The Contribution of Long-Term Research at Gombe National Park to Chimpanzee Conservation

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Abstract: *Long-term research projects can provide important conservation benefits, not only through research specifically focused on conservation problems, but also from various incidental benefits, such as increased intensity of monitoring and building support for the protection of an area. At Gombe National Park, Tanzania, long-term research has provided at least four distinct benefits to wildlife conservation. (1) Jane Goodall's groundbreaking discoveries of chimpanzee* (Pan troglodytes) *tool use, hunting, and complex social relationships in what was then a game reserve drew attention to the area and created support for upgrading Gombe to national park status in 1968. (2) The highly publicized findings have earned Gombe and Tanzania the attention of a worldwide public that includes tourists and donors that provide financial support for Gombe, other parks in Tanzania, and chimpanzee conservation in general. (3) Crucial information on social structure and habitat use has been gathered that is essential for effective conservation of chimpanzees at Gombe and elsewhere. (4) A clear picture of Gombe's chimpanzee population over the past 40 years has been determined, and this has helped identify the greatest threats to the viability of this population, namely disease and habitat loss outside the park. These threats are severe and because of the small size of the population it is extremely vulnerable. Research at Gombe has led to the establishment of conservation education and development projects around Gombe, which are needed to build local support for the park and its chimpanzees, but saving these famous chimpanzees will take a larger integrated effort on the part of park managers, researchers, and the local community with financial help from international donors.*

Keywords: chimpanzees, Gombe National Park, great ape conservation, Tanzania

La Contribución de la Investigación de Largo Plazo en el Parque Nacional Gombe a la Conservación del Chimpancé

Resumen: *Los proyectos de investigación de largo plazo pueden proporcionar beneficios importantes a la conservación, no solo a través de investigación enfocada específicamente a problemas de conservación, sino también a través de varios beneficios incidentales, como una mayor intensidad de monitoreo y construcción de soporte para la protección de un área. En el Parque Nacional Gombe, Tanzania, la investigación a largo plazo ha proporcionado por lo menos cuatro beneficios a la conservación de vida silvestre. (1) Los descubrimientos innovadores de Jane Goodall sobre el uso de herramientas, la cacería y las complejas relaciones sociales de chimpancés en lo que entonces era una reserva de caza atrajeron la atención al área y crearon el soporte para cambiar a Gombe a estatus de parque nacional en 1968. (2) Los hallazgos muy publicitados han ganado para Gombe y Tanzania la atención del público en todo el mundo incluyendo turistas y donadores que proporcionan*

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soporte financiero a Gombe, otros parques en Tanzania y a la conservación de chimpancés en general. (3) Se ha reunido información crucial sobre la estructura social y el uso del hábitat que ha sido esencial para la conservación efectiva de chimpancés en Gombe y otros sitios. (4) Se ha determinado un panorama claro de la población de chimpancés en Gombe durante los últimos 40 años, y esto ha ayudado a identificar las mayores amenazas a la viabilidad de esta población, a saber enfermedades y pérdida de hábitat fuera del parque. Estas amenazas son severas y la población es extremadamente vulnerable por su tamaño pequeño. La investigación en Gombe ha llevado al establecimiento de proyectos de desarrollo y de educación para la conservación en los alrededores del parque, lo cual es necesario para encontrar soporte local para el parque y sus chimpancés, pero el rescate de estos famosos chimpancés requerirá de un esfuerzo más integrado de parte de los manejadores del parque, investigadores y la comunidad local con la ayuda financiera de donadores internacionales.

Palabras Clave: chimpancé, conservación de simios mayores, Parque Nacional Gombe, Tanzania

Introduction

The great apes—our closest living relatives—have attracted intense interest from the general public and from researchers, especially those seeking to understand the origins and evolution of our own species. Despite this interest, their existence is threatened. Even chimpanzees (*Pan troglodytes*), the most abundant, widespread, and intensively studied of the great apes are at risk. Chimpanzees are believed to have declined from perhaps 1 million in 1900 (Teleki 1989) to an estimated 172,200–299,700 in 2000 (Butynski 2003) and are now listed as an endangered species. Although the total population size of chimpanzees is large compared with some critically endangered species, such as Sumatran orangutans (Oates 2006), chimpanzees reproduce and mature slowly, making them vulnerable to increased mortality from hunting and disease (Butynski 2001). The majority of chimpanzees live in the Congo basin, a region where armed conflicts create severe difficulties for wildlife protection. Clearing of forests for timber and agriculture is increasingly leaving chimpanzees in isolated, small populations that face edge effects, genetic isolation, and elevated risk of extinction (Hill et al. 2001). Even in regions with large expanses of intact forest, chimpanzees have suffered dramatic declines, due in part to disease (Walsh et al. 2003).

Long-term research has an important role to play in chimpanzee conservation. At the international level researchers have alerted the global community to the crisis facing chimpanzees and other apes (e.g., Peterson & Goodall 1993; Wrangham 2000; Walsh et al. 2003). At the local level the mere presence of researchers provides important conservation benefits because they "keep monitors in the field and enlarge the constituency of interest and support" (Wrangham 2000: 448). Research can promote positive attitudes toward protected areas by providing employment for local people and permit fees and other income at the national level. Long-term studies can also contribute needed baseline data for planning, monitoring, and evaluation of conservation projects (Chapman & Peres 2001). If researchers make the appropriate efforts, they can also increase their awareness of and involvement in conservation decision-making processes, providing scientific guidance and information for management decisions. We report the experience of Gombe, the first park created to protect chimpanzees and discuss how research there has contributed to conservation theory and practice at the international, national, and local scales.

Gombe National Park

Gombe National Park (GNP) is in the Kigoma Region of northwestern Tanzania (Fig. 1). The park is a narrow strip of mountainous landscape covering 35 km^2. A series of steep-sided valleys fall from the rift escarpment to Lake Tanganyika, with evergreen and semideciduous forest on the lower slopes and a mosaic of thicket, woodland, and grassland on the upper slopes (Goodall 1986). Although small, the park is rich in biodiversity, with elements of western Guinea-Congolean and Afromontane forests and Zambesian miombo woodlands (Clutton-Brock & Gillett 1979).

As early as the 1940s, deforestation fueled by growing human populations threatened this area (Moreau 1945). To protect the chimpanzees, the colonial government established Gombe Stream Game Reserve in January 1943 (Government Notice 46), adding a small extension in 1955 (Government Notice 95; Thomas 1961). Although we could not find documentation of the precise extent of the original reserve, one of us (J.G.) remembers that it originally extended some distance to the east of the rift escarpment but was effectively reduced in size when a warden mistook survey beacons along the top of the ridge for the markings of the reserve boundary. This error has had grave consequences for the viability of Gombe's chimpanzee population.

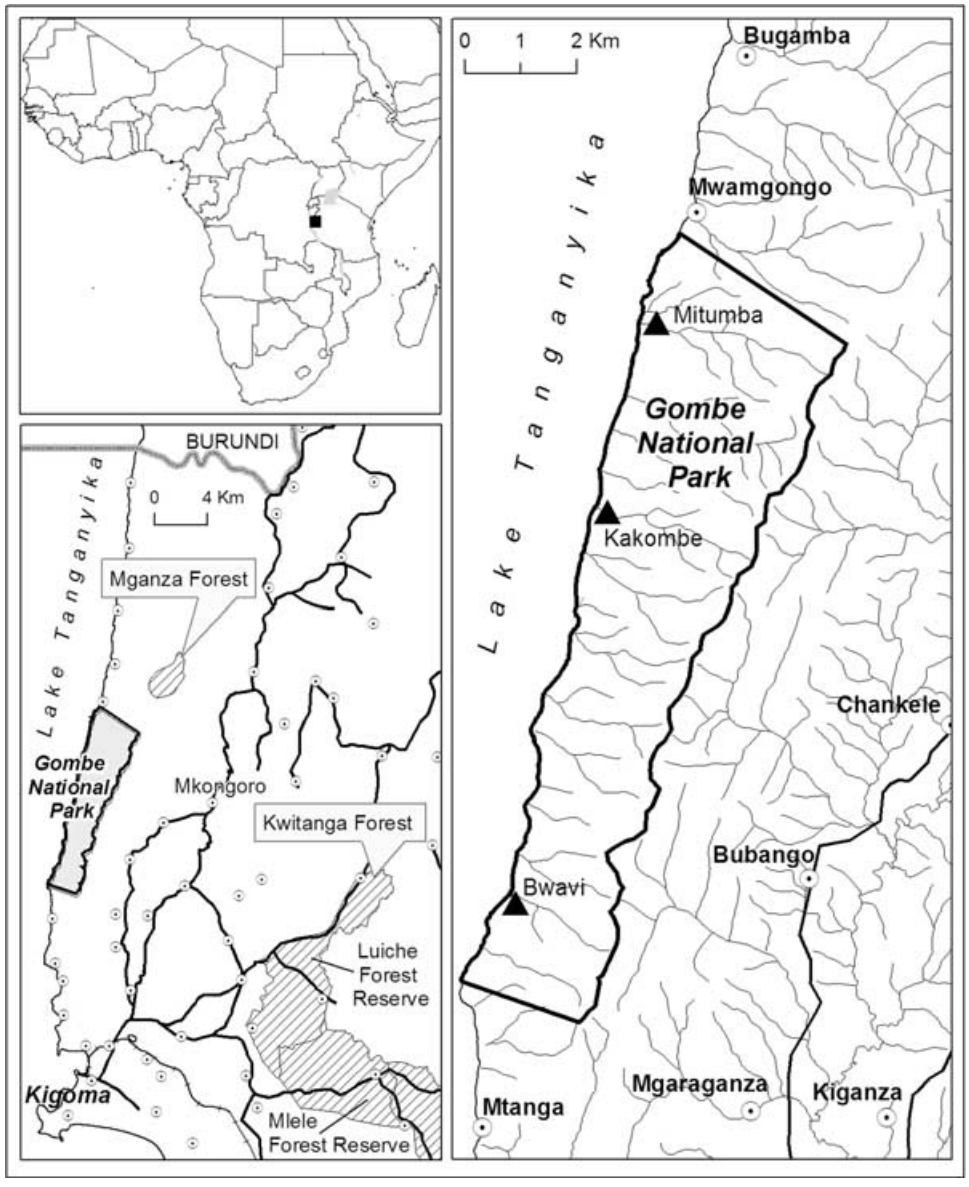

Figure 1. Gombe National Park in Tanzania. Park boundary, research and administrative settlements (triangles), streams, villages (circles), and major roads are delineated.

Jane Goodall began studying the chimpanzees of the Gombe Stream Game Reserve in 1960. At that time little was known of the natural behavior and social structure of wild chimpanzees. In the first year of her study she made landmark discoveries—that chimpanzees make and use tools (Goodall 1964) and hunt and eat meat (Goodall 1963a). These and subsequent discoveries were publicized in National Geographic articles and films. The resulting international attention prompted Tanzania's first president, Julius Nyerere, to declare Gombe a national park in 1968 (Government Notice 234). Goodall and her research team have continued the chimpanzee study for more than 45 years, and other species such as baboons and red colobus have also been studied (e.g., Clutton-Brock 1973; Ransom 1981; Packer et al. 1998; Stanford 1998), resulting in 35 Ph.D. theses, over 400 papers, and more than 30 books.

Contributions of the Long-Term Study to Conservation in General

The discoveries about chimpanzee behavior from the long-term Gombe study excited tremendous interest and attention in the scientific community, and, through popular media, Gombe has reached a global audience (Goodall 1963b, 1971, 2003; Goodall & Berman 1999; Science North 2002). Beginning in the 1980s, Goodall used the fame derived from her Gombe studies to advocate worldwide for the conservation and welfare of chimpanzees and for stewardship of the Earth (e.g., Goodall & Berman 1999; Goodall & Bekoff 2002). The Jane Goodall Institute (JGI), founded in 1977, supports wildlife research, conservation, and education. JGI is working in six chimpanzee range countries in Africa and has offices in 18 countries worldwide. The institute's Roots & Shoots pro-

gram is one of the fastest growing environmental education programs for youth with over 8000 active groups in 97 countries (www.janegoodall.org).

Many researchers who trained at Gombe now work at other field sites, where they have promoted conservation at local and international levels (e.g., Packer et al. 1999; Stanford 2001; Wrangham 2000; Tutin et al. 2001). Other field sites have been founded by researchers who describe themselves as inspired and influenced by Gombe research (e.g., Ghiglieri 1988; Boesch & Boesch-Achermann 2000).

The fame of the study attracts tourists to Gombe, despite its remote location, far from Tanzania's main wildlife tourism circuit. Although tourism may present risks to primate health (Butynski & Kalina 1998), tourists help pay for conservation at Gombe and by visiting other parks support conservation across Tanzania.

Understanding Chimpanzees

Social Structure

Because of chimpanzees' longevity (over 60 years in captivity), slow maturation (first birth at 11–14 years), large range areas, and dispersed societies, it took many years for scientists to understand their basic social structure, including relationships among individuals within groups and the patterns of transfer among groups. Nonetheless, from long-term observations of individually recognized chimpanzees at two principal study sites—Gombe (starting in 1960) and Mahale, 160 km to the south on Lake Tanganyika (starting in 1966)—a picture of chimpanzee society gradually emerged (Goodall 1986; Nishida 1990). This picture has subsequently been confirmed and expanded upon by studies at other sites across Africa (Mitani et al. 2002).

Goodall initially believed chimpanzees lived in loosely organized "communities" in which individuals of both sexes moved freely across the landscape, with populations separated only by geographical barriers (van Lawick-Goodall 1968). The existence of distinct, mutually hostile social groups ("unit-groups") was first documented at Mahale (Nishida 1968). Goodall eventually documented the existence of equivalent social groups at Gombe (Goodall 1973), but continued to use the term *community* rather than *unit-group*, as have most Anglophone researchers.

All members of a community rarely or never come together at once. Instead, chimpanzees spend their time in subgroups called parties that vary in size and composition, with males being more gregarious than females (Nishida 1968). Males cooperate to patrol their territory and occasionally attack and kill individuals from other communities (Goodall et al. 1979). A series of such intergroup killings resulted in the extinction of the Kahama community at Gombe (Goodall 1986). More intergroup killings have been observed recently (Wilson et al. 2004). Lethal intergroup attacks have been observed in the majority of long-term study populations (Wilson & Wrangham 2003). After disease, intergroup aggression is the leading cause of death for Gombe chimpanzees (Gombe Stream Research Centre, unpublished data).

Analysis of long-term demographic records of known individuals at Gombe and Mahale shows that males remain in the community in which they are born and that most females leave their natal community and join a new one before breeding (Nishida & Kawanaka 1972; Nishida 1979; Pusey 1979). Research at other sites has confirmed that this pattern of male philopatry and female dispersal is typical of the species (Mitani et al. 2002). The combination of intergroup hostility and male philopatry has two implications for conservation. First, if neighboring communities become unequal in size, the smaller community is at risk of being exterminated by its larger neighbor(s). Second, this intense hostility toward foreign chimpanzees complicates efforts to reintroduce captive chimpanzees to the wild. Males of any age, and infants of either sex, face a serious risk of being attacked and killed if released into areas with wild chimpanzees (Goossens et al. 2005).

Habitat Requirements

When Gombe was first established as a reserve, the amount of land and type of habitat needed for a viable chimpanzee population was entirely a matter of guesswork. Research at Gombe and other sites has since produced detailed information on diet and range use. Chimpanzees live in a variety of habitats, from savanna woodlands and woodland-dry forest mosaics to rain forests (Teleki 1989). They feed mainly on ripe fruit, but they also eat leaves, other plant parts, insects, and hunt monkeys and other mammals (Nishida et al. 1983). Because chimpanzees require ripe fruit, their ranges always include some proportion of evergreen or riverine forest, even when living in semiarid regions. Because their food resources are patchy and widely dispersed, chimpanzees require large home ranges, on the order of 5–20 km^2/community in Gombe (Pusey et al. 2005) and up to 30–40 km^2 in other forest sites (Wilson & Wrangham 2003). Chimpanzees living in drier habitats with more spatially and temporally scattered food resources require much larger home ranges (Baldwin et al. 1982). Recent GIS and remote-sensing applications offer new ways of understanding the roles of vegetation types, topography, and other habitat characteristics—such as distance from neighboring communities—on ranging and behavior. This new knowledge of chimpanzee habitat use gained from Gombe and other sites can provide critical information for better design of new protected areas (Pintea 2007).

Identifying Threats to Gombe Chimpanzees

Demographic Patterns

The detailed demographic data obtained at Gombe over the past 40 years had enabled the examination of population trends and identification of specific threats facing this small population of chimpanzees. Gombe currently contains three communities: Mitumba, Kasekela, and Kalande (Fig. 2). The Kasekela community has been studied since 1960, with all individuals recognized by 1966. Efforts to habituate the Mitumba community began in the mid-1980s, with most individuals recognized by 1993. Serious efforts to census the Kalande community began in the late 1990s (Greengrass 2000a). This community remains largely unhabituated, with the precise number of individuals unknown. Although accurate estimates of the size of the Mitumba and Kalande communities are not available before the 1990s, minimum and maximum estimates can be made, based on occasional sightings in earlier years.

Based on these estimates, Gombe's chimpanzee population has declined since the 1960s (Fig. 3a). Considering only minimum estimates, the population has declined at the rate of 0.56 chimpanzees per year since 1964 ($r^2 = 0.62$, $p < 0.0001$). It should be noted, however, that the extent of the decline depends greatly on the estimated sizes of the unhabituated communities. During the years with reasonably accurate data on all communities in the park (1996–present), the overall population has remained stable, but the pattern of population change has varied considerably among the different communities (Fig. 3b). In 1972 the main study community was divided into the Kasekela and Kahama communities. Kasekela males then killed at least six members of the Kahama community, leading to its extinction in 1977 (Goodall 1986). Over the years, the Kasekela population has ranged from 38 to 69 individuals. The community suffered a catastrophic drop in numbers from 57 in 1986 to 40 in 1988, largely from respiratory disease. Since then, the community has increased in size, both from a large number of new births and from extensive immigration from the declining Kalande community.

The Mitumba community experienced a steep decline due to respiratory disease in 1996 (Wallis & Lee 1999), but has since remained stable. The Kalande community declined from approximately 30 individuals in 1998 to perhaps 9 by mid-2006 (Greengrass 2000a, 2000b; Gombe Stream Research Centre, unpublished data). Over a 10-year period (1998–2006), at least 15 individuals emigrated from Kalande to Kasekela. Although many of these were

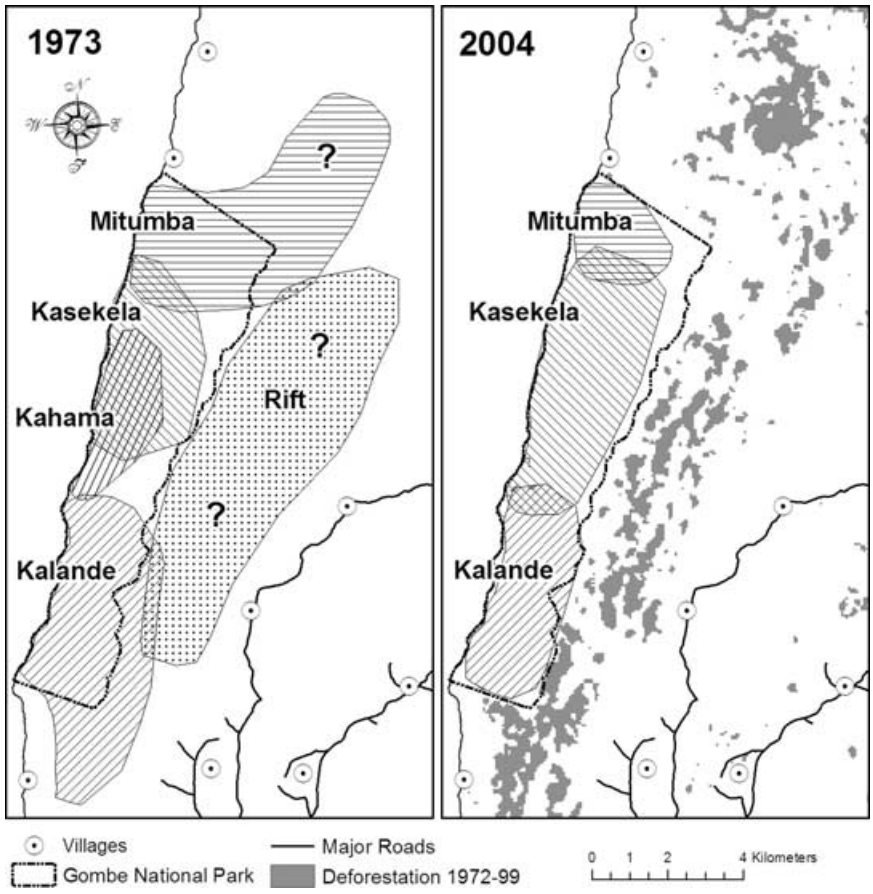

Figure 2. Chimpanzee community home ranges in 1973 and 2004. Woodland and forest area converted to grassland or farmland are estimated from 1972 Landsat MSS and 1999 Landsat ETM+ satellite images (Pintea 2007). The 1973 Kasekela and Kahama ranges are minimum convex polygons that encompass 99% of all location points recorded in 1973 (Williams et al. 2002). The 1973 Mitumba and Kalande ranges are estimates based on incidental observations inside and outside the park. The existence and location of the Rift community is based on a small number of sightings and the assumption that there was a community east of the Rift in the 1960s. The 2004 Kasekela and Mitumba community ranges are based on 99% minimum convex polygons enclosing 2004 location points. The 2004 Kalande community range is estimated from regular sightings.

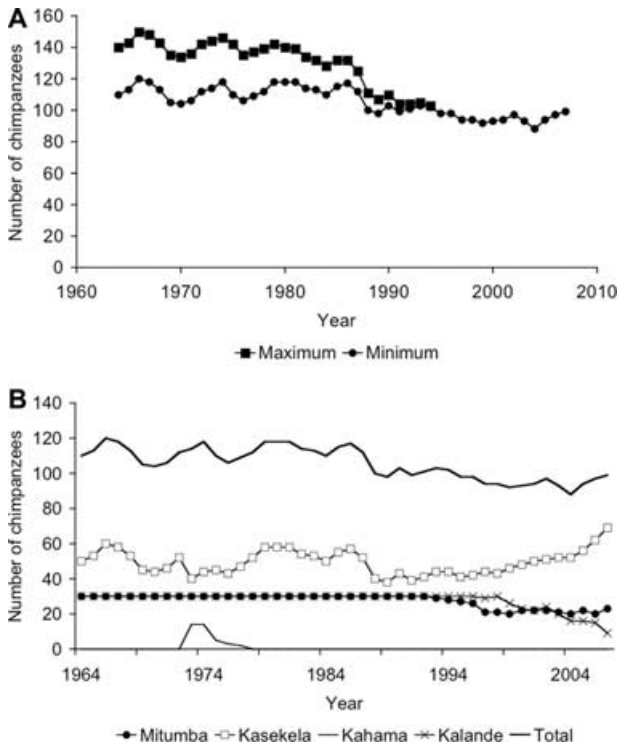

Figure 3. (a) Minimum and maximum estimates of the number of chimpanzees in the total population. (b) Minimum numbers in each community over time. Estimates for Mitumba and Kalande are highly uncertain before about 1995. Kalande numbers are based on the number of individuals known to be alive currently, plus the immigrants to Kasekela and the number of bodies found dead from disease, intergroup aggression, and poaching.

adolescent females that probably would have immigrated in any case, others, particularly three mothers with dependent offspring, probably would have remained in Kalande had the community not lost most of its adult males, as happened during the decline of K-group in Mahale (Nishida et al. 1985). The Kasekela community currently includes 62–69 individuals and the Kalande community 8–15 individuals, depending on the status of seven recently identified individuals that may be moving between the two communities.

Causes of Demographic Changes

Disease

As at other sites, such as Mahale (Nishida et al. 2003) and Taï (Boesch & Boesch-Achermann 2000), disease is the main cause of death for Gombe chimpanzees (Goodall 1983; Goodall 1986; Lonsdorf et al. 2006). It is likely that some of these diseases are anthropogenic in origin (Leendertz et al. 2006), coming either directly from humans (polio, respiratory disease, intestinal parasites) or from domesticated animals (mange).

Poaching

In much of Africa illegal hunting presents the greatest threat to chimpanzee populations. Until recently poaching was not considered a problem around Gombe. Researchers recorded only one case of a chimpanzee being killed by poachers in the first 35 years of the study (Goodall 1990). In more recent years (1998–2002) nine chimpanzees from the park are known or suspected to have been killed by poachers (Greengrass 2000a, 2000b; Gombe Stream Research Centre, unpublished data). Three males from the Mitumba community left the park to the north, and the rumor was that local people killed them. The body of one adult male of the Kalande community was found in the park with its genitals and hands cut off. The decomposing body of a female was found in Kalande at the same time Congolese people approached expatriates in Kigoma with offers of an infant chimpanzee for sale. The body of an adult male that had resided on village lands just to the east of Kalande was found inside the park with machete cuts. Finally, a report was heard of two females found dead in their nests in a valley just south of the park, although this case was not confirmed and the cause of death was not established. These must have originated from the Kalande community. In recent years other evidence of poaching within the park includes observations of snares, men with spears and hunting dogs, and occasional incidences of semiautomatic rifle fire (Greengrass 2000a). Although meat poaching is probably aimed at other species, there have been three cases of chimpanzees with snare wounds and two chimpanzees with spear wounds (F. Grossman, unpublished data). It is possible that poaching occurred previously but was undetected due to the lack of research activity in the northern and southern ends of the park.

Intercommunity Aggression

Observations from Gombe suggest that communities living at the edge of protected areas face a higher risk of mortality from anthropogenic sources, such as disease and poaching, and from intergroup aggression (Wilson et al. 2004). Communities that have lost males to anthropogenic factors are less able to defend themselves from communities with many males, which are more likely to win fights, gain territory (Fig. 2), and kill members of the smaller community (Wilson & Wrangham 2003). Chimpanzees living along park boundaries thus risk being caught in a slowly closing trap of habitat loss, disease, and poaching on one side and increasing pressure from more-powerful chimpanzee communities on the other side.

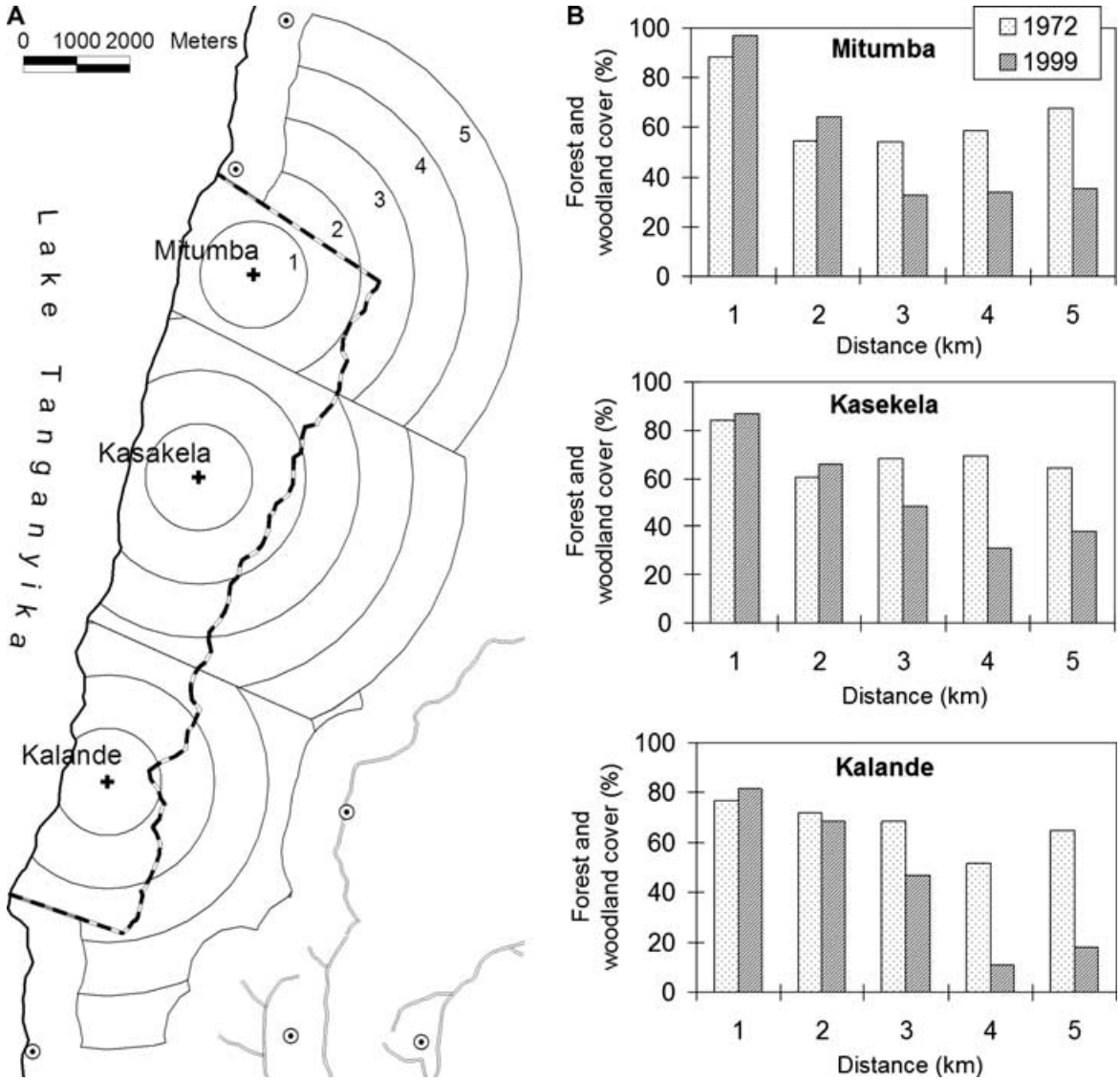

Figure 4. (a) Map of the study area showing five 1-km buffers around the centers of each chimpanzee community. The centers of the Mitumba and Kasekela communities are the centers of the minimum convex polygons of their 2004 ranges shown in Fig. 2. Areas outside the park within 1 km of villages along the lakeshore and major roads are not considered chimpanzee habitat and have been excluded. (b) Changes in percentage of forest and woodland cover between 1972 and 1999 in each buffer zone around each community (1–5 km outward; Pintea 2007).

Habitat Disturbance

Although habitat within the park remains well protected, destruction of forest and woodlands outside the park driven by rapid population growth and immigration of refugees fleeing wars in Burundi and Congo has had a devastating effect on the park's chimpanzees. Change-detection analysis, conducted with normalized NDVI differencing of 1972 Landsat MSS and 1999 Landsat ETM+ satellite imagery, indicates that forest and woodland cover has increased inside the park but declined severely outside the park (Pintea 2007; Fig. 4). A complementary change-detection analysis, conducted through post-classification of 1972 Landsat MSS, 1991 SPOT-2, and 2003 SPOT-4 satellite imagery, shows that in 1972 there were still large patches of forest and woodland adjacent to the park similar in size and distribution to patches detected from 1947 and 1956 aerial photos (Pintea 2007). By 1991 29% of the forest and woodland cover had been converted to farmlands, and by 2003 more than 50% of chimpanzee habitat adjacent to GNP had been lost.

Deforestation has had unequal effects on the three chimpanzee communities. The Kasekela chimpanzees, located in the center of the park, have been least affected by deforestation outside the park. In contrast, the Mitumba and Kalande communities have likely lost key range areas

(Fig. 2). Habitat loss outside the park has probably been most devastating to the Kalande community. The Kalande range is in the driest, narrowest part of the park, dominated by miombo woodland vegetation and heavily controlled by fires that burn a major part of the range each year. Restoring and protecting forest and woodland habitats outside the park within the former historical range would greatly improve the viability of the Mitumba and Kalande communities.

Reducing the Threats

Population Viability Analysis

Data on demography and population threats have been incorporated into a population viability analysis to determine the likely future of this population and to identify interventions most likely to improve population viability (J. Earnhardt et al., unpublished data). In 2000 iterations of the model, the Gombe chimpanzee population continued to decline, with a mean of 40 chimpanzees expected to remain 100 years from now. Unless something is done to reverse this decline, the population will become extinct eventually. Results from running the model with different scenarios suggest this decline could be reversed by the following actions: increasing carrying capacity through expanding habitat, reducing mortality from disease and poaching, and supplementing the population with reproductive females from other populations (such as sanctuaries). Although none of these interventions is likely to be easy, the model makes clear that appropriate action taken now could ensure the long-term survival of this population.

Disease

Although outbreaks of disease of possible anthropogenic origin occurred in the Gombe chimpanzees in the first decade of the study, these have been sporadic and separated by many years of comparatively good health. It therefore took researchers in Gombe and elsewhere a long time to fully acknowledge the risks of disease transfer from humans, and because of logistical difficulties in diagnosis, the true origin and transmission of these diseases are still unknown. In recent years researchers have led efforts to reduce the risk of disease transmission from humans. Following a respiratory outbreak in the Kasekela community in 2000 that resulted in two chimpanzee deaths, researchers halted artificial provisioning of chimpanzees. Although provisioning at other sites was either abandoned earlier (e.g., Mahale, in 1987 [Nishida 1990]) or never used (Ghiglieri 1984; Boesch & Boesch-Achermann 2000), it was continued at Gombe because it facilitated regular observation of individuals, filming, the ability to treat certain diseases (Goodall 1983, 1986), measurement of body mass (Pusey et al. 2005), and tourism.

The respiratory outbreak of 2000 led to the implementation of a set of health guidelines for researchers and tourists, including quarantine periods, minimum distances, and limited periods with chimpanzees (Collins 2003). Researchers introduced a shift system to reduce the number of people living in the park, built wire mesh "cages" at house entrances to prevent baboons and chimpanzees from handling dishes, clothes, and other objects and employed a sanitation guard to keep the staff quarters clean. Researchers also introduced a chimpanzee health-monitoring program comparable to that in place for mountain gorillas involving behavioral observation and analysis of noninvasively collected fecal and urine samples (Lonsdorf et al. 2006).

Poaching

Poaching represents a new and devastating threat to Gombe chimpanzees and may have been a major factor in the Kalande community's decline (Greengrass 2000a). The limited evidence of poaching within the ranges of the more intensively studied Kasekela and Mitumba communities supports the view that monitoring by researchers provides important conservation benefits. Preventing poaching, however, requires more than enforcing park boundaries. Increased poaching pressure is undoubtedly the result of the increase in human population around the park, poverty, and the need for protein. These are economic issues that need economic solutions. Although chimpanzees may be caught during poaching for meat of other species, deliberate killing outside the park may occur because of crop raiding (Greengrass 2000b) or as a preemptive measure in response to infrequent but well-remembered attacks on children by chimpanzees (Wrangham et al. 2000). Preventing such cases in the future requires changes in attitudes among local people toward chimpanzees, which will be difficult to effect. Given these constraints, the ideal solution to poaching would be to increase the amount of protected habitat available to chimpanzees, thereby reducing their rate of interaction with people outside the park.

Habitat

Increasing and improving the habitat available for chimpanzees outside the park poses the greatest challenge for conserving Gombe's chimpanzees. The park is surrounded by village land, with dense lakeside settlements on the park's northern and southern borders. The area within 2 km of the eastern boundary is less settled, with people living in hundreds of scattered households. Nevertheless, analysis of IKONOS and QuickBird satellite imagery acquired in 2000 and 2005 revealed that these scattered settlements have been expanding (Pintea et al. 2006). The land cover is largely converted to farmland

and oil palm or banana plantations, but, small, scattered forest and woodland patches still exist in the region.

Larger patches of miombo woodlands still exist northeast of the park along the rift escarpment extending towards the Burundi border, where farming is limited by high elevations, steep slopes, and remoteness from human settlements (Pintea 2007). Occasional chimpanzee sightings within and north of former Mganza forest were reported in 1992 (Massawe 1992) and 1997 (S. K., unpublished data). Surveys in 2006, using distance transects, documented the availability of woodland food species, and more recent surveys (April 2007) found chimpanzee nests 15 km north of Gombe, 6 km from the border with Burundi (S. K., unpublished data). According to the forest monitors hired by the Greater Gombe Ecosystem project, the area is used by chimpanzees that move across the Tanzania-Burundi border. Other patches that are still used at least occasionally by chimpanzees are near Mkongoro village, just 7 km east of Gombe (S. Ndimuligo, unpublished data). Currently, the closest forest patch with a permanent chimpanzee population is Kwitanga forest, 15 km east of Gombe (Massawe 1992; S. Ndimuligo, unpublished data).

Some of these patches were forest reserves, but because they lacked actual protection on the ground, they lost 80–90% of their original forest cover (Pintea 2007). These fragmented habitat remnants could potentially act as sources or sinks for the Gombe chimpanzee population. Therefore, habitat restoration and protection should be focused first in areas with clear conservation benefits to Gombe chimpanzees—within the former historic range of the Mitumba and Kalande communities. Habitat conservation strategies outside the park should be complemented by strategies eliminating other threats, such as poaching, to chimpanzees.

Although park expansion might be the most effective solution for protecting habitat, such expansion has high political and social costs, especially in densely settled areas and in areas affected by refugees. Park expansion does not appear to be a feasible option for Gombe. Instead, we are working with local people to support the restoration of habitat on village lands, especially on steep slopes and other areas unsuitable for farming. Any effort to protect and restore chimpanzee habitat outside the park will require the support of local people. It will also require extensive collaboration with village, district, and regional governments and must be fully transparent and participatory (Treves & Karanth 2003).

Working with People outside the Park

Researchers and managers are increasingly recognizing that successful conservation requires the support of local communities (Hackel 1999). Like many other protected areas, Gombe is probably still viewed negatively by people living near the park. Forcible evictions during the reserve's establishment in the 1940s and subsequent police actions into the early 1960s led many local people to perceive Gombe as lost land (Kamenya 1997). In an effort to build community support for conservation, park managers have conducted a Community Conservation Services program around Gombe since 1998, with park revenue providing assistance to villages, mainly through the building of classrooms (TANAPA 2005). The long-term research program operated by JGI has likewise led to community-focused conservation projects. In 1994 to address habitat loss outside Gombe, JGI started an integrated conservation and development project: the Lake Tanganyika Catchment Reforestation and Education project (TACARE). TACARE was designed to help arrest the rapid degradation of remaining indigenous forests.

After 10 years of operation, the TACARE project has contributed to increased awareness, positive attitudes, and some behavior changes with potential benefits for long-term conservation (Anderson et al. 2004). The project has demonstrated the enormous potential for restoration of miombo woodlands in Kigoma region and has been successful in opening the doors to communities.

TACARE interventions have not kept pace with the growing human population, which increased from 2.4%/year in 1988 to 4.8%/year in 2001 (Tanzania 2003 census estimate for Kigoma region). The deforestation rate in areas important for chimpanzees almost doubled from 87.5 ha/year from 1972 through 1991 to 171 ha/year from 1991 through 2003 (Anderson et al. 2004).

To save Gombe's chimpanzees from such human pressures, conservation strategies have to be more focused and strategic, reducing the most direct threats in areas with the most benefits to chimpanzees. The JGI is adopting The Nature Conservancy's Conservation Action Planning (CAP) (http://conserveonline.org/workspaces/cap) framework to identify what those conservation strategies might be and to monitor conservation success. A GIS database has been developed that integrates high-resolution satellite imagery (as detailed as 60-cm resolution) (QuickBird, DigitalGlobe), data from 35 years of daily observations of chimpanzees, and land-use maps developed in collaboration with the local communities (Pintea 2006). Funding from the U.S. Agency for International Development has provided resources to begin a Greater Gombe Ecosystem project designed to restore and protect habitat around Gombe in collaboration with local communities. The project will develop a chimpanzee conservation plan based on CAP methodology, support the development of land-use plans for 13 villages, and establish a network of interconnected forest reserves in areas important for chimpanzees jointly managed by local communities and TACARE.

Discussion

Despite the knowledge and support the long-term studies of chimpanzees at Gombe have provided, these chimpanzees remain vulnerable. The small size of the park, the fast-growing human population, the great poverty of this human population, and political unrest in adjacent countries are the major reasons for their vulnerability. Although, as in other parts of Tanzania (Pelkey et al. 2000), the protection offered by national park status has proved much more effective than lower levels of protection, such as forest reserves, rapid changes in land use outside the park have greatly reduced the total amount of habitat available to Gombe's chimpanzees. Because the total area of the park, 35 km^2, is only about the size of the home range of one chimpanzee community in other parks in east Africa, it is not surprising that the two outer communities have declined in number.

One may ask why it took so long for researchers to sound the alarm about the plight of the Gombe chimpanzees. One reason is that research was focused for many years on understanding the basic biology rather than on conservation of chimpanzees. Another is that the study was conducted on the Kasekela community, which, by its central position in the park was the best-protected community. The topography of the park is such that researchers working on the Kasekela community rarely had reason to visit the edges of the park or the opportunity to see conditions in the remote areas in the rugged hills to the east. When Goodall flew over the area in the 1980s, she first realized the full extent of deforestation. This eventually led to the establishment of TACARE. But the logistics of working in the areas directly surrounding the park were difficult, and efforts were concentrated in villages on the lakeshore and near roads farther east. Now, with the availability of very high-resolution satellite imagery, studying and monitoring of the vegetation and land-use patterns is possible at the various landscape scales across park boundaries. This new perspective on Gombe has been made publicly available by the JGI through technologies such as Google Earth. It is now possible, for example, to go on line and see at 60-cm resolution the lush forests of Gombe and the effects of deforestation in the surrounding region.

Another problem until recently has been the lack of an effective dialogue between researchers and park managers. Managers initially seemed reluctant to acknowledge researchers' reports of evidence of poaching in the south. On the other hand, managers encountered criticism from researchers for their building and tourist projects within the park without an acknowledgment of the need for adequate housing for park staff and income generation. This situation is now improving, as demonstrated by the recently approved general management plan (TANAPA 2005), which was the product of close cooperation between park managers and researchers.

We are in a race against time to save chimpanzees. Many may believe that because of their small population size, the Gombe chimpanzees are doomed. We acknowledge that the necessary conservation interventions will be costly. Nevertheless, we argue that despite the manifold threats facing these chimpanzees, we must make the most strenuous efforts to preserve them. The Gombe chimpanzees have unique scientific importance, a high public profile, and enormous symbolic and cultural value. Moreover, we hope that the knowledge, tools, and stories generated from the long-term study of the Gombe chimpanzees will help guide conservation practitioners in the difficult task of finding ways to ensure the long-term survival of our evolutionary cousins worldwide.

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