)	Ketamine (IM)
Kwibi	4.8 yrs	38 kg	2.85 mg	110 mg
Djalta	5.2 yrs	31 kg	2.4 mg	90 mg
Djaltam	4.2 yrs	28 kg	2.1 mg	100 mg
Kiba	3.4 yrs	21 kg	1.6 mg	60 mg
Ama	3 yrs	16 kg	1.2 mg	60 mg
Ima	1.5 yrs	12 kg	0.9 mg	
Kido	1.6 yrs	11 kg	0.8 mg	

Customs formalities were undertaken at Gatwick airport during the night of 6 to 7 August, before the gorillas were driven in a truck from Howletts Zoo, UK, to Paris airport, France, leaving at 05h00 and during which the gorillas were fed every two hours (Mahé 2006a). Travelling in the hold, the gorillas were fed just prior to take-off at 23h00 (fig 20), and slept well through the flight, arriving in Libreville at 07h00 on 8 August 2003 (Mahé 2006a). Formalities in Libreville were quick, and the crates were flown by small plane to Franceville, and then in two trips by helicopter to the release site in the PNPB, arriving at 13h00 (fig 20, Mahé 2006a). After a period to allow the gorillas to calm down, they were released from the transport cages in the presence of familiar staff members, before being encouraged into the compartmentalised wooden night cage constructed for them in the forest at the release site, the three oldest males being in a separate compartment from the four younger gorillas (Mahé 2006a). The following day they began the long-term routine of being accompanied daily in the forest from 08h00 and being returned to the night cage at 16h00 (Mahé 2006a, details below).

Fig 20. *Ex-situ* captive-born gorillas transferred to Gabon from UK benefited from intensive monitoring throughout transport by truck, plane and helicopter. (Photos: A. Courage)

8. Rehabilitation and Soft-Release Process

Stages and methods of rehabilitation and soft-release process

Gorillas that survive the initial period of quarantine and stabilisation following arrival at PPG, therefore entering the reintroduction programme, then undertake a lengthy period of preparation prior to final release (PPG 1998, 2003, Calaque 2003, King *et al.* 2005a). This pre-release rehabilitation can be undertaken pre- or post-transfer to the final release site, or in many cases during a combination of the two (see definitions of distinguishable phases in table 10). It is a gradual, long-term process, ending at full release, which we define as the last date that one or more of the group spends the night in a cage. It is after this date that group ranging can become independent of cage location, although supplementary feeding and post-release monitoring may continue to impact group behaviour.

Table 10. Definition of phases within the PPG-Gabon reintroduction programme. (*Pre-transfer preparation duration excludes captive-borns, as their pre-transfer preparation has occurred before arrival in Gabon)

Phase	Average duration	Definition
Stabilisation	2 months	First two months following arrival, with primary aim simply to ensure survival through medical and psychological treatment
Pre-transfer preparation	2* months	Post-stabilisation, individuals or groups sleeping in enclosures outside release site, with primary aim to prepare them for transfer to release site
Transfer date	1-3 days	Date of transfer to final release site, with enclosures for sleeping at night, after which the soft-release process can begin
Soft-release process	15 months	Post-transfer to release site, with all or some group members sleeping in enclosures, with primary aim to adjust gradually to the release site while ensuring group cohesion and safety from accidents and predators
Release date	1 day	The soft-release process is considered to have finished when all group members are sleeping outside of night-enclosures at the release site
Significant post-release support	20 months	All group members sleeping in the forest, but daily post-release monitoring with regular supplementary feeding and medical support provided if necessary
Minimal post-release support	Decades	Post-release monitoring reduced gradually to daily or even weekly determination of group location, composition and general health, and only occasional intervention as deemed necessary

Table 11. Timing of major events in the reintroduction process of the two groups of gorillas released in the PNPB.

Group	Initial number of gorillas	Arrival at PPG	Transfer to release site	Release	Final daily milk
1 (wild-borns)	17	Feb 1998 to Jul 2000	Aug 1998 to Nov 2000	Jan 2001	Dec 2002
1 (captive-borns)	2	1 Nov 1999	1 Nov 1999		
2 (wild-borns)	3	Jun 2002 to May 2003	21 Sep 2003	Aug 2004	Dec 2005
2 (captive-borns)	7	8 Aug 2003	8 Aug 2003		

Two groups have undergone the rehabilitation and soft-release process at PPG-Gabon, consisting of a total of 29 gorillas, including 20 wild-borns and 9 captive-borns (table 11). To date rehabilitation for future release has only been attempted with wild-born orphans arriving aged no more than 4.5 years, and usually less than 2 years (fig 17). Older captive wild-born individuals are rarely encountered *in-situ* unless kept in very good captive conditions, in which case there are usually welfare arguments not to include them as release stock (see 'Release Stock' section above). The rehabilitation and soft-release phase is a complex process that includes aspects such as psychological support, social integration, forest adaptation, behavioural and health assessments, and occasional medical interventions (PPG 1998, 2003, Calaque 2003, Mahé 2006a, 2006b).

Psychological support is generally provided in the first instance by human care-givers, but introduction to conspecifics is encouraged as soon as is appropriate in each case (PPG 1998). This is a crucial aspect of gorilla rehabilitation, as mental stress and physical health appear inextricably linked to a greater extent than in other great apes (PPG 1998, Attwater 1999, King *et al.* 2005a, 2006a, Mahé 2006a, 2006b).

Social integration has generally been within relatively even-aged groups of several juveniles and infants passing through the rehabilitation phase simultaneously (PPG 2003), and social hierarchies are established over time (PPG 1998). This method has the disadvantage of the absence of adult influence on the rehabilitating group (Mahé 2006a), but facilitates intensive monitoring of health and other aspects during the rehabilitation.

Forest adaptation is assured by daily excursions within the forest type present in the reintroduction site, accompanied by project staff, while at night the group is returned to a secure cage (PPG 1998, 2003, Mahé 2006a). Supplementary feeding is gradually reduced over time (PPG 1998, 2003, Mahé 2006a). Wild-born gorillas that were orphaned relatively late (ie at over approximately 1 year-old) already have a good feral knowledge, and generally adapt quickly to the habitat. Less experienced individuals, including those that have spent a longer time in captivity, learn by watching the more experienced individuals, and occasionally by watching human demonstrations.

The intensive pre-release monitoring allows assessment of behavioural, psychological and health aspects of each individual by project staff. Medical interventions are conducted as necessary (Mahé 2006a), and only three mortalities have been recorded during this phase at PPG Gabon (table 12). The remaining gorillas have all progressed to show the necessary characteristics in all these aspects to develop the survival-critical behaviours required for release (PPG 2003). The specific details concerning the soft-release process of the two PPG-Gabon groups are described below.

Table 12. Mortality during the soft-release phase of the PPG-Gabon reintroduction programme.

Group	Name	Sex	Age at arrival	Age at death	Survival	Cause of death
Wild-borns						
1	Djembe	m	1.6 yrs	2.1 yrs	6 months	unknown; large tumor found in intestines
Captive-borns						
1	Kwa Kwa	m	2.6 yrs	2.8 yrs	3 months	infective peritonitis due to inflammation of caecum
2	Kido	m	1.6 yrs	2.2 yrs	7 months	peritonitis & septicaemia due to oesophagostome intestinal infection

Group 1 soft-release process

The first group to undergo the soft-release process at the release site in the PNPB gradually grew to a total of 17 gorillas over a period of 27 months between August 1998 and November 2000, including two captive-borns introduced in November 1999. Individuals, or occasionally pairs, were slowly introduced to the group as they were deemed physically and psychologically ready. The growing group was accompanied in the forest daily by project staff, and returned to a simple wooden cage at night. Gorillas that knew each other pre-arrival, such as the two captive-borns, were given separate compartments within the night cage to allow them to build social relationships with other group members slowly and in relative safety. Younger gorillas spent time with the group in the forest during the day, but slept on the opposite bank of the Mpassa river until it was considered appropriate for them to sleep in a compartment of the night cage with other young gorillas, usually at at least nine months old, when they no longer needed night feeding of milk.

From April 2000, and before the final members of the group had been introduced, some of the older gorillas started sleeping outside the night cage on a fairly regular basis, but generally nested in the vicinity of the cage which contained the younger group members (Pearson 2000). A second night cage was constructed in August 2000, about 1 km south of the original, to help the group expand their ranging without being restrained by the large number of infants in the group. By the end of 2000 even the younger gorillas were occasionally found outside the cage in the morning, due to the older gorillas breaking the cage. During the first ten days of January 2001 the entire group started sleeping outside the cage on a daily basis, and so we consider this

moment as the group release date. Supplementary feeding with reconstituted milk continued on a daily basis until December 2002 (table 11). Of the nineteen gorillas to enter the soft-release process for this group, all but two survived to the release date of early January 2001 (table 12). The exceptions were a 2 year-old wild-born male (Djembe) who died in July 2000 six-months after arrival, whose autopsy showed a large intestinal tumour, and a 2.9 year-old captive-born male (Kwa Kwa), who died three-months after arrival, the cause being determined at autopsy as infective peritonitis caused by inflammation of the caecum (appendicitis) (Angus 2000, Pearson 2000).

Group 2 soft-release process

Mahé (2006a) gives a detailed account of the soft-release process for the second group to be reintroduced to the PNPB, which began in August 2003 with the arrival of seven captive-borns from the UK, included the introduction of three wild-borns in September 2003, and continued until all group members were sleeping outside the night-cage in August 2004 (tables 11 & 13). Following analysis of the methods used in the release process of the first reintroduced group, several methods were refined or altered for this second group, particularly with regard to the captive-borns. Probably the two most significant changes were the longer duration of psychological and veterinary support provided to the captive-born gorillas post-transfer by humans who were very well-known to the gorillas pre-transfer (see table 13), and the more gradual introduction of a much higher proportion of captive-borns to wild-borns within the group (7:3 over several days rather than 2:17 the first day). Other differences which may have also had a significant impact were the timing of the transfer (during the dry season) and the administration of an anti-malarial treatment for the captive-borns until 7-months post-transfer (Mahé 2006a, see page 32). These differences are thought to have been major contributors to the high pre- and post-release survival rates of the second group of captive-born gorillas, which were much better than for the first captive-born group, and comparable if not better than for wild-borns (table 16), although care must be taken when interpreting results based on such small sample sizes. The only mortality during the soft-release process for the second group was a 2.3 year-old captive-born male who died eight months post-transfer, with the autopsy showing cause of death to be peritonitis and septicaemia following infestation of the large intestine by *Oesophagostomum stephanostomum* roundworms (family Chabertiidae), despite many anthelminthic and antibiotic treatments (table 12, Paredes 2004, Mahé 2006a). Indeed, oesophagostomes and other intestinal nematode parasites proved a constant and probably the most significant health problem during the soft-release phase of the second group. Other health problems that required veterinary intervention included amoeba infection leading to dehydration, regenerative anaemia (probably caused by the oesophagostome loads), respiratory infections, scabies, fungal infections of the skin, a dental and a laryngeal abscess, and various traumatisms due to probable mild aggression in the night-cage, and even to a thorn in an eye-lid (Mahé 2006a).

Table 13. Time-line for major events during the pre-transfer and soft-release phases of the reintroduction of the second group of gorillas to the PNPB, Gabon (based on Mahé 2006a).

Date	Event
Pre-transfer preparation phase	
Jun 1998 onwards	7 captive-born gorillas hand-raised by team at Howletts Wild Animal Park, UK, particularly Lorna Wanless, with Colin Angus as head-keeper
Apr 2003	Start of vaccination programme for captive-borns pre-transfer
Jun to May 2003	3 wild-born females arrive at PPG-Gabon and start pre-release rehabilitation
Jun 2003	Sandrine Mahé, an experienced veterinarian, with captive-born gorillas daily for 2-months pre-transfer
Jun 2003	Diet of captive-borns modified 2-months pre-transfer to resemble more closely diet in Gabon, including cultivation of *Aframomum* which would be a staple component of diet in the wild
Aug 2003	Pre-transfer preventative deworming of captive-borns
6 to 8 Aug 2003	Transfer of 7 captive-borns from Howletts to Gabon release-site, accompanied by Sandrine Mahé and Colin Angus
Soft-release phase	
Aug 2003	3 oldest captive-borns separated from 4 youngest in the night-cage; reconstituted milk 3x per day, fruit 1x per day; accompanied in the forest daily 08h00 to 16h00
Aug 2003	Anti-malarial treatment for captive-borns for 7 months, and vitamin supplements for 1 year
Aug 2003	Regular post-transfer preventative deworming until present
Aug to Oct 2003	Psychological support from keepers from Howletts: Colin Angus stayed with group daily for 7 weeks post-transfer, replaced by Lorna Wanless for another 6 weeks
Aug 2003 to Apr 2004	Psychological and veterinary support: Sandrine Mahé stayed with group daily for 8 months post-transfer; after which Jorge Paredes provided veterinary support until the return of Sandrine Mahé from Jul 2004 to Sep 2005.
21 Sep 2003	Transfer of 3 wild-born females to release site, given a separate compartment of night-cage
23 to 24 Sep 2003	Controlled introduction of wild-borns and captive-borns, first encounters agonistic
Sep 2003	All captive-borns sleeping in same cage as it became too difficult to separate them; reconstituted milk reduced to 2x per day, fruit continued 1x per day
Oct 2003	Supplementary fruit stopped; reconstituted milk continued 2x day until Aug 2004
Dec 2003	Kido had respiratory infection and was treated with antibiotics

Jan 2004	4 gorillas (Kwibi, Zora, Ama, Ima) had an amoeba infection; treated with metronidazole; Zora and Ama were dehydrated and required drip administration under anaesthesia; all recovered well
22 Mar 2004	2.3 year-old captive-born male (Kido) died from peritonitis secondary to oesophagostomum infestation despite many anthelminthic and antibiotic treatments
Jul 2004	Cage broken regularly, older gorillas sometimes sleeping outside
Aug 2004	Morning milk diluted for all but two youngest gorillas (transition to 1 milk per day from Sep 2004 until milk stopped in Dec 2005)
12 Aug 2004	Release date: night-cage left open, although younger gorillas may have slept inside for a further day or two

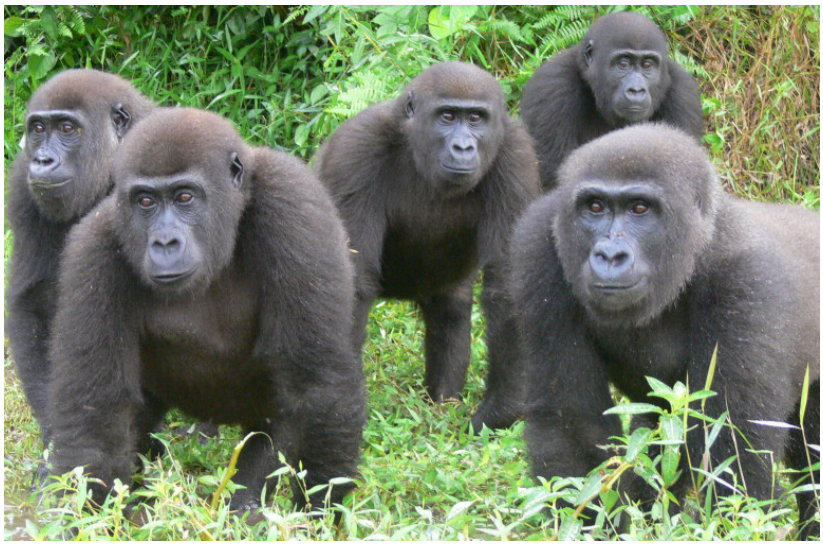

Fig 21. Members of the second group of western gorillas released in the PNPB, Gabon, in February 2007. (Photo: T. King)

9. Post-release Monitoring

Methods

Post-release monitoring of the released groups has been facilitated by the development of an extensive trail system within the release site, with each trail named and features marked at regular intervals to allow precise description of locations (fig 23). Monitoring post-release has been initially intensive, and gradually reduced over many months (Pearson & Percy 2001). Daily supplementary feeding with reconstituted milk continued for 23 and 16 months for the two groups respectively (table 11), with the concentration and quantity given depending on the age of each group member, and the frequency being reduced gradually over time (Pearson & Passaro 2002, Mahé 2006a). Post-monitoring teams, usually of two to four staff members based at the PPG base camp (fig 4), would initially spend much of each day with the group, in a similar manner to during the soft-release phase. With time, the amount of time spent with the gorillas each day was reduced until the post-release monitoring consisted of locating each group (directly or indirectly) on a daily or even weekly basis, and of noting group composition and general health when possible. Staff observations were noted on daily record sheets at the camp, and daily locations were plotted in a geo-referenced database. Post-release veterinary intervention continued when possible and if deemed necessary.

Survival

Following the long soft-release process described earlier, a total of 26 (12.14) gorillas have been released within the PNPB, in two groups consisting of 17 and 9 individuals respectively (tables 14 & 16). Two of these have died post-release (both males), and two others have disappeared, presumed dead (both females). One died only three weeks post-release while the other three died or disappeared between 1.5 and 2.2 years post-release (table 15). Overall confirmed survival is therefore 85% after three years post-release, and is almost identical for wild-born (84%) and captive-born (86%) individuals (table 16). Gorillas released between three and six years of age exhibited slightly higher confirmed survival three years post-release (92%) than did those released between one and three years of age (83%) or those released aged over six years-old (50%, table 17). Eighteen gorillas have so far reached eight years of age (table 18).

Causes of mortality

One of the confirmed mortalities was of a 1.3 year-old wild-born male found in the Mpassa river, almost certainly having drowned after falling from a night nest, only three weeks or so post-release (table 15). The other confirmed mortality was of a 6.4 year-old captive-born male, with unidentified ongoing health problems the cause (table 15), although blood tests had revealed the presence of the malaria parasite *Plasmodium falciparum*. Of the two females to disappear, the younger, at 4.3 years-old, was handicapped on the right side, probably due to bullet damage when she was hunted from the wild. She is thought most likely to have died due to an accident, such as falling from a tree, possibly into water, or maybe due to predation. The fate of the 8.6 year-old female is unknown. She had shown signs of bad health over the previous

two years and had appeared to lose weight, but had also shown signs of a tendency for dispersal (see section 'Dispersal' below).

Table 14. Composition of the two groups of western gorillas reintroduced to the PNPB, Gabon. (Arrival date concerns arrival in the PNPB).

Name	Sex	Origin	Date of arrival	Estimated ages		
				Arrival	Release	Dec 2007
Group 1, released Jan 2001						
Choupette	♀	Ogooué-Maritime	01/02/1999	4.4 yrs	6.3 yrs	disappeared
Kwam	♂	captive-born	01/11/1999	3.8 yrs	4.9 yrs	died
Marco	♂	Haut-Ogooué	01/08/1998	2.3 yrs	4.8 yrs	11.7 yrs
Tonga	♂	Ogooué-Maritime	01/02/1999	2.4 yrs	4.3 yrs	11.3 yrs
Sophie	♀	Estuaire	01/08/1998	1.8 yrs	4.2 yrs	11.1 yrs
Lekedi	♀	Haut-Ogooué	01/08/1998	1.1 yrs	3.5 yrs	10.4 yrs
Kongo	♂	Ogooué-Maritime	05/01/1999	1 yr	3 yrs	9.9 yrs
Moanda	♀	Haut-Ogooué	01/08/1998	3 mo	2.7 yrs	9.6 yrs
Ndjima	♀	Haut-Ogooué	01/02/1999	7 mo	2.5 yrs	9.4 yrs
Otala	♀	Haut-Ogooué	26/05/1999	7 mo	2.3 yrs	9.2 yrs
Ivindo	♂	Ogooué-Ivindo	07/07/2000	1.5 yrs	2 yrs	8.9 yrs
Ngoma	♂	Haut-Ogooué	06/04/1999	3 mo	2 yrs	8.9 yrs
Miyandza	♀	Haut-Ogooué	12/07/1999	5 mo	1.9 yrs	8.9 yrs
Boumango	♂	Haut-Ogooué	07/06/2000	11 mo	1.5 yrs	8.4 yrs
Mboundou	♀	Ogooué-Ivindo	23/10/1999	1 mo	1.3 yrs	8.3 yrs
Opoungou	♂	Haut-Ogooué	25/03/2000	5 mo	1.3 yrs	died
Belinga	♀	Ogooué-Ivindo	07/07/2000	7 mo	1.1 yrs	8 yrs
Group 2, released Aug 2004						
Djalta	♂	captive-born	08/08/2003	5.2 yrs	6.2 yrs	9.5 yrs
Kwibi	♂	captive-born	08/08/2003	4.8 yrs	5.8 yrs	9.1 yrs
Djaltam	♂	captive-born	08/08/2003	4.2 yrs	5.2 yrs	8.5 yrs
Zora	♀	Estuaire	08/12/2002	2.9 yrs	4.5 yrs	7.9 yrs
Kiba	♀	captive-born	08/08/2003	3.4 yrs	4.4 yrs	7.8 yrs
Ama	♀	captive-born	08/08/2003	3 yrs	4 yrs	7.3 yrs
Souba	♀	Haut-Ogooué	19/06/2002	11 mo	3.1 yrs	6.4 yrs
Ima	♂	captive-born	08/08/2003	1.5 yrs	2.5 yrs	5.9 yrs
Tchimbele	♀	Estuaire	19/05/2003	8 mo	1.9 yrs	disappeared

Table 15. Mortality (and presumed mortality) during the post-release phase of the PPG-Gabon reintroduction programme.

Group	Name	Sex	Age at release	Age at death	Post-release survival	Cause of death
Wild-borns						
1	Opoungou	m	1.3 yrs	1.3 yrs	3 weeks	Drowned
1	Choupette	f	6.3 yrs	8.6 yrs	2 yr 3 mo	Disappeared
2	Tchimbele	f	1.9 yrs	4.3 yrs	2 yr 4 mo	Disappeared
Captive-borns						
1	Kwam	m	4.9 yrs	6.4 yrs	1 yr 6 mo	Health problems

Table 16. Numbers and survival rates of gorillas entering different phases of the PPG Gabon reintroduction programme, 1998 to 2007.

	Soft-release	Release	Alive Dec 2007	Soft-release survival	Post-release survival	Overall success
Group 1, released January 2001						
wild-born	17	16	14	94%	88%	82%
captive-born	2	1	0	50%	0%	0%
Group 2, released August 2004						
wild-born	3	3	2	100%	67%	67%
captive-born	7	6	6	86%	100%	86%
Combined						
wild-born	20	19	16	95%	84%	80%
captive-born	9	7	6	78%	86%	67%
Total	29	26	22	90%	85%	76%

Table 17. Impact of age at release on post-release survival of western gorillas reintroduced to the PNPB, Gabon.

Age at Release	Total released	Mortality 1st year	Mortality 1-3 yrs	Survival >3 yrs
1-3 years	12	1 (8%)	1 (8%)	10 (83%)
3-6 years	12	0	1 (8%)	11 (92%)
6-8 years	2	0	1 (50%)	1 (50%)
Total	26	1 (4%)	3 (12%)	22 (85%)

Table 18. Survival to 8 years-old of western gorillas reintroduced to the PNPB, Gabon (Dec 2007).

	Survival (age)								
Age at release	1-3 yrs old		3-6 yrs old		6-8 yrs old		8+ yrs old		total
	died	alive	died	alive	died	alive	died	alive	
1-3 years	1	0	1	1	0	0	0	9	12
3-6 years	-	-	0	0	1	4	0	7	12
6-8 years	-	-	-	-	0	0	1	1	2

Health

Apart from the two mortalities most likely due to health problems (see above), post-release health has otherwise been good in both reintroduced groups, contributing to the high post-release survival rate. Some post-release deworming has been undertaken, as stool sampling of both groups have found fairly high loads of nematode eggs (either *Oesophagostomum* or *Ankylostoma* sp.), and oesophagostome infestation was shown to have led to at least one mortality during the soft-release phase of the programme (see page 33). Both groups regularly suffer the inconvenience of tick and mite colonies, especially around the eyes, and of tumbu (or mango) blow-fly larvae (*Cordylobia anthropophaga*) feeding in and under the skin, but neither of these parasites appear to cause any health problems (fig 22).

Fig 22. Parasites such as a) tumbu blow-fly larvae (*Cordylobia anthropophaga*) and b) ticks and mites especially around the eyes, may cause discomfort but appear not to cause health problems. (Photos: L. Pearson (a), A. Courage (b))

Accidental falling from trees has caused some major injuries, particularly within group 1 during the first year post-release, resulting in a broken arm, a broken leg and a cracked skull amongst the most serious injuries (table 19). The female gorilla with the cracked skull would surely have died without the intensive care provided by PPG staff, while one mortality is almost certainly due to drowning after falling from a tree (table 19).

Table 19. Reported cases of gorillas falling from trees during the first year post-release of group 1, PNPB.

Name	Date	Est. age	Notes
Marco	13/01/2001	4 yr 9 mo	fell from tree and broke right femur - given pain killers for 4 days; after 1 month he was putting weight on the leg again.
Opoungou	28/01/2001	1 yr 3 mo	found dead in river under tree used as night-nest by group, presumed to have fallen from tree and drowned.
Boumango	23/02/2001	1 yr 7 mo	fell from tree onto his stomach, had difficulty breathing for 30 minutes - no treatment.
Miyandza	06/10/2001	2 yr 8 mo	fell from night-nest in tree, with Ndjima, a piece of wood cracking open her skull and lodging in the brain - removed from the group for removal of wood and two weeks intensive care.
Ndjima	06/10/2001	3 yr 3 mo	fell from night-nest in tree, with Miyandza, breaking her right arm just above elbow – treated with dolipran and nilfluril for 2 weeks.

Home range size

The daily location information collected by the post-release monitoring team has been incorporated into a spatially referenced database to allow calculation of ranging behaviour for each group since release. We present here ranging data to the end of April 2007. To aid the analysis of the data, the release site was split into several zones, demarcated on the ground by the extensive system of trails established over the years to aid the monitoring (fig 23). The use of such zoning of the area allows the general location of the groups to be noted even when the exact location is unclear, based on indirect observations such as presence or absence of recent or old tracks and other signs.

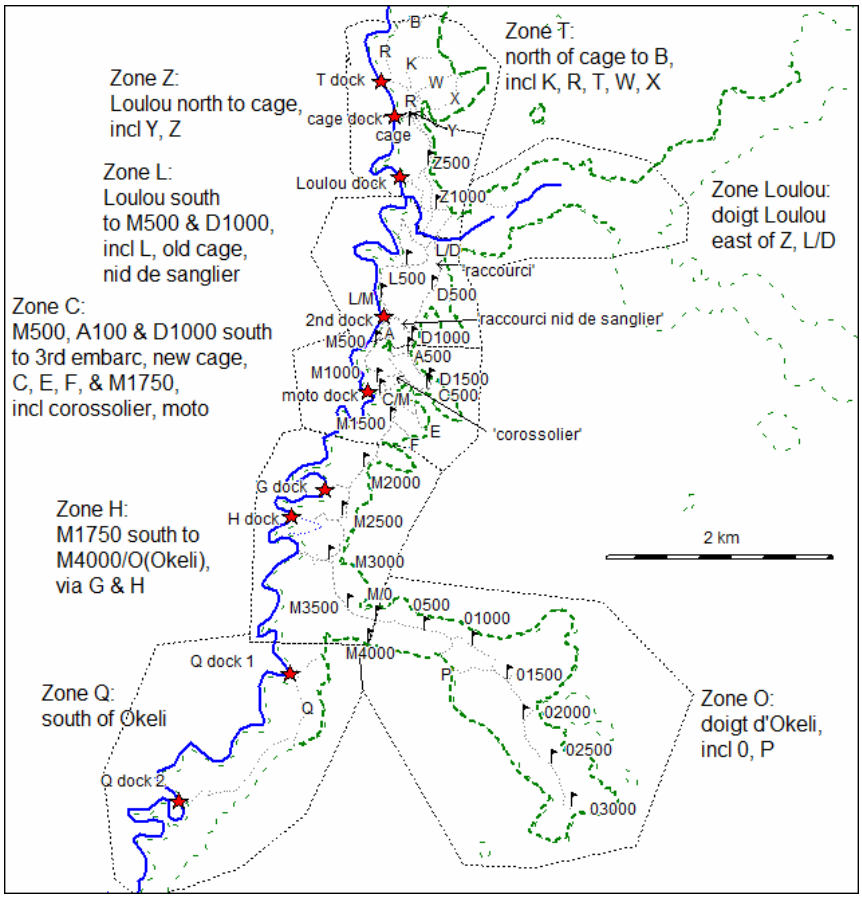

Fig 23. Zonation of release site using trail system developed for post-release monitoring.

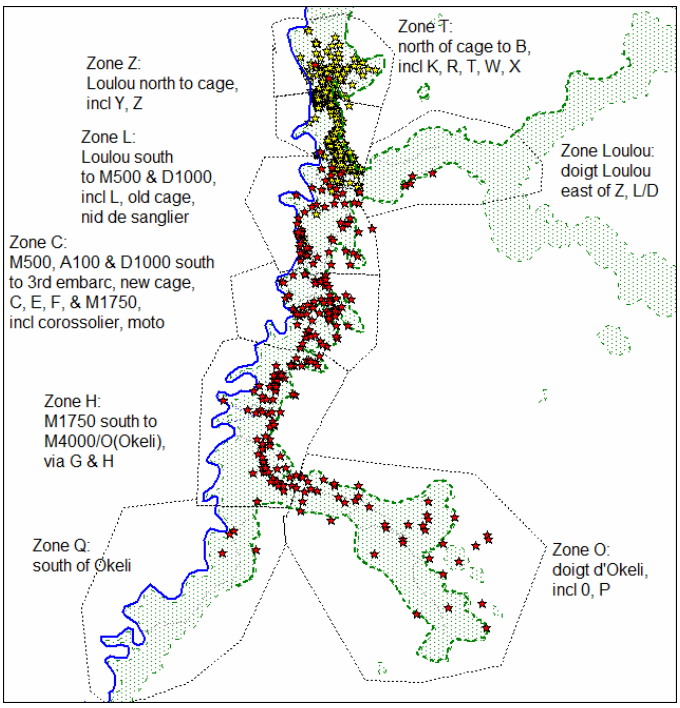

Fig 24. Direct daily location observations for the year 2006 (group 1 in red, group 2 in yellow), overlayed onto the digital map of forest cover and zones of the reintroduction site.

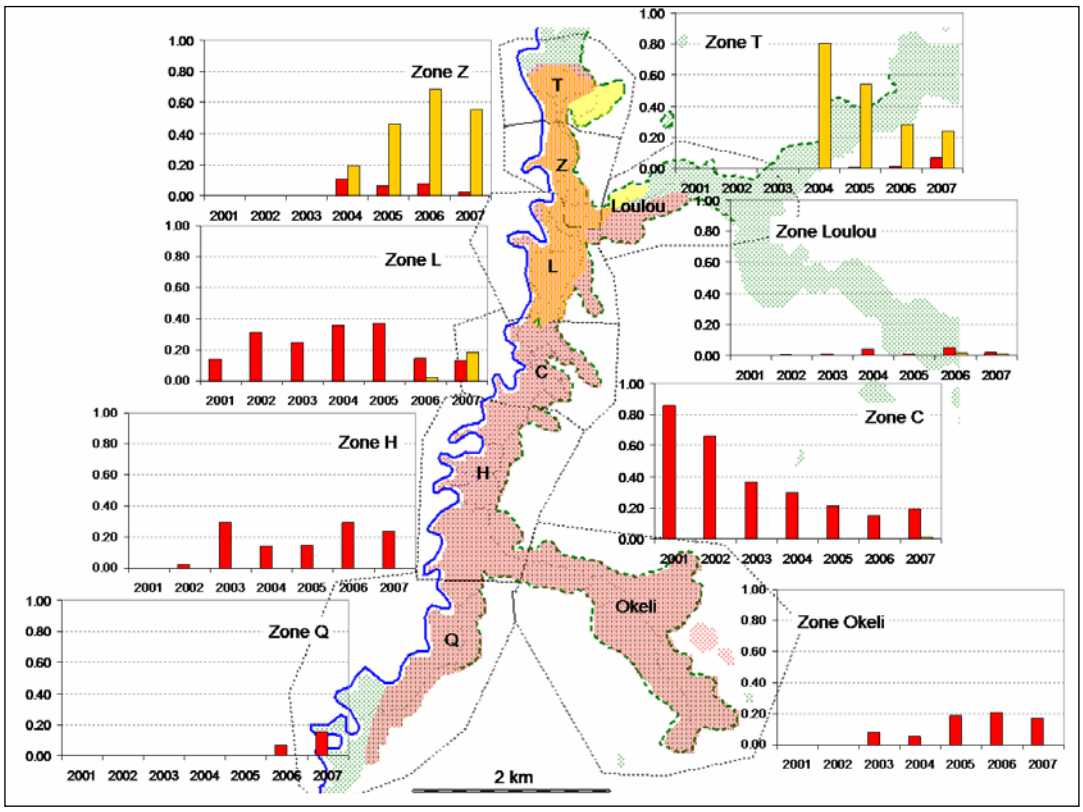

Fig 25. Annual home range utilisation by group 1 (in red, released Jan 2001 in zone C) and group 2 (in yellow, released Aug 2004 at the border of zones T & Z); 2007 data is for the first four months only.

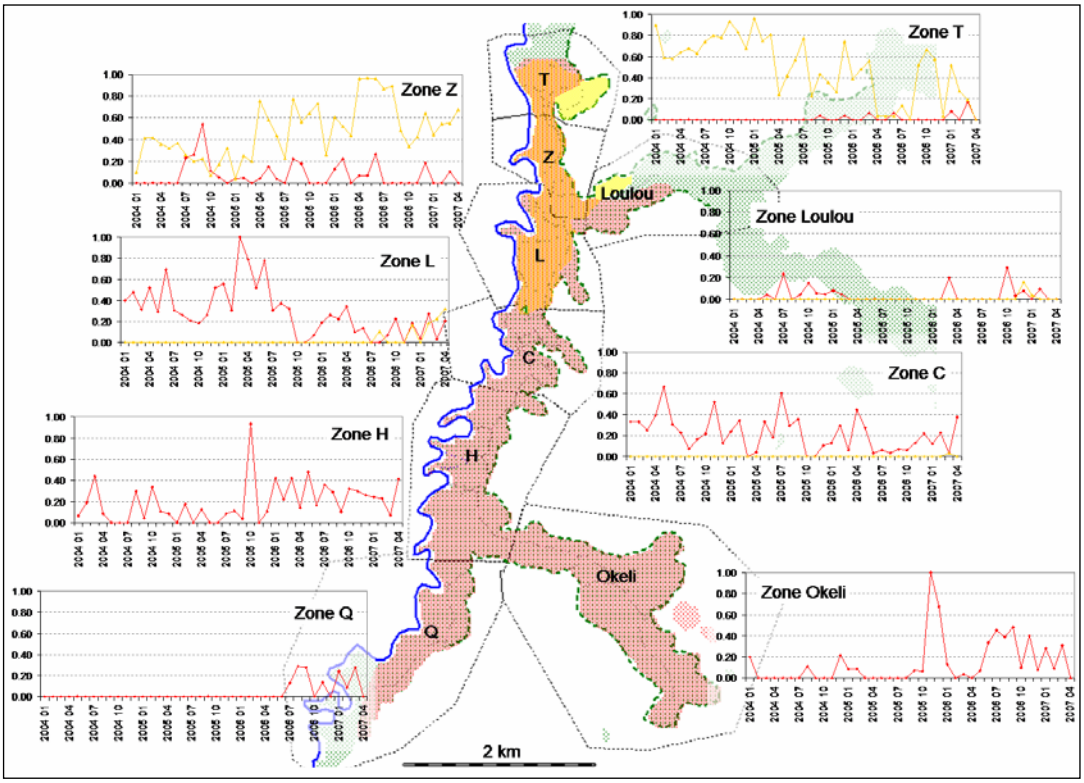

Fig 26. Monthly home range utilisation by group 1 (in red) and group 2 (in yellow) from January 2004 to April 2007.

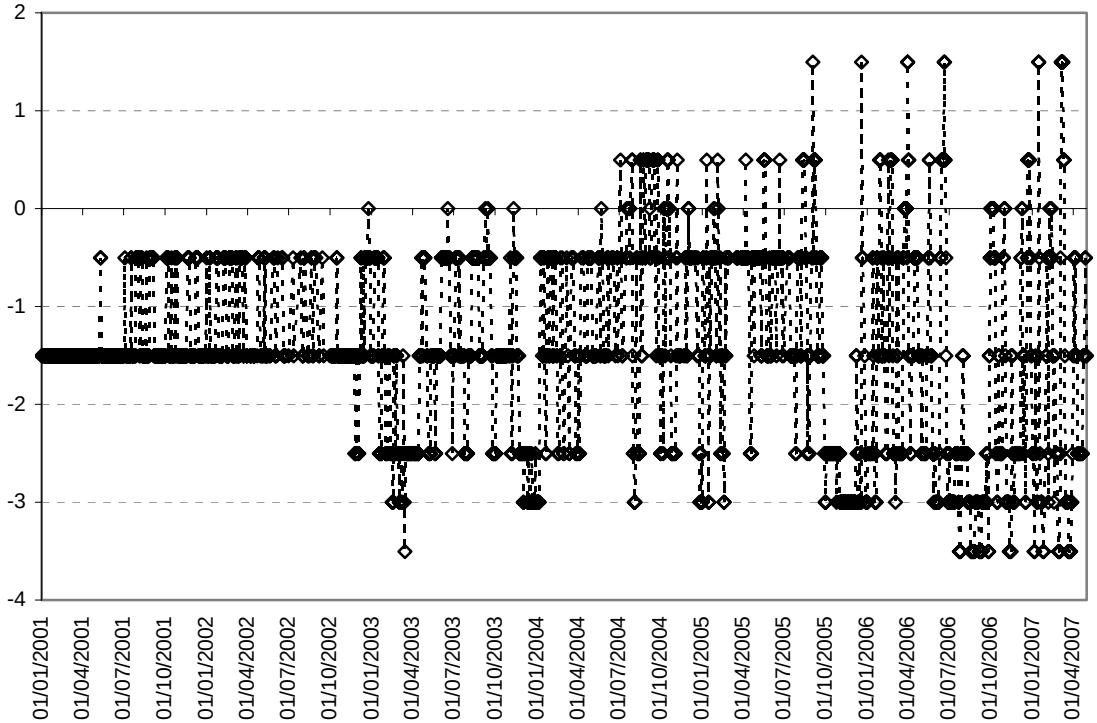

Fig 27. Zonal daily locations of group 1 from Jan 2001 (release date) to 30 Apr 2007, north (>0) and south (<0) of the Loulou river. (Zones given numerical values relative to the Loulou river: T (1.5), Z (0.5), east Loulou (0), L (-0.5), C (-1.5), H (-2.5), Okeli (-3), Q (-3.5)).

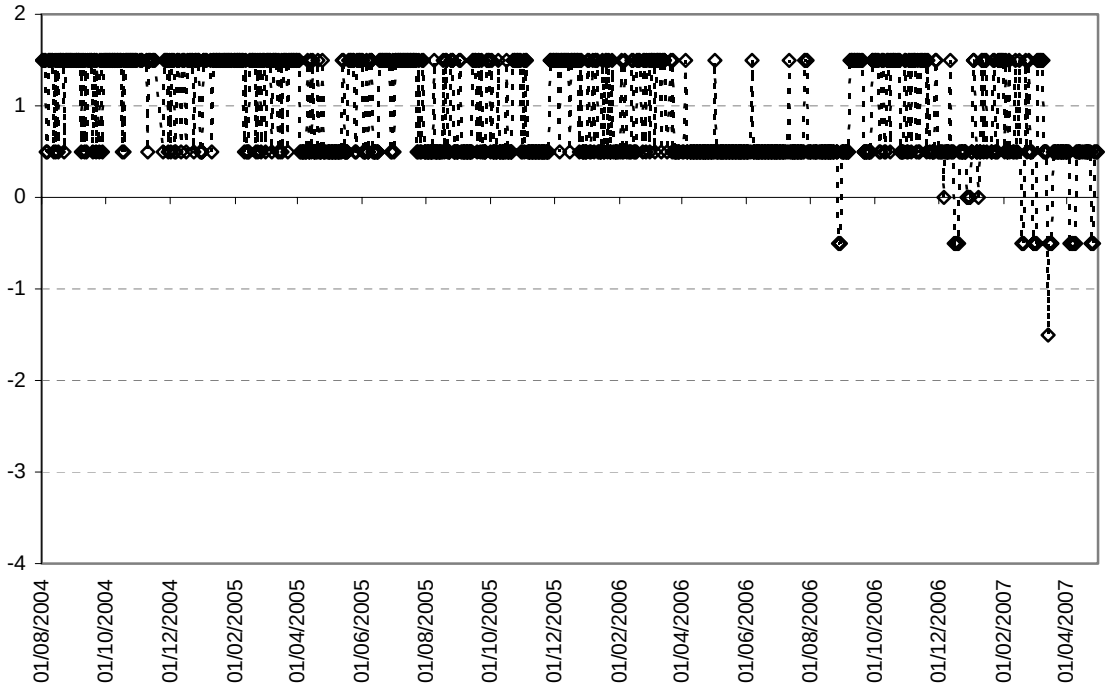

Fig 28. Zonal daily locations of group 2 from Aug 2004 (release date) to 30 Apr 2007, north (>0) and south (<0) of the Loulou river. (Zones given numerical values relative to the Loulou river: T (1.5), Z (0.5), east Loulou (0), L (-0.5), C (-1.5), H (-2.5), Okeli (-3), Q (-3.5)).

Calculation of home range sizes was undertaken by overlaying the daily location observations onto a digital map of forest cover within the PNPB digitised from satellite maps (fig 24). The home range figures therefore only include forest area – while both groups do forage in the wooded grassland bordering the gallery forests, and will often travel through grassland rather than struggle through thick forest, the extent of grassland utilised is minimal compared to that of forest. Following release, both groups remained initially within the zones that they had explored during the soft-release phase (group 1: L & C zones; group 2: T & Z zones) (table 20). After the first year or so post-release, annual and cumulative forest area within the home ranges of both groups has increased slowly but gradually, to a cumulative total of 5.6 and 1.4 km² for each group as of April 2007 (table 20). Both groups have considerably increased their ranging further during the remaining months of 2007.

Table 20. Forest area (km²) within each zone utilised each year post-release by group 1, Jan 2001 to Apr 2007, and group 2, Aug 2004 to Apr 2007.

Forest zone	Forest area utilised in each zone per year (km²)						
	2001	2002	2003	2004	2005	2006	2007 to Apr
Group 1							
T zone					0.1	0.1	0.3
Z zone				0.2	0.3	0.3	0.3
east Loulou			0.1	0.2	0.2	0.2	0.2
L zone	0.4	0.6	0.6	0.6	0.6	0.6	0.6
C zone	0.4	0.5	0.5	0.5	0.5	0.5	0.5
H zone		0.1	1.1	1.1	1.1	1.1	1.1
O zone			0.7	0.6	1.1	1.7	1.7
Q zone			0.0			0.3	0.7
Total annual range	0.8	1.3	3.1	3.1	3.9	5.0	5.6
Cumulative range	0.8	1.3	3.1	3.3	3.9	5.0	5.6
Group 2							
T zone				0.4	0.3	0.5	0.4
Z zone				0.1	0.2	0.3	0.3
east Loulou							0.1
L zone						0.2	0.5
C zone							0.0
Total annual range				0.5	0.6	1.1	1.3
Cumulative range				0.5	0.6	1.1	1.4

Home range utilisation

A major natural feature that acts as a semi-boundary within the release site is the Loulou river (fig 23). Crossing points available to the gorillas are rare towards the confluence with the Mpassa river, requiring tree-falls to form natural bridges, but become increasingly frequent further east along the Loulou, as the opposing canopies become increasingly interconnected. The Loulou has therefore acted to some extent as the northern limit of the home-range of the first released group, and the southern limit of the second, certainly during the soft-release phase for both groups when staff were

unable to cross therefore influencing ranging, and also in the initial years following release. The home range of the first group was therefore centred initially in the 'C' and 'L' zones, south of the Loulou, while that of the second group in the 'T' and 'Z' zones north of the Loulou (figs 25 - 28, tables 20 & 21). With time, both groups have crossed the Loulou, extending their ranging into what is effectively the core home range of the other group, but as of April 2007, both still spend the majority of their time on their respective sides of the Loulou river (table 21, figs 25 - 28). Neither group has yet spent much time exploring the Loulou gallery forest eastwards (figs 25 & 26, table 21).

Table 21. Proportion of time spent annually post-release by each reintroduced group in zones to the north, east, south and far south of the Loulou river (note that group 2 was released in August 2004).

Zones in relation to	Proportion of time spent in each zone per year						
Loulou river	2001	2002	2003	2004	2005	2006	2007 to Apr
Group 1							
North (T & Z)				0.10	0.07	0.09	0.10
East (east Loulou)			0.01	0.04	0.01	0.05	0.02
South (L, C & H)	1.00	1.00	0.91	0.80	0.73	0.58	0.56
Far south (O & Q)			0.08	0.05	0.19	0.28	0.32
Group 2							
North (T & Z)				1.00	1.00	0.96	0.80
East (east Loulou)						0.01	0.01
South (L, C & H)						0.02	0.19
Far south (O & Q)							

Daily ranging

Daily path lengths (dpl) have rarely been recorded for either released group, to ensure that post-release monitoring methods have a minimal impact on the ranging behaviour of the gorillas. However, a good indication of daily ranging can be obtained by comparing the zonal location of the group on consecutive days, and calculating the difference between the numerical values given to each zone relative to their distance from the Loulou river (see fig 27 for values). The average daily difference for each month for group 1, between 2003 and 2006, is given in fig 29. Apart from 2004, where group ranging appears to have been heavily influenced by the release of group 2, fig 29 shows a general trend of more movement between zones in the months December to March than during the rest of the year. However, as shown in fig 27, the group is still expanding its home range over time, indicating that the group does not yet have a stable home range established. It is therefore difficult to differentiate ranging based on environmental factors such as rainfall or fruiting seasons from simple range size increases with increased time from release. This is even more evident for group 2 (fig 28), and so analysis of daily ranging is not presented here for this group.

Another method for illustrating daily ranging is straight-line distances between daily locations. The longest straight-line distance so far recorded between two sight observations on consecutive days is 4.9 km for group 1 on 21 January 2006. This is an

underestimation of the total distance travelled by the group on this occasion, as the straight-line route passes through extensive savanna grassland far from the gallery forest; the actual distance travelled between the two locations would have been at least 5.5 km.

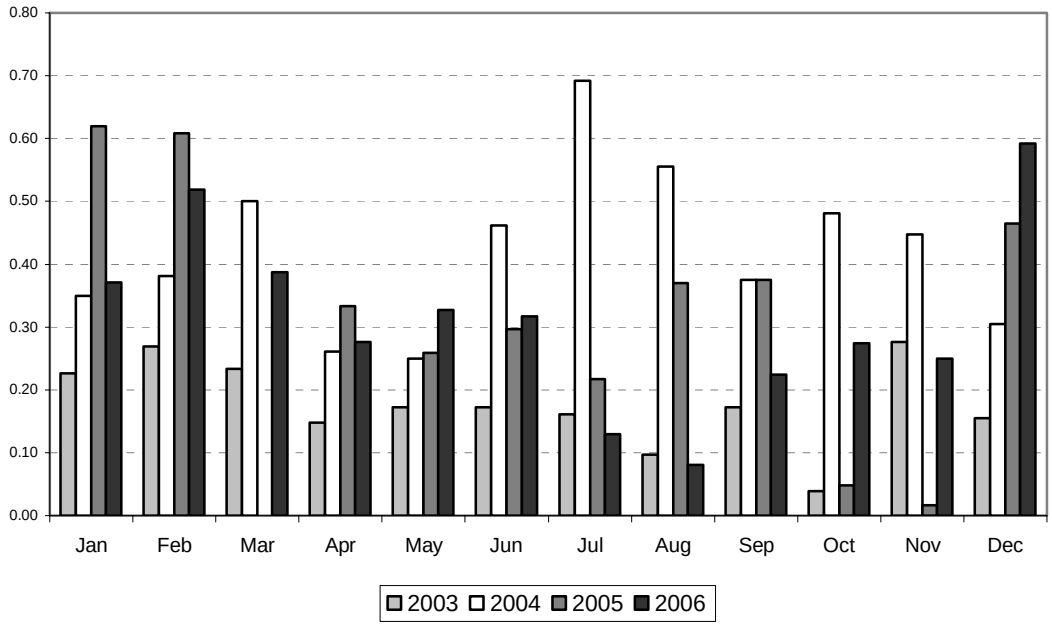

Fig 29. Index of relative daily ranging by group 1 each month, 2003 to 2006. (Index calculated as average difference between daily zonal locations given numerical values relative to the distance to the Loulou river (see fig 27 for explanations)).

Intergroup encounters

Although the home-ranges for the two released groups are to some extent separated by the Loulou river (figs 25 & 26), both groups have crossed the Loulou on numerous occasions to spend brief periods of time within the core home-range of the other group (figs 30 & 31). This has resulted in the two groups being located in the same zone of the reintroduction site on a number of occasions since September 2004 (fig 32). It is unclear how often this proximity has led to intergroup encounters, either direct or indirect, as few direct observations have been made.

The first direct encounter between the groups is known to have occurred in September 2004, only one month after the release of group 2, to the north of the Loulou river (Mahé 2006a). The exact details of the encounter are unknown, but it is evident that both groups fled, with group 1 returning to the south side of the Loulou river the same day, and group 2 splitting temporarily into two, but reuniting by the end of the day (Mahé 2006a). Both groups were visited the following day, and no injuries were observed (Mahé 2006a). Minor injuries have been observed following subsequent probable encounters, but it is unknown whether these were caused by intra- or inter-group relations.

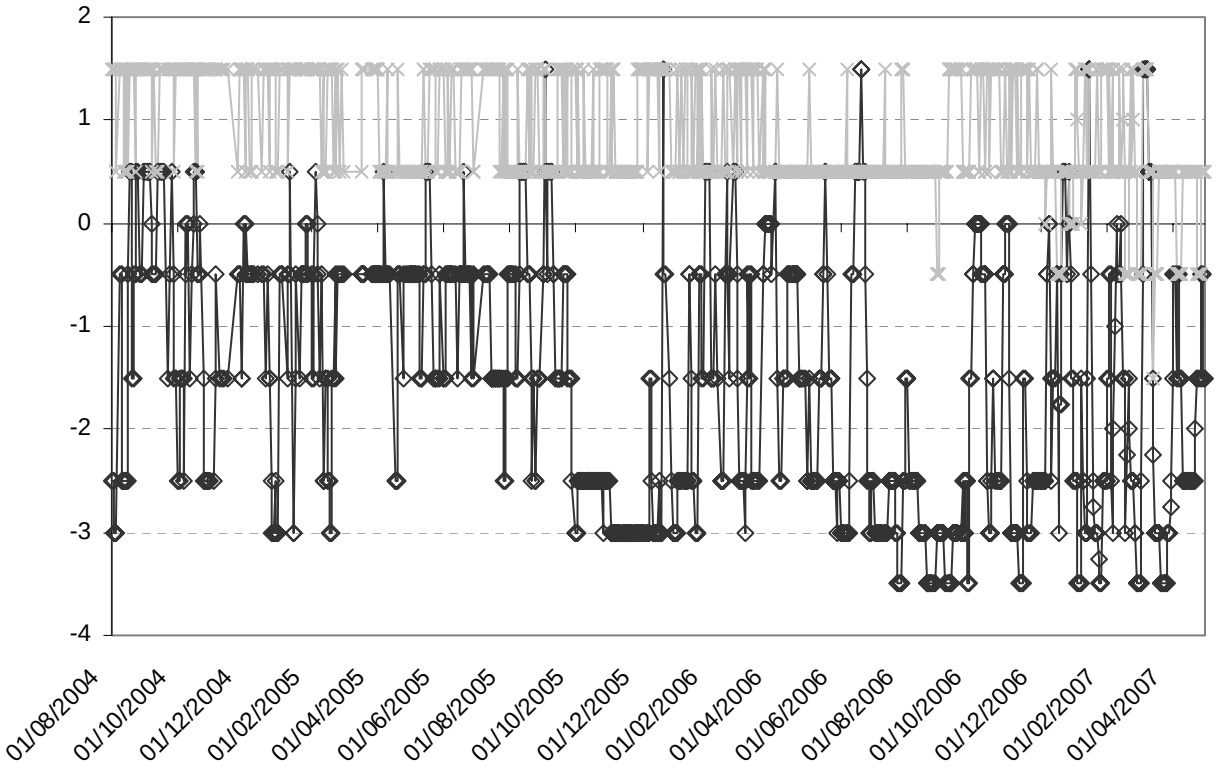

Fig 30. Zonal daily locations of group 1 (in black) and group 2 (grey) from Aug 2004 to Apr 2007, north (>0) and south (<0) of the Loulou river, showing relative distances between the two groups on each day. (See fig 27 for definition of zonal locations).

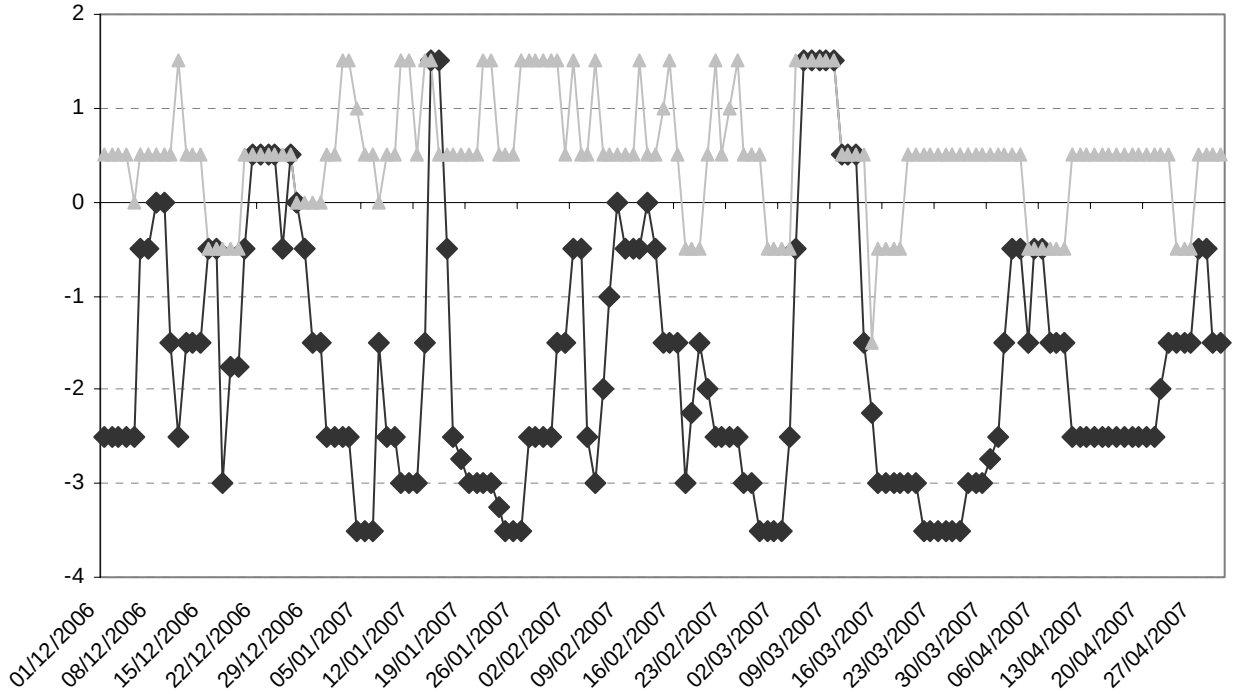

Fig 31. Zonal daily locations of group 1 (in black) and group 2 (grey) from 1 Dec 2006 to 30 Apr 2007, north (>0) and south (<0) of the Loulou river, showing relative distances between the two groups on each day.

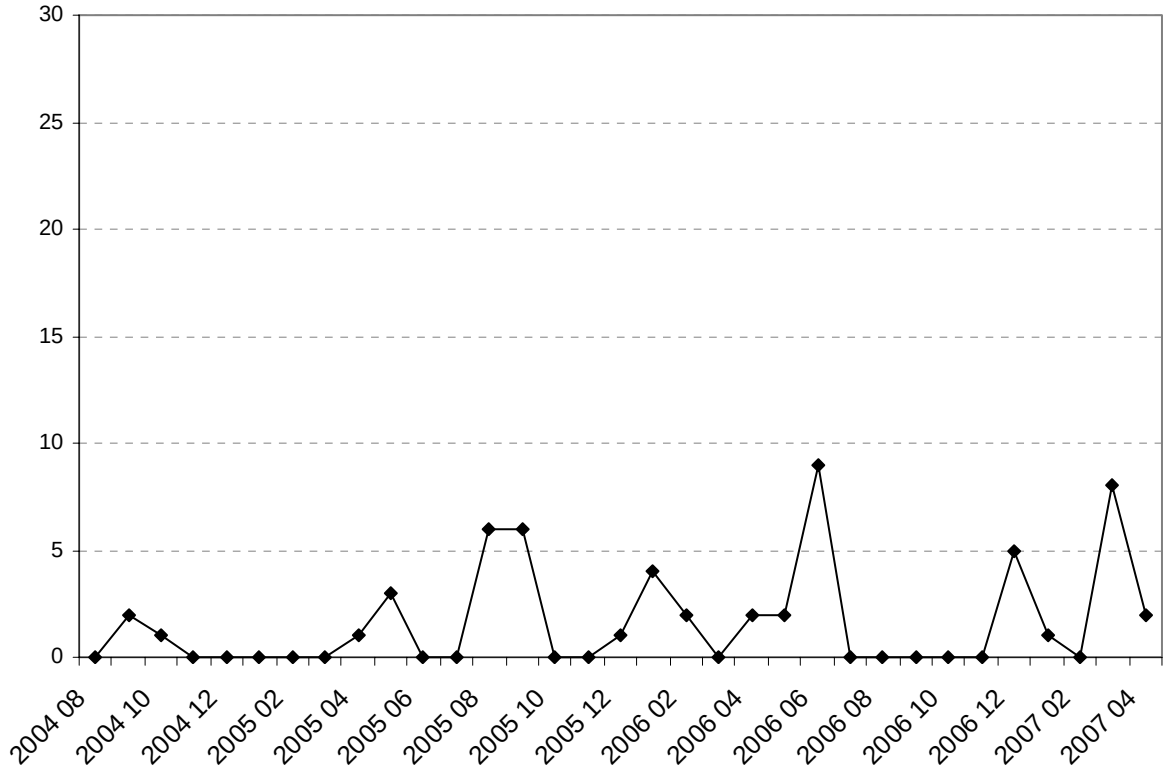

Fig 32. Number of days per month the two reintroduced gorilla groups were thought to be located in the same zone, PNPB, Gabon, Aug 2004 to Apr 2007.

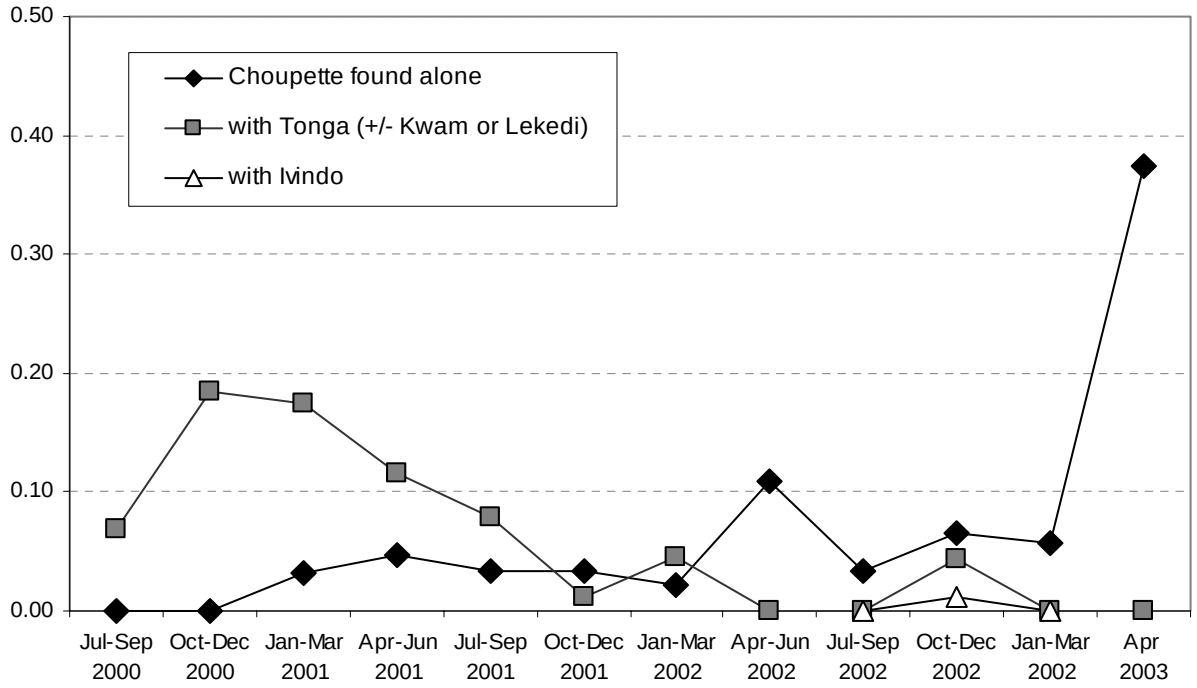

Fig 33. Proportion of days the eldest female of group 1 (Choupette) was found apart from the majority of her group between July 2000 and her disappearance in April 2003.

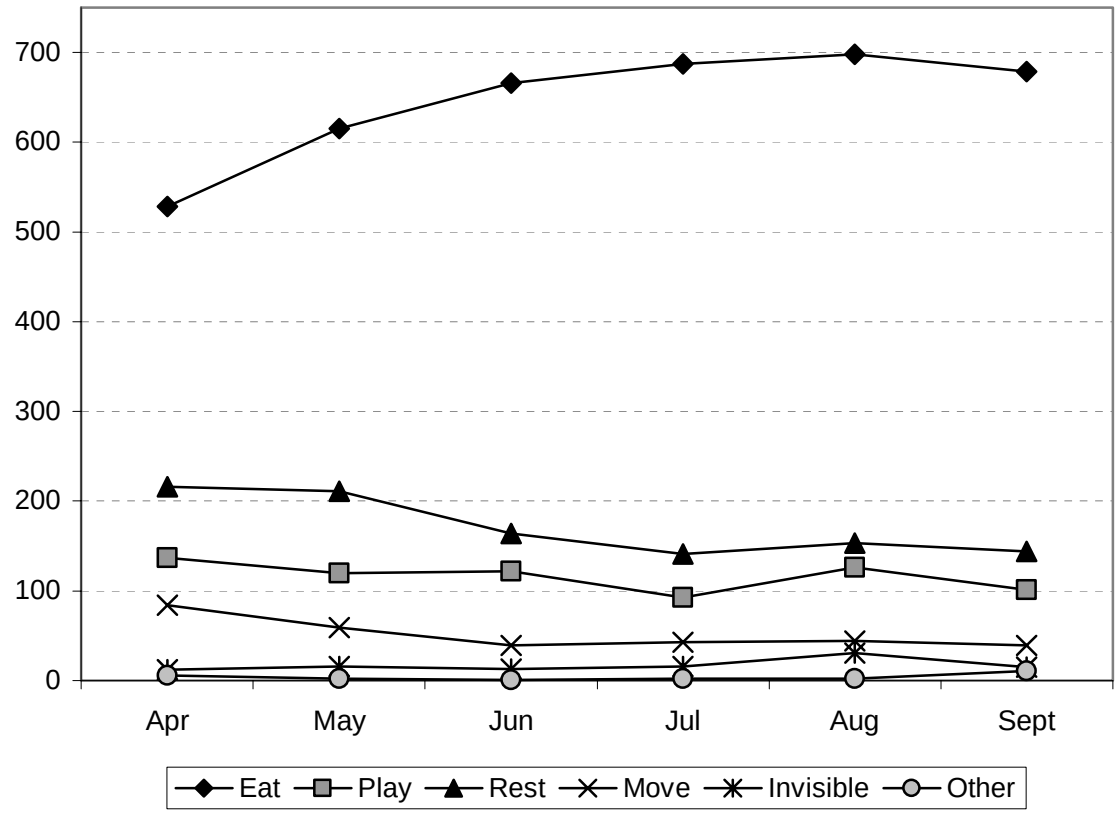

Fig 34. Monthly activity scores during focal sampling of group 1, Apr – Sep 2001 (from Pearson & Percy 2007).

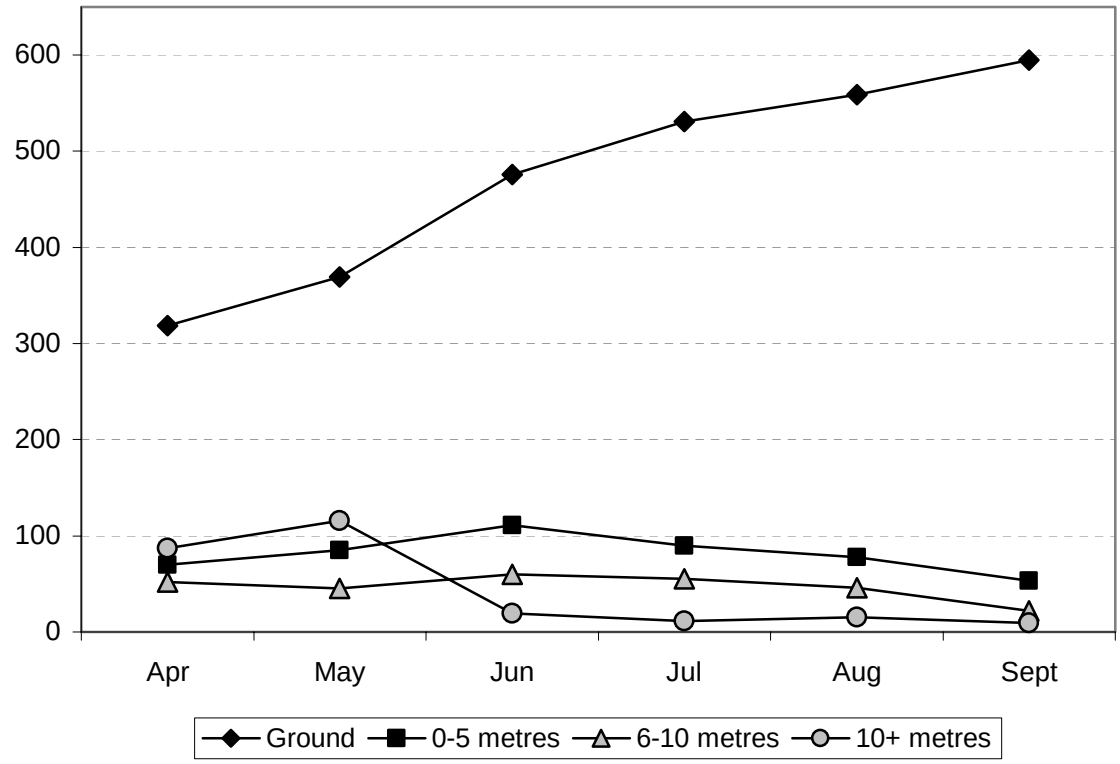

Fig 35. Monthly scores for height of feeding activity during focal sampling of group 1, Apr – Sep 2001 (from Pearson & Percy 2007).

Dispersal

In wild gorilla populations, the majority of males and females disperse from their natal group, generally between the ages of 7 and 10 years for females, and 10 and 15 years for males (Harcourt & Stewart 2007). The PPG Gabon reintroduction programme is still relatively young considering the long and slow life-histories of gorillas, but some of the males are now approaching the age where dispersal may be expected, while several females might have dispersed already but for the lack of opportunities for transfer to another group. While typical male emigration or female transfer events have not yet been observed, three cases of females separating from their groups within the age-range of the majority of natal dispersal events in wild female gorillas may indicate a tendency to dispersal (table 22). The disappearance of the eldest (Choupette) followed a period of 27 months during which she was often found separated from her group, initially usually accompanied by a young male (Tonga) with whom she had spent a considerable time in captivity before arrival, but in the final year more often alone (fig 33), although during this period she also often showed signs of tiredness and weight-loss, suggesting that illness may be the most likely cause of her disappearance.

Table 22. Cases of possible female dispersal amongst reintroduced gorillas in the PNPB, Gabon.

Name	Date	Est. age	Notes
Choupette	Apr 2003	8 yr 7 mo	Disappeared, presumed dead. Had been found alone or with Tonga (male) fairly often during the previous 27 months.
Lekedi	Oct 2005	8 yr 3 mo	Alone for six weeks or more before rejoining group. No previous instances of lone behaviour.
Zora	Aug 2007	7 yr 6 mo	Disappeared; found alone 3 months later in good health, and returned to original group.

Activity budgets and behaviour

As has been mentioned above, the daily time spent with each group during post-release monitoring has been gradually reduced to decrease the potential human influence on behaviour. Therefore opportunities for activity budget and behavioural studies are limited to the soft-release phase, and the initial year or so post-release. Such studies have been carried out on both released groups, for just over a year each, before or soon after release (table 23). A variation on focal animal sampling was used for these studies, with specific individuals selected for data collection each day (two per day for group 1, five per day for group 2) (Pearson & Percy 2007). Behaviours were recorded using instantaneous recording, every 30 minutes from 08h00 to 16h00 for group 1, and every 15 minutes for group 2, generally from 09h00 and ending between 14h00 and 16h00 (Pearson & Percy 2007). One of five behavioural categories was noted for each of the focal gorillas at each sample instant, these being 'Move', 'Eat', 'Play', 'Rest' and 'Other', and a score was given for 'Height' off the ground, '1' representing on the ground, '2' from 0-5 m above the ground, '3' from 6-10 m, and '4' higher than 10 m (Pearson & Percy 2007). The name, or a description, of foods utilised, and for group 2, the part of each food plant eaten (ie fruit, leaf, stem etc), was also noted (Pearson & Percy 2007).

Table 23. Comparison of group details during behavioural studies of the two groups of reintroduced gorillas in PNPB, Gabon (modified from Pearson & Percy 2007).

	Group 1	Group 2
Release date	Jan 2001	Aug 2004
Sample period	Apr 2001 to Apr 2002	Dec 2003 to Feb 2005
Group size	16	9
Sex ratio	7.9	4.5
Male age-range	2.5 to 6 years	3 to 6.5 years
Female age-range	2 to 7 years	2 to 5 years

Both studies await full analysis, but Pearson & Percy (2007) present some preliminary results arising from the study of group 1. Overall activity scores showed that the gorillas spent most of their time feeding (65-69%), while resting (15-17%) and playing (11-14%) took up much of the remainder of their time. Their initial analysis suggested that the gorillas spent more time feeding, and less time moving and resting, during Jun to Sep 2001 than they did during Apr and May of the same year (fig 34). This result could be related to fruit-availability, as wild western gorillas have been shown to travel further during periods of high-fruit availability (Tutin 1996), while in periods of low-fruit availability they spend more time feeding on low herbaceous vegetation (White *et al.* 1995, Kuroda *et al.* 1996). Although requiring more robust analysis, Pearson & Percy (2007) note that this theory is further supported by the observation that the group spent more of their feeding time on the ground during Jun to Sep than during Apr and May (fig 35). They also found that the dominant male (Marco) had the highest combined scores for 'play' during both survey periods, while the eldest female (Choupette) and the eldest male (Kwam) had the lowest.

Fig 36. Reintroduced gorillas feeding on low herbaceous vegetation in the PNPB, Gabon: a) Marantaceae sp.; b) *Palisota* sp. (Commelinaceae). (Photos: L. Pearson)

Diet

The reintroduced groups have been observed to utilise over 50 species of plants as food items, of which Mahé (2006a) gives preliminary identifications for about 30. Many species remain unidentified, and it is likely that many more food plants are utilised that have not yet been observed, particularly those high in the forest canopy; for example, reintroduced gorillas in Congo have been observed to utilise over 100 plant species (Mbani Akangala 1998). As has been observed in wild western gorilla

populations, the reintroduced groups feed greatly on fruit when it is available (fig 37), while in periods of low fruit availability they eat higher quantities of non-fruit items, particularly low terrestrial vegetation of the Marantaceae, Zingiberaceae and Commelinaceae families (Mahé 2006a, fig 36), but also flowers, bark and even sap (fig 38). Despite the larger home-range of group 1, preliminary analysis indicated similar seed diversity in faecal samples from the two groups (J. Paredes, in. litt.).

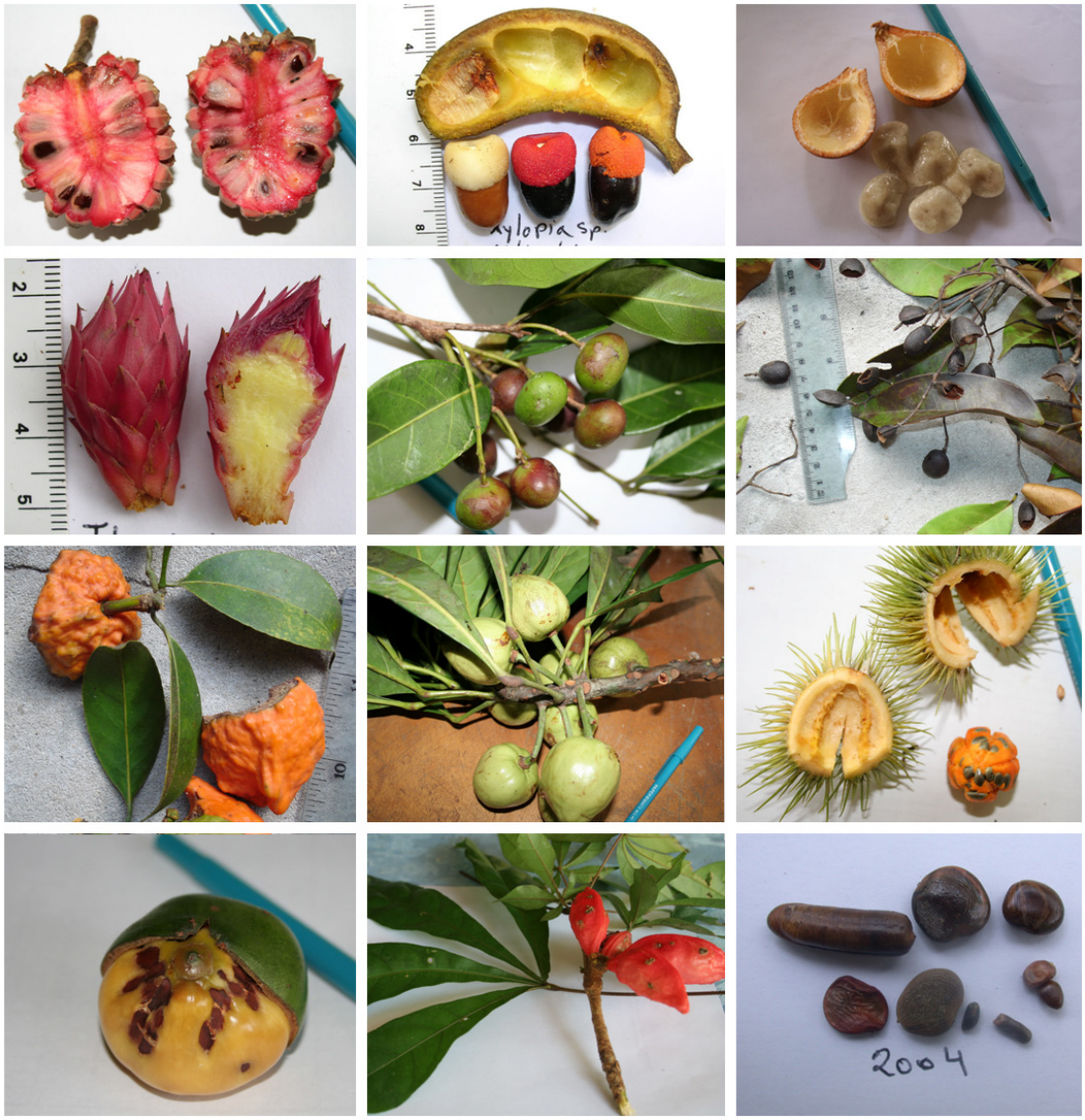

Fig 37. Various food plants utilised by the reintroduced gorillas in the PNPB, Gabon: a) *Pachypodanthium staudtii* (Annonaceae); b) *Xylopia* sp. (Annonaceae); c) *Landolphia* sp. (Apocynaceae); d) *Thonningia sanguinea* (Balanophoraceae); e) *Santiria trimera* (Burseraceae); f) *Dialium* sp. (Caesalpiniaceae); g) *Salacia* cf *mayumbensis* (Celastraceae); h) *Uapaca* cf *heudelotii* (Euphorbiaceae); i) *Caloncoba welwitschii* (Flacourtiaceae); j) *Ongokea gore* (Olacaceae); k) *Cola* sp. (Sterculiaceae); l) various unidentified seeds from the stool of group 1, May 2004. (Photos: J. Paredes, S. Mahé, L. Pearson, H. Quetier)

Fig 38. A variety of food items supplement the principally frugivorous and foliovorous diet of the reintroduced gorillas, including: a) flowers of *Palisota* sp.; and b) sap of an Apocynaceae vine. (Photos: L. Pearson)

Reproduction

There has been one baby born to date within the released groups (fig 39), with most of the release stock only recently reaching adulthood or still immature (table 14). The baby was observed for the first time on the 5 October 2007, during regular post-release monitoring of group 1 (Pearson & King in press). The mother is the second-eldest female in the group (Lekedi), aged 10.2 years at the time of the birth. The identity of the father is unknown. However, it is likely to be the dominant male in the group (Marco, 11.5 years at the time of the birth), although all five other males in the group could theoretically be the father, aged from 8.2 to 11 years at the time of the birth. The identity of the father will only be established through future genetic paternity testing.

Fig 39. The first baby born within the reintroduced gorilla population in the PNPB, Gabon, photographed here the 22 October 2007, 2.5 weeks after the first sighting on the 5 October. (Photos: S. Ognele)

10. Conclusions

Ten years since the conception of PPG-Gabon, and seven since the first release, the ambitious programme to reintroduce the critically endangered western gorilla to the Batéké Plateau National Park (PNPB) of Gabon is still young when considering the long and slow life-history of the species. The first birth within the reintroduced population, in early October 2007, is an indication of the successful adaptation of the release stock to the release site, while the cohesion of the two released groups indicates the successful development of social relationships between gorillas from a wide range of backgrounds. It is still too early to judge the programme in terms of overall reproductive success, and it will be many years before the aim of re-establishing a viable, self-sustaining population within the former range of the species may be achieved.

At the present time a measure of reintroduction success might be made through comparison of post-release survival rates with other reintroduction projects, although this should be done cautiously due to the differing methods in project implementation, assessment and species. The post-release survival of both wild-born and captive-born gorillas in the PNPB (84 and 86% respectively) are higher than any of the confirmed survival rates of other primate species in a number of release projects around the world for which published data was found, which vary from <10% in the least successful to around 62 to 82% in the most successful (table 24). Captive-born primates have generally had lower post-release survival than wild-borns, a striking example being demonstrated by the well-known golden lion tamarin reintroduction project, with reintroduced captive-borns exhibiting a 70% mortality rate in the first year post-release, while translocated wild groups showed an 82% survival rate per year (Kierulff *et al.* 2002). The high survival rate of the second group of *ex-situ* captive-born gorillas transferred from the UK to Gabon, at 86% during the soft-release phase and 100% during the first three years post-release, has undoubtedly been due to changes in release preparation and implementation based on the experience gained with the first group. The most significant of these changes were the longer duration of psychological and veterinary support from well-known humans, the higher proportion of captive-borns to wild-borns within the group, and possibly the timing of transfer and the administration of a 7-month anti-malarial treatment.

Another comparison of survival rates that could be made is proposed by Beck *et al.* (2007), who suggest that ‘ideally, survival prospects of released apes should approach those of wild apes of the same age and sex’. Infant mortality to three years of age in wild western gorillas has been recorded at levels varying from 22% to 65% (Robbins *et al.* 2004), and overall survival to adulthood in eastern gorillas in the Virungas is reported to be 60% (Robbins 2006 in Harcourt & Stewart 2007). Therefore the survival of released gorillas at PPG-Gabon is at least as good as, if not better than, wild gorillas, with an 83% survival rate of gorillas released at between 1 and 3 years-old, and currently only 14% of released individuals dying before reaching 8 years-old.

Preliminary analysis of ranging and foraging behaviour also show similarities with wild western gorilla populations. During the dry season, released gorillas were found to spend more time feeding, and more feeding-time on the ground, than during the wet season. This observation reflects the habits of wild western gorillas, who have been shown to reduce ranging and feed more on low herbaceous vegetation during the dry

season, when fruit-availability is low (White *et al.* 1995, Kuroda *et al.* 1996). As of April 2007, annual and cumulative home range sizes for both groups are still small compared to wild western gorillas, but both groups are continuing to expand their ranges, in a gradual manner over several years post-release.

Table 24. Post-release survival within a selection of primate release programmes.

Species	Primary release stock	Number released	Confirmed survival	Notes
Western gorilla *Gorilla g. gorilla*	captive wild-borns	22	82% after 3-8 years	1
Chimpanzee *Pan troglodytes*	captive wild-borns	37	62% after 2-8 years	2
Bornean gibbon *Hylobates muelleri*	captive wild-borns	122+	<10%	3
White-handed gibbon *Hylobates lar*	captive wild-borns	12*	67% after 3 years	4
Golden lion tamarind *Leontopithecus rosalia*	captive-borns	153	30% in first year	5
Golden lion tamarin *Leontopithecus rosalia*	wild	6 groups	82% per year	6
Black & white ruffed lemur *Varecia v. variegate*	captive-borns	13	38% after 2-10 years	7
Black howler monkey *Alouatta pigra*	wild	62	73% after 5 years	8

Notes: 1: Lesio-Louna, Congo (King *et al.* 2006a); 2: Conkouati, Congo (Goosens *et al.* 2005); 3: Sarawak, Malaysia (Bennett 1992, Ramlee 2006); 4: Phuket, Thailand (*excluding 4 individuals returned to captivity) (Shanee & Shanee 2007); 5: Poço das Antas, Brazil (Kierulff *et al.* 2002); 6: Fazenda União, Brazil (Kierulff *et al.* 2002); 7: Betampona, Madagscar (Britt *et al.* 2004); 8: Cockscomb Basin, Belize (Horwich *et al.* 2002)

The success of the reintroduction in reaching the aim of re-establishing a viable, self-sustaining population within the former range of the species will clearly depend on the fate of the release stock and their survival, adaptation, reproduction, and long-term genetic viability. These variables are influenced not only by biological and ecological factors, but also by anthropological factors that have an impact on the population or the release site. The gorilla reintroduction project has therefore been a catalyst for the development of natural resource management activities in the area, with the creation by the Gabonese government of a National Park to contain the release site, and partnerships with the government and non-government organisations for the management of the National Park and the development of communication and education activities within the local population surrounding the Park, on both sides of the Gabon-Congo national border. These advances have laid the foundation for the challenging goal of the development of an integrated and participatory approach to sustainable development and natural resource management across the whole region. Our hope is that the next generation of humans and gorillas to grow up in the Batéké Plateau region of Gabon and Congo will once again benefit from a functional ecosystem that allows for the long-term preservation of local tradition and culture.

At an international level, the reintroduction programme has proved to be attractive to the popular media, generating global publicity for the plight of the gorilla. The transfer of captive-born gorillas from UK has been particularly well covered by international media, with two television series and numerous newspapers and magazines following the transfer and progress of the gorillas 'sent home'. National Gabonese media have been less involved in the project in the past, but will be invited to cover future transfers in the hope of improving public awareness of the issues facing gorillas across the country. The combination of the initial success of the reintroduction programme as described in detail in this report, and the associated benefits from wide-ranging popular media coverage, has demonstrated the high conservation value of what remains a growing and pioneering project in natural resource management in Central Africa.

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