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Holistic Approach for Conservation of Chimpanzees in Kibale National Park, Uganda

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Introduction

Human population growth coupled with crippling poverty in many rural areas across Africa has threatened the extinction and endangerment of many wildlife species (Estrada et al. 2017; Lamarque et al. 2009), especially those in small reserves (Brashares, Arcese, and Sam 2001). In particular, all four subspecies of chimpanzees (*Pan troglodytes* spp.), our closest living relatives, are classified as endangered (Humle et al. 2016) and many populations living in human-dominated landscapes are facing local extinction (Guinea: Hockings 2009; Nigeria: Greengrass 2009; Uganda: McLennan 2010). In the last century anthropogenic pressures—deforestation, bushmeat hunting, and disease transmission—have caused the confirmed or likely extinction of wild chimpanzees in four countries (Benin, Burkina Faso, Gambia, and Togo; Campbell and Houngbedji 2015; Ginn et al. 2013), and dramatic population decline in their remaining 21 range countries (IUCN: Humle et al. 2016; Eastern chimpanzees: Plumptre et al. 2010; Nigeria-Cameroon chimpanzees: Morgan et al. 2011; Western chimpanzees: Kühl et al. 2017; Kormos et al. 2003; central chimpanzees: Morgan et al., chapter 27 this volume). These pressures also threaten the health, longevity, and viability of many small unprotected local populations (Cowlishaw and Dunbar 2000; McCarthy et al. 2015; McLennan 2010). By 2030, predictions estimate that of the suitable African great ape habitat that currently remains, less than 10% will be relatively undisturbed by human infrastructural development (Nelleman and Newton 2002), thereby isolating most populations (Fitzgerald et al. 2018). While many species of animals and plants are endangered globally, the African great apes are particularly vulnerable because they have large home ranges and low population densities. The loss of apes is troubling because they are effectively "umbrella species" (Lambert 2011), meaning that ape conservation efforts also help to conserve

many other sympatric species (Chapman et al., chapter 25 this volume). Such conservation activities are badly needed because, based on current and accelerating rates of bushmeat hunting and forest loss, it has been suggested that wild chimpanzees, gorillas, and bonobos all risk extinction by 2100 (Nishida et al. 2000).

While this biodiversity loss of chimpanzees and other great apes is of serious concern (Butchart et al. 2010), so too is the livelihood of local people. Unfortunately, the clash between the needs of rural populations and habitat protection has often been unsatisfactorily mitigated. During the last century over 14 million people have reportedly been displaced from their homes across Africa in the name of conservation (Dowie 2011). Tactics designed to protect wildlife areas included "fortress conservation," which can vilify traditional practices of land and animal use (Brockington 2004). Superficially, results can look good for conservation—over the past two decades the proportion of terrestrial land in Africa given to protected areas has grown from 9% to 15.5% (UNEP-WCMC 2019). But while legal protection to wildlife has increased (Bruner et al. 2001; Struhsaker, Struhsaker, and Siex 2005), the apparent success can be misleading as laws and policies may not actually be enforced. Many protected areas are merely "paper parks" (Blom, Yamindou, and Prins 2004) that exist on maps and in legislation, but in reality offer little to no protection. While these areas are officially designated as protected, conservation activities are often insufficient to halt degradation. How to implement successful conservation policies that are truly effective and sustainable in the long term is thus a critical question. During periods of active investment by relevant institutions, conservation initiatives, ecotourism, and educational outreach have all shown positive impacts on great ape biodiversity and species preservation (Tranquilli et al. 2011). However, such activities are vulnerable to failure when the initiative stops. For example, a conservation organization's presence in Marahoué National Park, Côte d'Ivoire, had elevated protection levels, but within six years of the conservation efforts ceasing, there was a 93% decrease in forest cover and an 82% reduction in the chimpanzee population (Campbell et al. 2008).

One solution may be the establishment of long-term (multi-decade) field sites, which have repeatedly been found to generate both direct and indirect conservation benefits in chimpanzees (Budongo, Uganda: Reynolds 2005; Gombe, Tanzania: Pusey et al. 2007; Kibale, Uganda: Wrangham and Ross 2008; Taï, Côte d'Ivoire: Campbell et al. 2011), other great ape species (gorillas: Williamson and Fawcett 2018), protected areas in general (Tranquilli et al. 2014), and even unprotected areas (Piel et al. 2015) such as logging concessions (Morgan et al. 2013, chapter 27 this volume). Long-term research

sites create unique opportunities for on-the-ground conservation promotion, management, and sustainability because researchers stay long enough to build trusted relationships with key stake-holders, partly by providing practical help (Kibale, Uganda: Wrangham and Ross 2008). Even when researchers begin by focusing on purely scientific studies, they tend to incorporate conservation initiatives and/or educational outreach. Their local knowledge makes them well positioned to address issues of sustainability using appropriate approaches, while also being sensitive to the needs and struggles of peoples living sympatrically with wildlife. Results seem to be beneficial, such as in Taï National Park, Côte d'Ivoire, where a detailed study found that researcher presence positively affected biodiversity abundance relative to adjacent areas (Campbell et al. 2011), and when anti-poaching patrols were coordinated with local law enforcement, primate densities in particular were up to 100 times larger near research stations (N'Goran et al. 2012). While many studies have been published on the anthropogenic threats to chimpanzee conservation (see Chapman et al., chapter 25 this volume, for a review of these threats) and the actions of law enforcement to mitigate these threats in protected areas (Critchlow et al. 2015; Kablan et al. 2017), only a handful of research sites have published on their conservation and/or educational outreach initiatives (see Wrangham and Ross 2008 for a review of long-term chimpanzee research sites at Bossou, Budongo, Gombe, Kibale, Mahale, and Taï, and for the Virunga mountain gorillas). It is not clear whether this is due to a lack of establishment, data, priority, or something else.

The best-known and most long-term chimpanzee conservation and education initiatives come from Gombe Stream Research Center in Gombe National Park, Tanzania. Their community-centered conservation approach, Lake Tanganyika Catchment Reforestation and Education Project (TACARE), was established in 1994 to initially address deforestation outside the park. TACARE has contributed to positive attitudinal and behavioral changes (Anderson et al. 2004) as well as a reduction in the rate of forest degradation in and around Gombe (Pusey et al. 2007). However, to keep pace with the growing human population around the park (Anderson et al. 2004), more focused conservation strategies were identified, in collaboration with the Nature Conservancy, to incorporate satellite imagery in analyses and work more closely with local communities (Pusey et al. 2007). Over the years TACARE has grown their community-based conservation programs and is now the Jane Goodall Institute's flagship population, health, and environment project with six major initiatives that focus on community development, forestry, agriculture, health, land use planning with GIS, and the globally recognized environmental education for youth program, Roots and Shoots. However, we

recognize that scaling community-based conservation projects to the level of the Jane Goodall Institute is challenging and requires more funding and management than most long-term research projects can afford.

Several other long-term chimpanzee research sites have reported a range of successful conservation education programs in/around their parks (see Wrangham and Ross 2008 for review). In West Africa, the Taï Chimpanzee Project in Taï National Park, Côte d'Ivoire, established the Wild Chimpanzee Foundation, which focuses on environmental education in local villages, wildlife and human encroachment field surveys, and supporting local development actions (Boesch et al. 2008b). Repeated exposure of their multimedia bushmeat awareness campaigns resulted in a significant (62%) decrease in bushmeat consumption in poverty-stricken rural households (Kouassi et al. 2017). In partnership with local teachers, their environmental education club PAN (peoples, animals, and nature) positively influenced children's attitudes toward nature and significantly increased their environmental knowledge (Borchers et al. 2014). The Bossou Chimpanzee Project in Guinea established environmental education and community development campaigns (Matsuzawa, Humle, and Sugiyama 2011), which included the Green Corridor Project to reconnect Bossou to the Nimba Mountains by replanting trees along a 4 km corridor (Matsuzawa and Kourouma 2008). While the corridor is nearly complete, the study chimpanzee population has sadly decreased to only seven as of March 2017 (Fitzgerald et al. 2018). In East Africa, the Mahale Mountains Chimpanzee Research Project in Mahale National Park, Tanzania, established the Mahale Wildlife Conservation Society, which in turn founded the *Pan African News* for researchers, built a nearby primary school and park visitor center, and guided student field trips in the park (Nishida and Nakamura 2008). The Budongo Conservation Field Station in the Budongo Forest Reserve, Uganda, has an active snare removal team, sustainable vermin control, selective forest harvesting programs, and local veterinary and education services (Asiimwe et al. 2016; Babweteera, Reynolds, and Züberbuhler 2008). The Ngogo Chimpanzee Project in Kibale National Park, Uganda, has an active snare removal team and works in collaboration with the North Carolina Zoo's UNITE for the Environment on conservation education initiatives in nine local schools.

From what has been learned at Gombe and other sites, a successful long-term future for conservation surely depends on capacity building and buy-in from people surrounding the protected areas (Shaffer et al. 2017). For this reason it has been suggested that future research and conservation initiatives need to integrate conservation biology with social action (Adams and Mulligan 2003; Lwanga and Isabirye-Basuta 2008) so as to build long-term

relationships of trust with local communities (Breuer and Mavinga 2010; Collins and Goodall 2008; Kasenene and Ross 2008). Using a holistic approach to conservation, the Kibale Chimpanzee Project in Kibale National Park, Uganda, employs a conservation team who regularly patrol the park while working on conservation education initiatives in partnership with the Kasiisi Project in 16 local schools within 5 km of the national park. The success of this partnership is partly the result of the project founders, Drs. Richard Wrangham and Elizabeth Ross, whose marriage has fostered strong communication and collaboration between the two projects for the past 20 years. This chapter presents a case study of these two collaborative projects working in and around Kibale National Park to conserve chimpanzees.

THREATS TO CHIMPANZEES LIVING IN KIBALE NATIONAL PARK

Kibale National Park (hereafter refered to as Kibale) lies in the Eastern Afromontane region, one of the world's thirty-five biodiversity hotspots (Mittermeier et al. 2005; Wright 2005), and is a mid-altitude rainforest of 795 km^2 with the highest primate density and diversity in East Africa (Fashing and Cords 2000; Oates et al. 1990). Kibale is home to the largest known population of the eastern chimpanzee subspecies (*P. t. schweinfurthii*, Plumptre et al. 2010), and serves as a stronghold for many other threatened and endangered species, including 12 other primate species, elephants, golden cats, pangolins, and hundreds of other rare mammal, bird, reptile, amphibian, insect, and plant species (Plumptre et al. 2007). Chimpanzees living in Kibale have been designated by the IUCN as a high priority for conservation (Plumptre et al. 2010).

Though announced as a national park in 1993, Kibale faces numerous long-term threats. In 2015, the human population density around Kibale was estimated at 308 people/km^2 (MacKenzie et al. 2017a). Neighboring human populations are growing by 3.5% annually (Goldman et al. 2008; WPR 2017) and with 50% under the age of 15 (Bwambale 2012), the surrounding population is predicted to increase almost five-fold by 2050 (PRB 2017). Due to the low annual income in the region (Tumusiime and Vedeld 2015), wildlife is often viewed as a "free" resource tempting people to enter the park illegally to poach for bushmeat. Given the permeable nature of the park boundary, chimpanzees and other wildlife (typically elephants and baboons) sometimes range outside of the park when habitat and food sources are lost and/or seasonally variable. Resource-dense areas, such as a crop fields (mainly maize, fruits, sugar cane, etc.), located near the forest edge can become favorable

foraging targets for chimpanzees. While chimpanzees are less destructive than many other wildlife (e.g., elephants, baboons, bush pigs, other monkeys; Naughton-Treves 1997; Tweheyo, Hill, and Obua 2005), at times, they do destroy villagers' crops (MacKenzie and Ahabyona 2012). Additionally, chimpanzees have injured and even killed children (Wrangham et al. 2000). Thus, the people living around Kibale have good reason to dislike the chimpanzees and farmers who are victims of these chimpanzee crop-foraging attacks may (over time) develop negative attitudes toward chimpanzees and their conservation (Garriga et al. 2017; McLennan and Hill 2012). People sometimes respond by setting snares in their gardens and/or attacking chimpanzees with dogs and spears when they encounter them.

Ultimately, it is the movement of both people and chimpanzees in and out of the park that fuels the human-chimpanzee conflict and directly threatens the survival of Kibale's chimpanzees. This manifests in three main ways, as chimpanzees (1) are caught in snares set for other bushmeat species in the park, (2) are injured or killed during crop foraging, and (3) catch human and domestic animal diseases (Parsons et al. 2014), including things like the common cold, which can lead to mortality (Scully et al. 2018). This chapter focuses predominantly on snaring and human-chimpanzee conflicts, rather than disease.

Though prohibited by law, snare traps made of wire or nylon are commonly set by hunters within the park's boundaries to catch small game (i.e., antelope, bushpigs). Snares act like landmines in the forest—they are cryptic, indiscriminate, and deadly. While not the intended target, chimpanzees are often accidental victims: their appendages become entangled and over time the snares cut deep into their flesh causing pain, infection, and permanent damage—often they lose hands and/or feet (fig. 26.1, Cohen 2010). Wrangham and Mugume (2000) estimated there were 15,000 snares set in Kibale at any given time, resulting in a 3.7% risk of a chimpanzee being snared each year. This anthropogenic pressure is too intense for the national wildlife authority to mitigate on their own, and as a result, approximately one-third of chimpanzees in Uganda have permanent snare injuries, ranging from missing/paralyzed digits to limb amputations (Plumptre et al. 2010).

Given that the threats to chimpanzees are so intertwined with human activity, for conservation efforts to succeed, local people must see value in chimpanzees and other wildlife despite the challenges they bring. Villagers' needs must therefore be incorporated into conservation agendas (Adams and Hutton 2007). This can be difficult because a fear of chimpanzees is instilled even in young children. In 2014, 62% of children's negative comments about chimpanzees cited their aggressive behavior (Elizabeth Ross, unpublished

FIGURE 26.1. Max (pictured left) lost both of his feet in two separate snare injuries, one at the age of five and the other at the age of eight, with the likely culprits being wire foot snares (pictured right).

data). Therefore, one of the keys to long-term conservation is to focus efforts toward young children. This is best achieved by improving academic and environmental standards (Fiallo and Jacobsen 1995; Kideghesho, Røskaft, and Kaltenborn 2007) since individuals who do not complete school tend to be poor and/or unemployed, and therefore more likely to poach wildlife (Knapp, Peace, and Bechtel 2017). Less than 60% of Ugandan children complete primary school (Mwesigwa 2015; UNPC 2017) and academic standards in rural schools, such as those surrounding Kibale, have tended to be low. Lacking the education and skills needed to enter the job market, local children turn to subsistence farming on progressively smaller patches of land as they transition to adulthood, and in tough times often depend on the forest and its resources to make ends meet. These ongoing community challenges both inside and out of the park must be continually assessed and addressed for local conservation strategies to work.

Our Holistic Approach: A Community Call to Action

Our NGOs, the Kibale Chimpanzee Project (KCP) and the Kasiisi Project, have developed collaborative initiatives that focus on the conservation of

chimpanzees living in Kibale National Park. Established in 1987 by Richard Wrangham, KCP studies the Kanyawara chimpanzee community located on the northwest side of the park (Chapman and Wrangham 1993). After 10 years of long-term research, KCP, in partnership with the Uganda Wildlife Authority (UWA), established two key conservation-based projects in the area: the Kibale Snare Removal Program (KSRP) and the Kasiisi Project. Core aims of the KSRP and the Kasiisi Project partnership are to address the persistent threats to chimpanzee conservation in and around the park. The broader mission of both projects is conservation of Kibale and its wildlife residents. Together we use a multifaceted approach that includes on-the-ground conservation efforts within the park (KSRP) paired with community outreach and development outside the park (Kasiisi Project) to address persistent and evolving human-chimpanzee conflict issues. Both approaches work in concert with one another and are crucial to the conservation of chimpanzees and other wildlife at a local level. However, we do not stand alone. Our effectiveness depends on long-term partnerships with other conservation- and education-focused govermental organizations, NGOs, educators, and scientists at local and international levels (see acknowledgments).

In addition to our conservation efforts, our projects offer Ugandans highly desired, competitive salary positions with further education, health, and retirement benefits (KCP/KSRP: 21 personnel, Kasiisi Project: 18 personnel). Most employees live at the field station or in nearby communities along the park boundary. Because they share their experiences with family and friends, employees sensitize local communities to conservation issues and appear to help deter illegal activities in the park.

KIBALE SNARE REMOVAL PROGRAM: CONSERVATION VIA PARK MONITORING

As the conservation arm of KCP, the Kibale Snare Removal Program was founded in collaboration with the UWA in response to the high proportion of debilitating chimpanzee snare injuries observed in the park. KSRP has five main goals within and around Kibale: 1) conduct regular patrols to remove snares and apprehend poachers (when accompanied by UWA), 2) collect data on the occurrence and location of snares and other illegal activities, 3) collaborate with UWA to strengthen law enforcement, 4) provide data on snares and other illegal activities to park management, and 5) educate local communities to help curtail poaching.

Over the past 20 years, KSRP has grown from two employees to six, who deploy as two independent patrol teams that are often accompanied by UWA

rangers. While the KSRP patrols cover roughly two-thirds of the park, UWA rangers conduct patrols throughout the entire park, and other snare removal teams (Ngogo and Sebitoli) cover their chimpanzee home ranges and beyond. These complementary and collaborative patrol efforts by all parties result in patrol coverage redundancy within the park, and therefore help strengthen our overall effectiveness as conservationist and wildlife protectors.

Like UWA rangers, KSRP immediately confiscates and destroys all encountered snares and other hunting evidence, such as nets and spears. When KSRP patrols are accompanied by UWA personnel, poachers are arrested. Rigorous data collection protocols and GPS technologies are used to document the location and relevant details of snares, other hunting/poaching events, additional illegal activities, and wildlife abundance measures. These data are used to evaluate the program's general effectiveness, improve its efficiency, and provide intelligence to the patrol teams regarding hotspots of snares and other poaching/illegal activities.

In past years, and as needed, KSRP has employed local village residents to serve as Community Liaisons to document and mitigate human-chimpanzee conflicts in communities where crop foraging and aggressive encounters were high. Liaisons engaged in open discussions with villagers about their feelings toward chimpanzees and the actions they took when faced with encounters. They advised about chimpanzee behavior and how villagers could avoid or reduce aggressive interactions. To further mitigate conflict, research project field assistants notify local farmers when chimpanzees are actively crop foraging, giving farmers the opportunity to encourage the chimpanzees to leave in non-aggressive ways.

KASIISI PROJECT: CONSERVATION VIA COMMUNITY DEVELOPMENT

As the community arm of KCP, the Kasiisi Project partners with with the Kibale Forest Schools Program (KFSP, Ugandan-registered NGO) to address the environmental impact of a rapidly increasing human population. The premise of the educational program is to enhance tolerance by highlighting the unique situation of living alongside chimpanzees and other endemic wildlife (Lee and Priston 2005). The project aims to foster this attitude in communities around Kibale. By linking our programs to research, school curricula, and community needs, we can change attitudes and behavior in ways that have powerful and practical conservation benefits. Our vision is to guide and nurture a generation of committed rural conservationists who are passionate about protecting the forest now and in the future by implementing

sound environmental practices in their homes. This is especially important in the park-boundary communities where human-wildlife conflicts are often daily occurences. We address four main objectives known to significantly improve conservation outcomes: age, academic standards, environmental knowledge, and community trust and support.

Age: We target children in pre-adolescence, a time when they are most receptive to conservation messages (Chawla 2007), by working in 16 government primary schools located within 5 km of the northern and western boundary of Kibale, reaching over 11,000 children aged between six and 16.

Academic Standards: Our higher academic standards are achieved by utilizing a range of support strategies including improving infrastructure, teacher training, libraries and literacy, post-primary scholarships, clean water and sanitation, health education, school lunches, pre-schools, boarding facilities, and addressing the special needs of girls (e.g., sanitary pads, sex education). Prioritizing teachers is key to successful education outcomes. To incentivize teachers and combat absenteeism, we provide clean and safe classrooms, adequate latrines, and opportunities for advancing qualifications.

Environmental Knowledge: Increasing environmental knowledge is achieved by empowering children with accurate, exciting, and engaging information about their environment (specifically, Kibale and its chimpanzees). Conservation education programs for children are run primarily after school in Wildlife Clubs (WLCs) headed by teacher patrons. WLCs are familiar organizations that promote environmental knowledge and active conservation, and support the academic curriculum. We build passion for the environment through interesting, interactive, and comprehensive conservation education programs that prioritize hands-on engagement. Using brief instructional talks coupled with films, art/drama, debate, field trips, practical conservation activities, and interactive games, our programs build knowledge, stimulate empathy toward chimpanzees and other wildlife, and encourage changes in behavior. Programs are evaluated by measuring student attitudinal and behavioral changes using pre- and post-surveys, program participation and retention, and performance on standarized exams.

Community Trust and Support: As important centers of the community, schools offer regular access to parents, local government, and political leaders. All programs are designed and implemented in collaboration with parents, teachers, school management committees, district education and health departments, local clinics, village health teams, churches, and local political leaders. Regular community questionnaires keep the project updated on parents' opionions and requests. The project has a strong reputation for nonpartisanship, built on long-term reliable investment in areas people highly

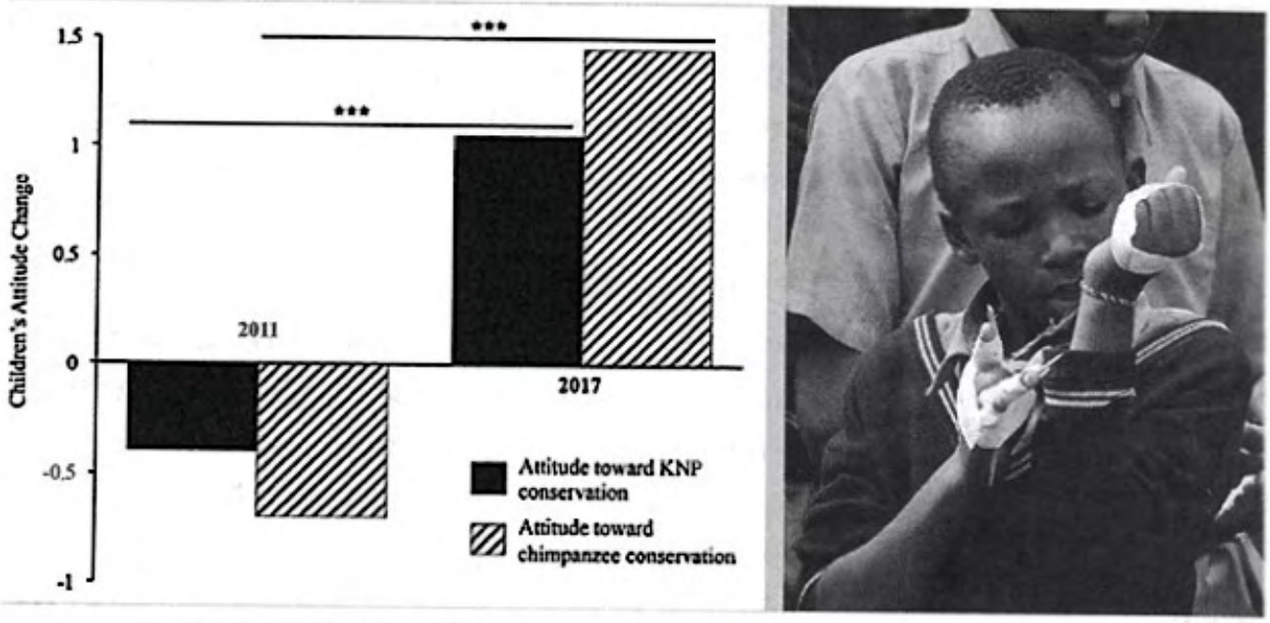

FIGURE 26.2. As the Kasiisi Project's conservation education programs have grown and improved, students' attitudes towards Kibale National Park and chimpanzees have gotten more positive (bar graph). In the Snare Care activity (pictured right) using tape and sticks to immobilize their fingers, wildlife club students get to experience some of the challenges chimpanzees face when they have paralyzed or missing digits/limbs from snares. *** $p < 0.05$.

value, such as their children's health and education. The schools where we work are key to building effective conservation networks between community, research, and local government, and our programs are crucial to molding young environmental stewards.

THE KSRP-KASIISI PROJECT PARTNERSHIP

KSRP and Kasiisi Project work collaboratively to integrate on-the-ground conservation efforts with educational outreach. To aid in this goal, the projects jointly employ a Conservation Education Liaison who works with both organizations to coordinate KSRP-led conservation education activities in Kasiisi Project schools and maintain an interactive connection between our programs. KSRP has a mini-documentary with local language subtitles (produced by Jane Goodall Institute) that is shown during conservation education presentations. Conservation films that specifically address regional threats have been found to positively influence student knowledge of and attitudes toward great apes (Leeds et al. 2017). Beyond presentations, KSRP employees engage WLC students and community members in chimpanzee-focused conservation activities and games. In 2014, KSRP implemented two interactive games, Snare Care and Ape Survivor, with WLC members. The goal was two-fold: to sensitize students to the anthropogenic dangers chimpanzees face in the forest and to help students empathize with the chimpanzees who have been permanently handicapped by snares. Snare Care (fig. 26.2)

required students to identify a photographed snare hiddened in the forest. Failure to do so resulted in the student being "snared." Their new injury, which was constructed using tape and sticks, mimicked a Kanyawara chimpanzee's snare injury. Snared students then had to compete in a foraging task against non-snared students. Afterwards, KSRP team members and students discussed the snared individuals' challenges in the context of the chimpanzees living in Kibale and what the students could do to help. Both projects also regularly seek partnership opportunities with UWA and other local conservation-based organizations to implement new conservation education initiatives whenever possible.

Results

Both KSRP and Kasiisi Project initiatives have been ongoing since 1997, but data collection and reliability were not always consistent. The conservation data presented in this chapter were predominantly extracted from 2006 to 2017. Below we describe our findings regarding the demographics of chimpanzees affected by the snares, the efficacy of the Kibale Snare Removal Program, and the results of the Kasiisi Project, our conservation education and community outreach program.

CHIMPANZEE SNARE DEMOGRAPHICS

Community size (excluding infants) as of December 2017 was 42 chimpanzees with a cumulative total of 453 possible years exposed to snare risks. Approximately 28% of the currently-living Kanyawara chimpanzees (past the age of infancy) have been snared at least once (four individuals were snared twice), resulting in a 4.0% risk of being snared per year. Among those, 57% have suffered a permanent snare injury, including the young male Max who lost both of his feet in two separate snaring events (fig. 26.1). However, when accounting for the entire known history of the Kanyawara chimpanzee community (from 1987 to present, N = 107 chimpanzees with 1,225 possible years of snare risk), the percentage is much higher. Approximately 45% of the past and present community members (past the age of infancy) have been snared at least once (seven individuals snared twice or thrice), resulting in a 4.7% cumulative risk of being snared per year. Of those, 88% suffered a permanent snare injury. Two individuals in the study population are known to have died directly from snare wounds.

The data show no significant difference between the proportion of male (N = 22) and female (N = 27) snare victims ($x^2[1] = 0.5$, ns, data analyzed in

SPSS v.23). However, there was a significant interaction between snarings and chimpanzee age ($x^2[2] = 10.7$, $p < 0.01$). Juveniles (4.0 to 9.9 years) were the most at-risk age category for being snared (59%, N = 20) followed by adults (15.0 years and older, 26%, N = 9) and then subadults (10.0 to 14.9 years, 15%, N = 5). There have been no known infant snaring events at Kanyawara. The mean snare age was 12.4 years (±6.8 SD, N = 32). There was no significant interaction between sex and age ($x^2[2] = 1.1$, ns).

KIBALE SNARE REMOVAL PROGRAM

The number of permanent snare injuries has declined in recent years due to the implementation of veterinarian-supervised snare interventions starting in 2006. Emergency protocols were developed in partnership with local veterinarians, the Jane Goodall Institute in Uganda, and UWA to improve response time and reduce snare severity, infection, and permanent damage. Sine 2006, 64% of attempted interventions (N = 11 attempts out of 15 snare events) have resulted in successful snare removal. Additionally, in all of these success cases, the digit/limb was saved from amputation. However, social, behavioral, and environmental conditions sometimes make intervention attempts impossible (27% of cases).

Chimpanzee Snaring Interval

The inter-snare interval (ISI) refers to the length of time elapsed between observed chimpanzee snare injuries at Kanyawara. Prior to KSRP (from 1990 to 1997), the ISI averaged 8.9 months (±2.2 SE, N = 7) compared to 13.0 months (±3.0 SE, N = 19) after KSRP began to be present.

Poacher Activity

Since 1997, KSRP has worked closely with UWA to deploy more than 5,000 KSRP patrols removing over 8,500 snares from the park and assisted UWA in the arrest of countless poachers. On these patrols, significantly more neck snares (68%) were removed compared to foot snares (32%, $x^2[1] = 326.8$, $p < 0.0001$) and significantly more wire snares (89%) were removed compared to nylon snares (11%, $x^2[1] = 2052.1$, $p < 0.0001$) from 2014 to 2017. For chimpanzees, foot snares are notoriously more dangerous because of their trigger/spring mechanism that causes the wire/nylon to instantly tighten, embed, lock, and restrict blood supply to extremites. The savagery of the snare is typically exacerbated by the newly entangled chimpanzee's startled reaction as

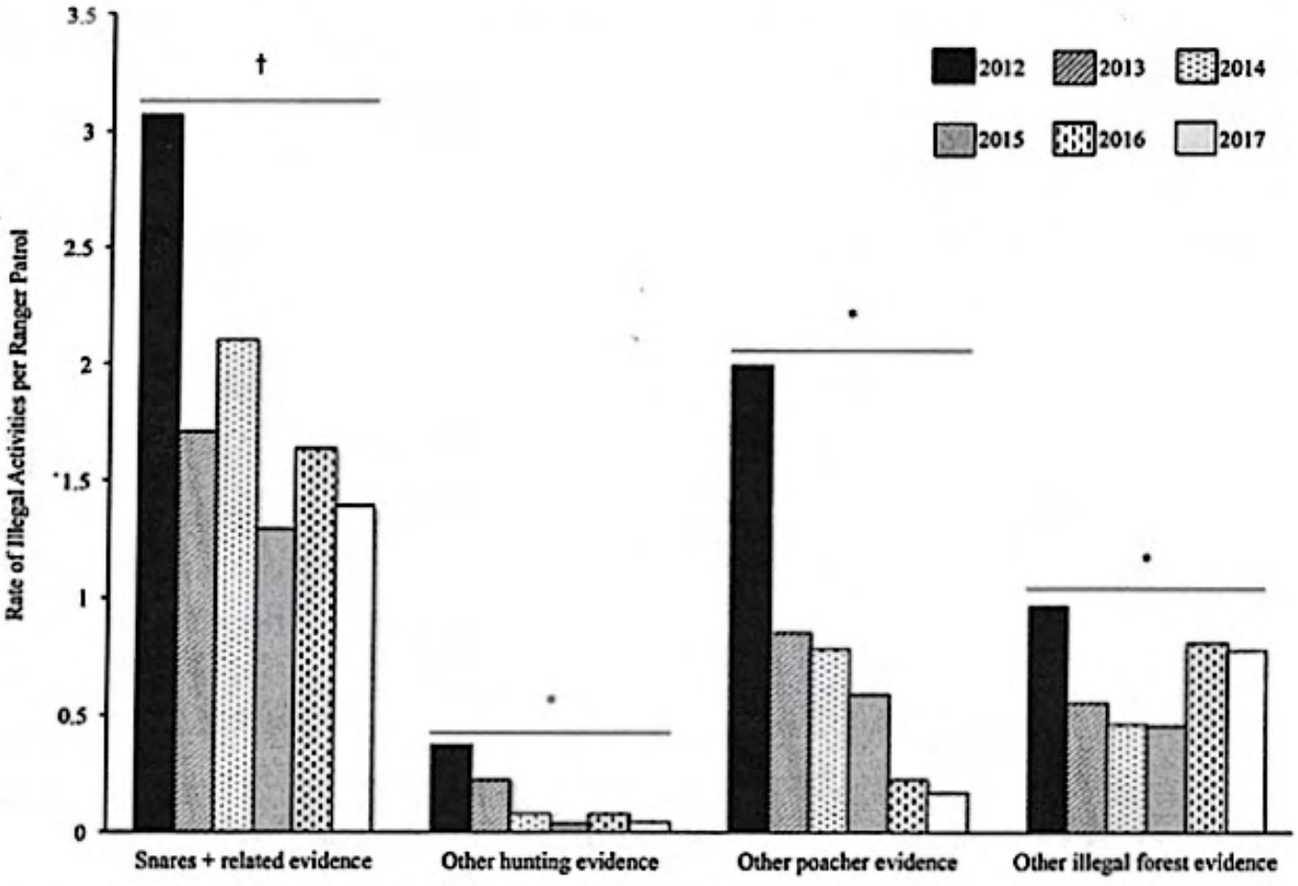

FIGURE 26.3. Over a five-year period (2012–2017), KSRP has observed a steady decline in all poacher-related activities per patrol (*$p < 0.05$; †approaching significance).

she or he struggles to break free, which only causes the snare to tighten even more and the likelihood of permanent injury to increase (fig. 26.1). Over the life of the program, KSRP patrols have resulted in the removal of 44.4 snares/month (on average) from Kibale. In 2014, when the program expanded to include two independent snare removal teams, the monthly snare removal average significantly increased from 39.2 (±3.1 SE) snares per month to 60.2 (±4.8 SE) snares per month ($t[192] = 3.5$, $p < 0.001$). While increased patrol effort and manpower over the life of the program may predict an increase in snare detection and removal per patrol, instead a significantly steady decline has been observed in all poacher-related activities from 2012 to 2017 ($F[1,4] = 12.4$, $p < 0.05$). Specifically, the number of snare ($F[1,4] = 5.9$, $p = 0.07$), non-snare hunting ($F[1,4] = 11.0$, $p < 0.05$), and non-hunting poacher ($F[1,4] = 17.7$, $p < 0.05$) activities per patrol have declined over recent years (fig. 26.3).

Data from 2009 to 2017 show that the type of illegal activity significantly influenced its distance from the park boundary ($F[3] = 566.8$, $p < 0.0001$). Snares tended to be more densely concentrated near the park boundary and outside of the Kanyawara chimpanzee home range (fig. 26.4). The average distance of snares from the park boundary was 0.9 km (±15 SE). Snares were significantly closer to the park boundary compared to other non-snare hunting (avg. 2.6 km ±104.2 SE; $t[5417] = -16.9$, $p < 0.0001$) and non-hunting

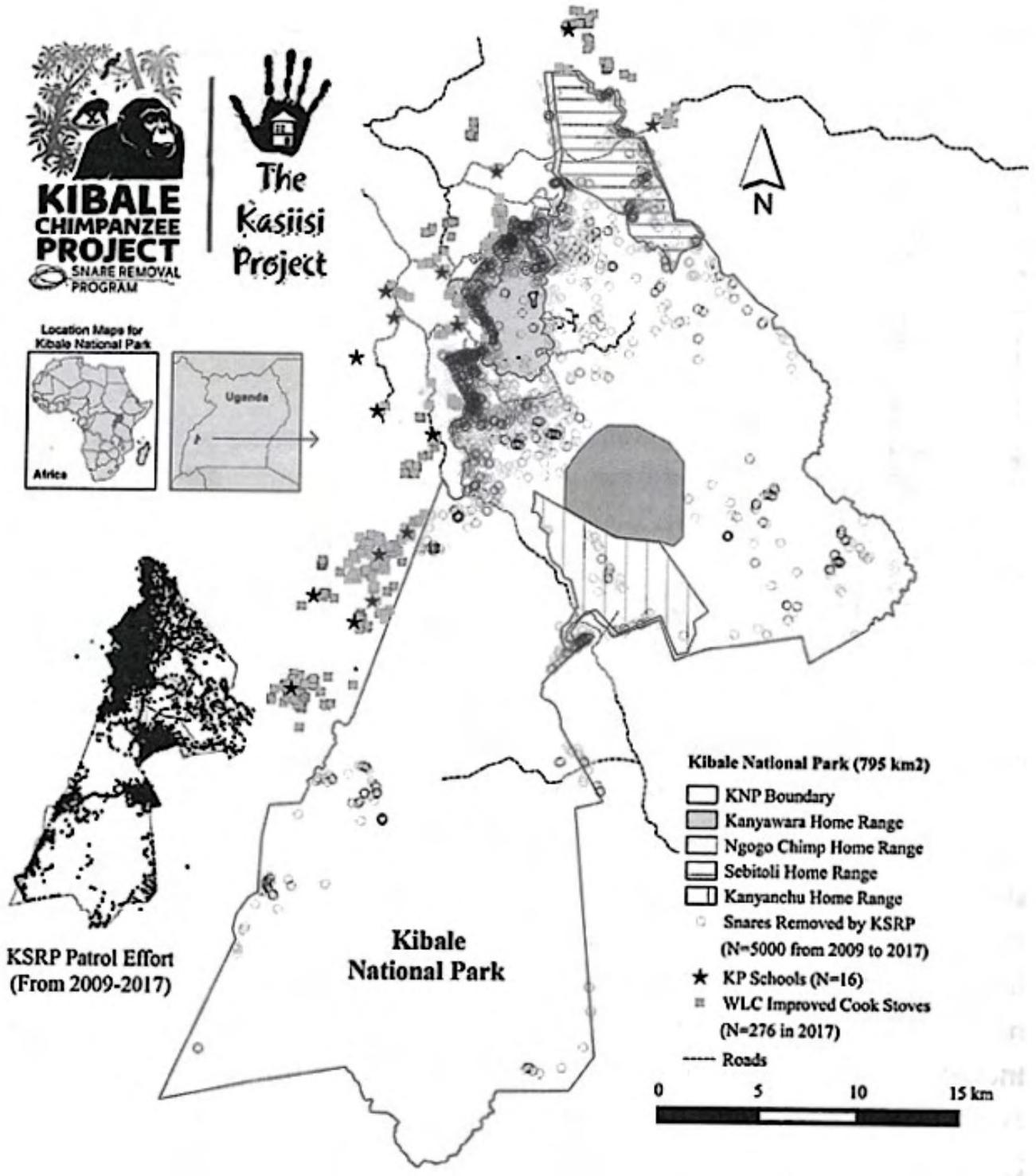

FIGURE 26.4. Larger map depicts the collaborative conservation work of KSRP (with UWA support) and Kasiisi Project both inside and outside of KNP. Snares occur at higher densities along the boundary of KNP and outside of the Kanaywara chimpanzee home range. As a community development initiative, Kasiisi Project students built improved cook stoves for local people living near KNP. KNP boundary shapefile downloaded from Protected Planet (2019) with reported area of 795 km^2 provided by UWA. Chimpanzee homerange shapefiles provide by Paco Bertolani (pers. comm.) for Kanyawara or created using maps published in Amsler (2009) for Ngogo and CCB (2015) for Kanyanchu and Sebitoli.

poacher (avg. 11.5 km ±36.4 SE; $t[6645] = -7.5$, $p < 0.0001$) activities. However, snares were significantly further from the park boundary compared to other non-poaching illegal activities (avg. 0.3 km ±10.0 SE; $t[7957] = 29.9$, $p < 0.0001$). The majority (65%) of KSRP patrol effort was outside of the Kanyawara chimpanzee home range. However, effort alone did not account for the high proportion of illegal activity (82%) observed outside of the well-

protected home range. This majority was significantly more than expected based on the percentage of patrol effort outside of the Kanyawara home range ($x^2[1] = 1278.0$, $p < 0.0001$). Only 15% of snare hunting, 7% of non-snare hunting, 18% of non-hunting poaching, and 22% of non-poaching illegal activities were observed within the home range.

Deforestation

In addition to snare removal, KSRP patrols help mitigate deforestation and resouce extraction in the park. Using MODIS data (NASA's Moderate Resolution Imaging Spectroradiometer data) to investigate changes in forest cover from 2000 to 2010, forest cover within the Kanyawara home range increased by +4.1% and by +0.7% for park areas within 5 km of Kanyawara. Conversely, forest cover in the remainder of (−2.7%) and outside (−3.1%) the national park declined during this same time period. Kibale has two other long-term chimpanzee field sites (Ngogo and Sebitoli) and one chimpanzee tourism site (Kanyanchu). Unlike Kanyawara, the other three long-term sites all showed forest cover decline: Ngogo (−3.8%), Sebitoli (−0.3%), and Kanyanchu (−6.2%, fig. 26.5). Simiar to the snare location pattern, and in support of the MODIS data, on-the-ground deforestation events documented by KSRP were concentrated more densely along the park boundary (avg. 0.3 km ±10 SE) and outside of the Kanyawara home range (77%).

KASIISI PROJECT

Academic Improvement

Academic performance is measured by government administered Primary Leaving Exams (PLE). Schools are divided into three types: 1) Kasiisi Project Core Schools—15+ year program members with full range of our academic programs, 2) Kasiisi Project Satellite Schools—fewer than eight-year program member with partial academic programs, and 3) non-Kasiisi Project Peer Schools. Data show improvement in PLE scores in all schools between 2004 and 2017 (lower scores are better, fig. 26.6), but Kasiisi Project schools significantly outperformed Peer Schools. In 2013 mean score for Kasiisi Project schools (16.02 ± 2.05) was significantly better than for peer schools (27.91 ± 1.55) (unpaired t-test: $t = 2.67$, df 26, $p < 0.01$). In Kabarole District, the most significant predictor of academic success in forest-edge schools was attending a Kasiisi Project school (MacKenzie et al. 2017b). Results from PLE scores in 2017 ranked five Kasiisi Project schools in the top 12 for the district despite

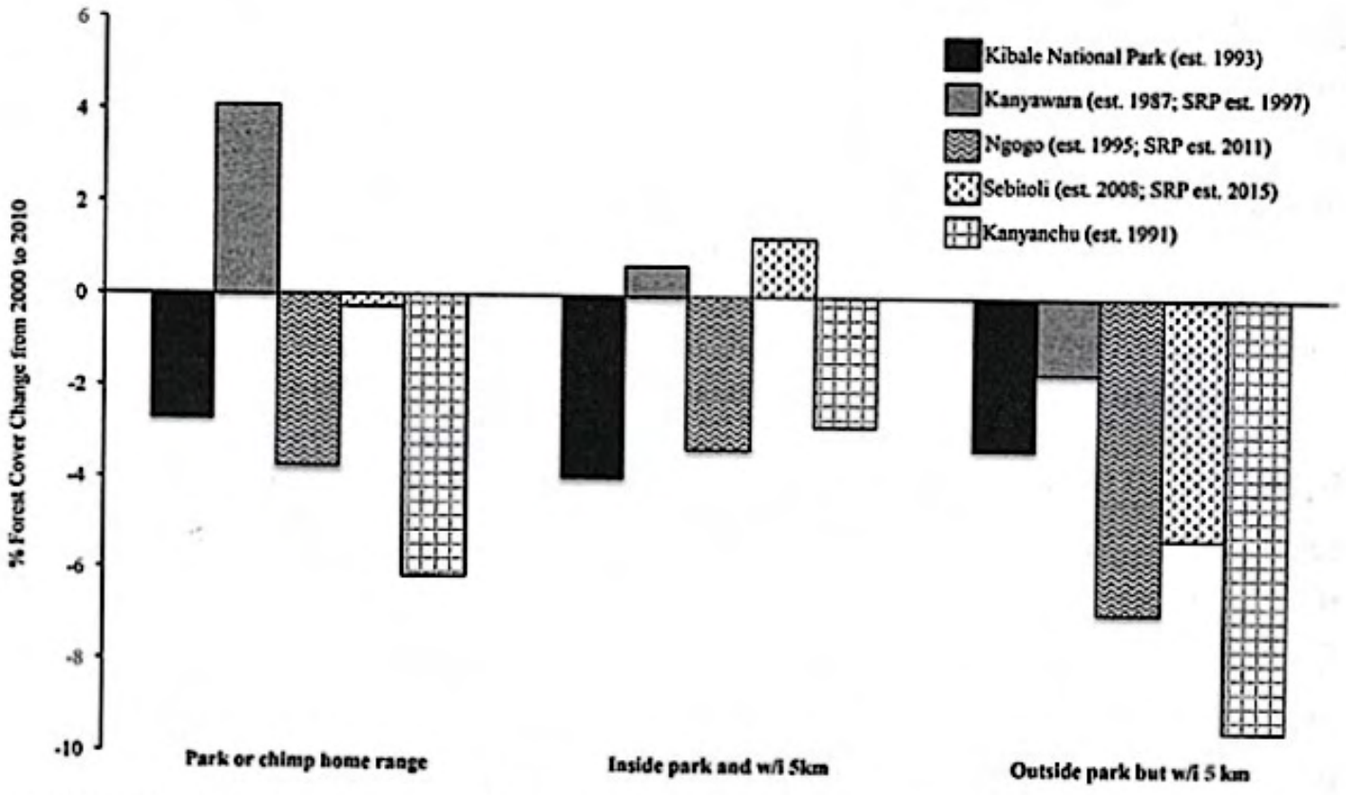

FIGURE 26.5. Kanyawara was the only area that showed an increase in tree cover over the 10-year period. It should be noted that while Kanyawara does have the longest running snare removal program of all the habituated field sites in Kibale, this area was selectively logged in the 1990s and forest regrowth may be contributing to an inflated value. Park or chimp home range represents the percent of forest cover change from 2000 to 2010 throughout KNP and also within the habituated chimpanzee community home ranges. Inside park and within 5 km represent boundary edges that are within 5 km of the park boundary or home range boundary and still fall within the park. Outside park but within 5 km represent boundary edges that are within 5 km of the park or home range boundary but are not inside the park boundary. Data from 2000 and 2010 MODIS satellite imagery.

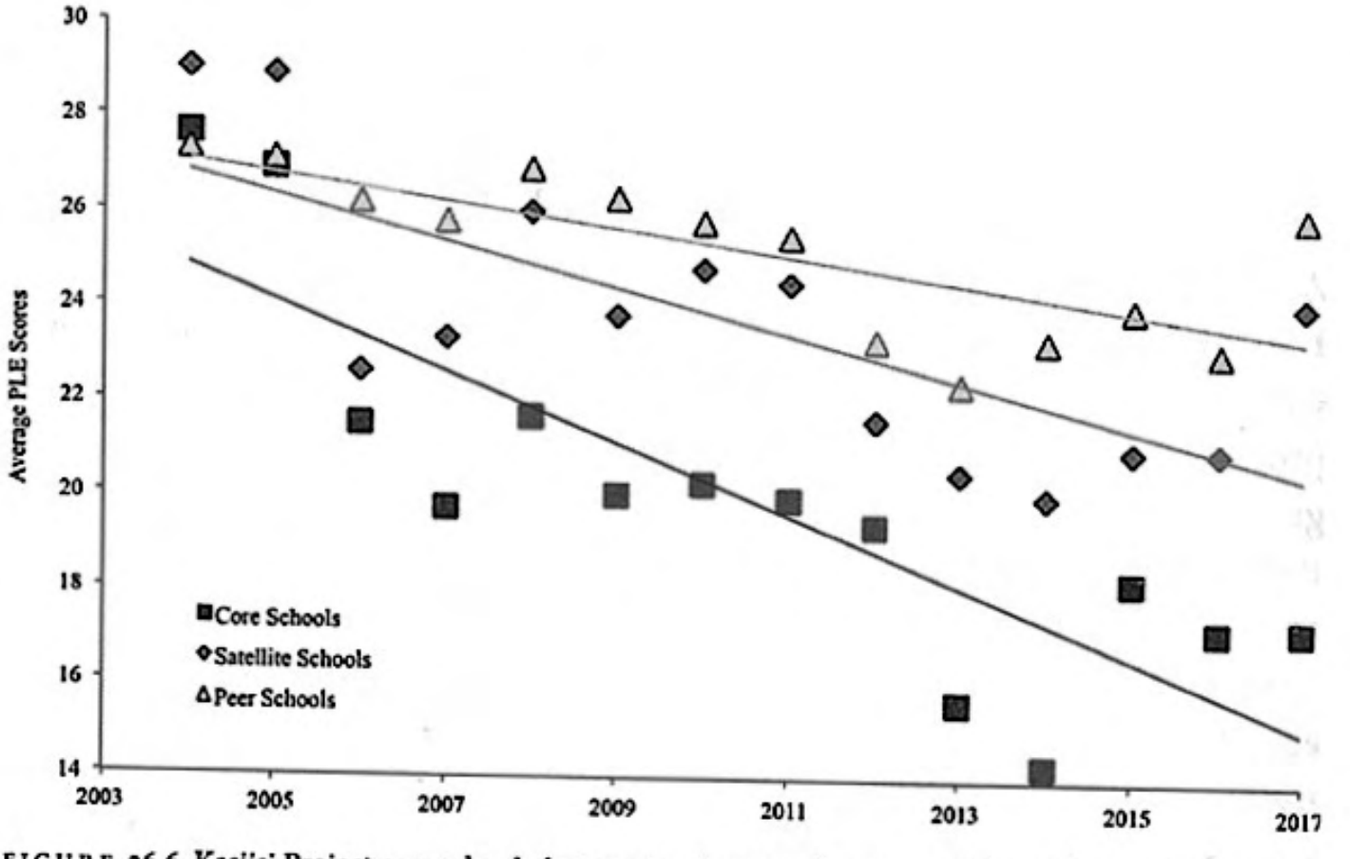

FIGURE 26.6. Kasiisi Project core schools (15+ year project members) outperformed both Kasiisi Project satellite schools (less than 8 year project members) and non-Kasiisi Project peer schools (no project membership). Lower Primary Leaving Exam (PLE) scores are better.

competition with private schools, which a) restrict enrollment and b) send poorly performing students to other PLE centers.

Conservation Education

Since 2007 we have collected data on schools' engagement in conservation programs, environmental knowledge, attitudes toward conservation, and rates of practical conservation activities in students, teachers, and parents.

When teachers were asked in 2008 what factors made teaching about the environment difficult, 60% cited lack of skills and knowledge, but by 2016 this dropped to only 10% of teachers. In 2016, teachers ranked Kasiisi Project conservation education programs highest in value to their schools and students (health ranked second).

In 2017, 14 Kasiisi Project/KFSP WLCs enrolled 680 children and conducted 135 conservation activities reaching 2,500 children. Enrollment and conservation activities in 2017 were up 40% from 2016 and 90% from 2015, indicating the schools' growing interest in good conservation education programs. In 2017, WLC members from Kasiisi Project schools scored significantly higher than non-members on environmental-based questions. Mean score for WLC members (5.44 ± 0.40) was higher than for non-WLC members (2.76 ± 0.68, unpaired t-test: $t = 3.3$, $df = 169$, $p < 0.001$). There was no difference in knowledge scores between members (2.65 ± 0.86) and non-members in control schools (3.05 ± 0.86, $t = 0.27$, $df = 34$, ns).

Mean children's attitude scores toward Kibale in Kasiisi Project schools were significantly higher in WLC members (1.27 ± 0.07) than non-members (0.89 ± 0.07, unpaired t-test: $t = 2.9$. $df = 279$, $p < 0.01$). Children's attitudes toward both Kibale and chimpanzees have significantly improved from 2011 to 2017 (fig. 26.2). Mean attitude scores toward Kibale were significantly higher in 2017 (1.41 ± 0.14) than 2011 (-0.13 ± 0.05, unpaired t-test: $t = 11$, $df = 791$, $p < 0.001$). Mean attitude scores toward chimpanzees were significantly higher in 2017 (1.14 ± 0.12) than 2011 (-0.13 ± 0.05, unpaired t-test: $t = 9.64$, $df = 755$, $p < 0.001$), a big change from 2011 when 66% responded with statements like "chimpanzees are dangerous" and "chimpanzees ruin our crops" (Glennon 2011).

Community Engagement and Trust

Our data show a growing engagement of parents in their children's conservation activities and increasing demands for accurate and practical environmental education.

In 2016, 65% knew the name of their child's WLC patron, 84% wanted more conservation education for their children, 87% wanted more engagement in their children's education, and 93% wanted their children to learn to conserve elephants.

In 2017, 276 families requested WLCs build fuel-efficient cookstoves in their homes (fig. 26.4), a 168% increase from 2016 (N = 103). In response to such community engagement requests, students from 14 Kasiisi Project schools completed over 390 practical conservation activities, including tree planting, building beehives and fuel-efficient stoves, planting sustainable gardens, and digging rubbish pits.

In 2017, 20% of parents ranked conservation as the most important program, even above those with more obvious practical impacts (i.e., 18% health, 15% sanitary pads, 14% latrines, 10% libraries, and 5% scholarships). Separate interviews with parents showed that 92% understood what the WLCs do, 89% had positive comments about it, and 75% agreed with conservation activities conducted at home as reported by their children.

Critical to gaining community support is trust—our most valuable asset and greatest achievement. We maintain a strong reputation for nonpartisanship, which shepherds our cooperation with parents, schools, and local government. Of 3,000 parents surveyed in 2016, 74% said that the Kasiisi Project could be trusted to be fair, a 164% increase since 2007. When asked for the best outcome from Kibale becoming a national park, 33% of parents said that it brought our programs to their communities, whereas 34% said increased income and employment.

Discussion

Due to the support and long-term presence of KCP, for over 20 years KSRP and Kasiisi Project have been active and collaborative players aiming to help conserve Kibale National Park. While both projects address chimpanzee conservation, each takes its own approach. KSRP uses on-the-ground tactics to promote chimpanzee conservation and preserve the integrity of Kibale in real-time, whereas Kasiisi Project uses educational tactics to sensitize young people and increase the likelihood they will adopt conservation practices as adults in the future. Simply put, KSRP functions as the immediate bandaid to poaching, while Kasiisi Project aims to be the future cure.

KSRP has been successful over the years in helping UWA to reduce the overall snare density in the park, particularly at Kanyawara, while concurrently sensitizing local communities and schools to snare and other poaching-related wildlife injuries and causalities. As a result of this collaborative effort,

the snare probability for chimpanzees and other wildlife in Kibale has declined along with other poacher threats. While cumulative snaring rates at Kanyawara exceed the estimated rate of chimpanzee snare injuries for Uganda (33%; Plumptre et al. 2010), rates among presently-living chimpanzees are lower (28%). Declining snare rates at Kanyawara suggest that the consistent presence of KSRP and UWA patrols may be acting as a deterent to local poachers within the Kanyawara home range. Contrary to the canopy cover declines observed in other areas of Kibale, the forest cover at Kanyawara has shown signs of regrowth following its logging in 1995. On all accounts, Kanyawara appears to be better protected than other areas within the park—an effect that is likely the combination of UWA-supported KSRP patrols plus many field assistants, students, long-term researchers, and trail cutters who also frequent the area. As a further deterrent, Kanyawara is home to the Makerere University Biological Field Station and an UWA outpost. For poachers, Kanyawara is more risky than other areas in the park. However, the snare and other illegal activity (i.e., firewood and forest product collection) pressure along the park boundary and outside of the Kanyawara home range remains intense and future efforts should concentrate more heavily in these areas.

The Kasiisi Project has worked diligently to make their rural forest schools academically, professionally, and practically competitive with private schools. Kasiisi Project schools have consistently outranked many private schools in the region, and have had many pupils receive academic scholarships and go on to graduate from local and international universities, including Harvard University. Some scholars have even returned to Kasiisi Project as teachers or administrators. Through their popular WLCs and conservation education programs, children's attitudes toward chimpanzees and other wildlife have improved, inspiring some to join UWA and work in conservation. Taï's educational outreach program reported similar attitudinal and behavioral shifts in 16 nearby villages due to the implementation of an interactive play about a chimpanzee's family whose mother is killed by a poacher. The chimpanzee family mourned the loss of their mother, exhibiting many human-like behaviors. The most common message retained by villagers four months after the play was "The chimpanzee is like a human," which reportedly led to reduced bushmeat consumption and a more positive perception of chimpanzees (Boesch et al. 2008b). The Kasiisi Project also regularly uses interactive student-based performance dramas with empathetic undertones to effectively communicate complex and culturally sensitive conservation messages to both children and adults.

Kasiisi Project has also given students the tools to implement practical conservation strategies at home through their fuel-efficient cookstoves and

other sustainability programs. However, it is difficult to measure the true effectiveness of these conservation education programs in real time. It may be a decade before Kasiisi Project students are in decision-making positions. Gradually, adults have recognized the value that Kasiisi Project brings to the community and are slowly becoming more open-minded and willing to change. In the meantime, Kasiisi Project is striving to empower students and give them the tools they need to succeed both personally and professionally, so unlike their parents, they will not have to depend on the forest for resources.

Long-term conservation can be enhanced by active conservation measures paired with a well-educated population with good environmental knowledge (Fiallo and Jacobson 1995; Kideghesho, Røskaft, and Kaltenborn 2007). By linking our programs to long-term research, school curricula, and community needs, we can galvanize today's youth and change attitudes and behavior in ways that have powerful and practical conservation benefits. In the past 20 years, in an area of forest with KSRP's active conservation program that is bordered by six Kasiisi Project school communities, the park boundary has not been eroded. In that time there have been many signs of success. There has been a 43% increase in the local chimpanzee community (from 42 individuals to 60; Muller and Wrangham 2014); populations of wild pigs, duiker, and monkeys have grown; and buffalo have returned to the forest swamps. Furthermore, the average time interval between snaring incidents in chimpanzees has risen from 8.9 to 13.0 months, and despite a 3-fold rise in elephant traps, relative abundance of elephants (measured by tracks crossing a set of trails walked twice a month for a year) have increased tenfold (Chapman, pers. comm.; Omeja et al. 2016; Wrangham, pers. comm.). On a small scale, what we are doing appears to be working for now.

Future Directions

While these programs have made measurable progress in and around Kibale, chimpanzees and the other wildlife living under their umbrella remain under siege from the expanding human population. Manpower has been key to increasing program success. In recent years, Ngogo and Sebitoli also established snare removal programs in and around their long-term field sites in Kibale, which has resulted in patrol coverage for approximately two-thirds of the park in addition to regular UWA patrols that strive to cover the entire park. Given that snare density is highest within 1 km of the park boundary, establishing additional patrol teams who could exclusively cover the park boundary zones in their entirety could further assist UWA's existing efforts to

discourage poachers from entering the park while increasing snare extraction rates. However, funding and program management can be a limiting factor. Other long-term field sites should work in collaboration with their national wildlife authority to establish their own conservation patrol teams who are focused on the anthropogenic threats most common in their region. Field sites in close proximity to one another should collaborate to maximize the coverage and effectiveness of their patrols.

In addition to scheduling regular patrols, we must be innovative in our approach to keep up with the compounding poacher presence. Alternative methods of poacher detection using drones (Bondi et al. 2018; Wich 2015) and camera traps (Hossain et al. 2016; Widness and Aronsen 2018) have been used in the past, but a growing area of interest is the use of conservation dogs (Hurt and Smith 2009). For some time now, detection dogs have been used to reliably locate the feces of many elusive species (i.e., black bear: Wasser et al. 2004; whales: Rolland et al. 2006), including primates (i.e., cross-river gorilla: Arandjelovic et al. 2014), with most studies reporting higher success rates in dog-directed surveys than human-directed efforts. Conservation dogs have been used to detect both biological scents (i.e., animal and human scents, including poachers) and non-biological scents (i.e., landmines, flammable products, hazardous chemicals) with a high degree of confidence (reviewed in Browne, Stafford, and Fordham 2006). Given their consistent success across diverse habitats (Leigh and Dominick 2015), this has led to the integration of dogs in conservation practices that extend beyond species and fecal detection (Hurt and Smith 2009). However, the data regarding snare detection is still spotty due to limited scent markers in the materials used. Working Dogs for Conservation is one organization that is currently marketing and testing the validity of using dogs to detect snares in savanna environments (Parker 2015). To date, however, there is no published information available on conservation dogs detecting snares in forested habitats, which is where most chimpanzee populations live. As more data become available and training techniques are perfected, this and other innovative approaches to conservation may revolutionize methods that wildlife authorities and conservation programs use to patrol protected areas while concurrently improving their effectiveness. Conservation dogs could also be an effective education tool in schools used to sensitize students to animals in general. However, this unorthodox method is not without challenges, including (but not limited to) extensive and continuous professional training of dogs and local handlers, mitigating zoonotic disease transmission threats, acquiring governmental clearance for use of dogs in a protected area, and providing preventative veterinary care, a balanced diet, sanitary and social housing with handlers, and armed protection

for the dogs. Moving forward, these innovation approaches should be further explored and evaluated in the context of chimpanzee conservation to revise best practices when and where applicable.

At times, we have found our chimpanzee conservation efforts to be limited by veterinary availability and response time. Until recently, our project did not employ a full-time veterinarian, and at times there was no resident wildlife veterinarian in the region. Whenever a chimpanzee was snared, we would immediately send an emergency request to the Jane Goodall Institute in Uganda to deploy a veterinarian with a UWA mandate. Over the years, very few veterinarians in Uganda have been qualified and authorized to intervene in chimpanzee snare injuries, which can be problematic for these time-sensistive injuries if authorized veterinarians are not immediately available to respond. Employing a permanent veterinarian who specializes in chimpanzees and other wildlife would not only benefit long-term projects, but also benefit the park in general. A resident veterinarian could also respond to anthropogenic-induced emergencies in real time throughout the park, continually monitor the health of local chimpanzee populations, and educate the local communities about anthrozoonotic disease transmission (Lukasik 2002). A resident veterinarian would likely maximize the probability of snare removal intervention success and reduce the likelihood of permanent injury. The Budongo Conservation Field Station employs a resident chimpanzee veterinarian for this very purpose, which has reduced respiratory and gastrointestinal infections (Asiimwe et al. 2016), improved emergency response time in the field, and benefited other neighboring chimpanzee communities living in forest fragments and human-dominated landscapes (McLennan and Asiimwe 2016; McLennan et al. 2012). Veterinarian retention and long-term funding is undoubtedly challenging, but field sites with larger service areas or limited access to local wildlife veterinarians should consider whether the conservation benefits could outweigh the financial and management costs. It should be noted that deciding whether or not and how to intervene is fraught with philosophical, ethical, and logistical challenges. Prior to interventions, projects should discuss and develop a "standard protocol" for intervention, contingency plans, logistical preparation, and training opportunities with their veterinarian (see Lonsdorf et al. 2014 for intervention lessons learned and recommendations).

While Kasiisi Project programs primarily target children as the decision makers of tomorrow, today some of their parents are poaching duiker and clearing forests—hence the immediate need for KSRP. Unfortunately, there remains a prevailing perspective from the local people that the drawbacks of

living close to the forest outweigh the benefits of such proximity (MacKenzie et al. 2017a). Time is of the essence and reaching beyond children to adults is urgent. Damerell, Howe, and Milner-Gulland (2013) found that educating children led to better conservation practices in their parents, suggesting that school-based programs can have an active reach beyond the children they target. In recent years, the Kasiisi Project has incorporated more forest schools along the northwestern boundary of the park into its program. The North Carolina Zoo's UNITE for the Environment program works in nine forest schools along the eastern boundary. Together they are implementing conservation education initiatives in schools along nearly half of the park's boundary. Long-term research programs should look for school and/or community-based NGOs they can partner with to develop and implement chimpanzee conservation initiatives near their study site. Researchers must invest in this effort and extend their involvement beyond the occasional talk or demonstration. Using a bottom-up approach, Kasiisi Project schools will continue to operate as the center of Kibale's rural communities to promote changing attitudes and practical conservation messages, starting with their students who then spread these values to their families and neighbors.

The KCP/KSRP-Kasiisi Project collaboration described in this chapter has been a voice of change in the region by providing desirable employment opportunities to local people while concurrently promoting chimpanzee research, conservation, and education initiatives. While there is still have a long way to go, improvements have been observed over the years in local people's actions and attitudes toward chimpanzees and the national park in general. We therefore recommend that other long-term field sites couple active, on-the-ground conservation strategies with consistent educational outreach in schools and local communities. A staying presence with regular programs is key to the success and local acceptance of these initiatives.

We extend a call to action to all chimpanzee researchers and long-term field sites to work together to develop and/or improve local conservation and education initiatives in their areas. We invite discussions and are happy to provide any resources for those interested in establishing programs and/or collaborating. After 20 years, we still remain committed to our mission and will continue to work with our local and international partners to conserve Kibale's chimpanzees and national park. Despite chimpanzees extreme behavioral flexibility in increasingly challenging anthropogenic environments (Hockings et al. 2009), the current trajectory is not sustainable. For the future of the species, it is imperative that we fight to keep chimpanzees in their own context—in viable habitats free of deadly anthropogenic threats.

Acknowledgments

We thank our field team, community educators, funders, and collaborators for their hard work, dedication, and generous support over the years. Without them, our work would not be possible.

KCP thanks the National Institutes of Health, National Science Foundation, Wenner-Gren Foundation, and Leakey Foundation for funding. KSRP thanks the Jane Goodall Institutes (JGI) in Austria, the Netherlands, and Switzerland for funding, and the North Carolina Zoo/UNITE for data collection devices and technical support. KCP and KSRP depend on long-term collaboration with the UWA and Makerere University Biological Field Station. Other important collaborators include the Uganda and USA JGI branches and the Ngogo and Sebitoli Chimpanzee Projects.

Kasiisi Project thanks the Disney Conservation Fund, Columbus Zoo, Cleveland Metroparks, National Geographic Soceity, Zoos and Aquariums Committed to Conservation, British and Foreign Schools Society, African Bird Club, and International Elephant Foundation for funding, and Francis Rwabuhinga, Gorret Nyabutono, Corey Dickinson, Zach Manta, Caroline Warne, and Sonya Kahlenberg for their hard work and contributions.

References

Adams, W. M., and J. Hutton. 2007. "People, parks and poverty: Political ecology and biodiversity conservation." *Conservation and Society* 5 (2): 147–83.

Adams, W. M., and M. Mulligan. 2003. *Decolonizing Nature: Strategies for Conservation in a Post-Colonial Era*. London: Earthscan Publications.

Amsler, S. J. 2009. "Ranging behavior and territoriality in chimpanzees at Ngogo, Kibale National Park, Uganda." PhD diss., University of Michigan.

Anderson, G. W., L. Gaffikin, L. Pintea, G. C. Kajembe, K. Yeboah, and B. J. Humplick. 2004. "Assessment of the Lake Tanganyika Catchment, Reforestation and Education (TACARE) project." Report to the US Agency for International Development and the Jane Goodall Institute. Washington, DC.

Arandjelovic, M., J. S. Head, C. Boesch, M. M. Robbins, and L. Vigilant. 2014. "Genetic inference of group dynamics and female kin structure in a western lowland gorilla population (*Gorilla gorilla gorilla*)." *Primate Biology* 1 (1): 29–38.

Asiimwe, C., G. Muhanguzi, E. Okwir, P. Okimat, A. W. Bugenyi, T. Mugabe, and F. Babweteera. 2016. "Transdisciplinary approach to solving conservation challenges: A case of Budongo Conservation Field Station, Uganda." *PeerJ Preprints* 4: e1848v1.

Babweteera, F., V. Reynolds, and K. Züberbuhler. 2008. "Conservation and research in the Budongo Forest Reserve, Masindi District, Western Uganda." In *Science and Conservation in African Forests: Benefits from Long-Term Research*, edited by R. W. Wrangham and E. A. Ross, 145–57. Cambridge: Cambridge University Press.

Blom, A., J. Yamindou, and H. H. T. Prins. 2004. "Status of the protected areas of the Central African Republic." *Biological Conservation* 118 (4): 479–87.

Boesch, C., H. Boesch, Z. Bertin, G. Bi, E. Normand, and I. Herbingee. 2008a. "The contribution of long-term research by the Taï Chimpanzee Project to conservation." In *Science and Conservation in African Forests: Benefits from Long-Term Research*, edited by R. W. Wrangham and E. A. Ross, 184–200. Cambridge: Cambridge University Press.

Boesch, C., C. Gnakouri, L. Marques, G. Nohon, I. Herbinger, F. Lauginie, H. Boesch, S. Kouamé, M. Traoré, and F. Akindes. 2008b. "Chimpanzee conservation and theatre: A case study of an awareness project around the Taï National Park, Côte d'Ivoire." In *Conservation in the 21st Century: Gorillas as a Case Study*, edited by T. S. Stoinski, H. D. Steklis, and P. T. Mehlman, 128–35. Boston: Springer.

Bondi, E., F. Fang, M. Hamilton, D. Kar, D. Dmello, J. Choi, R. Hannaford, A. Iyer, L. Joppa, M. Tambe, and R. Nevatia. 2018. "Spot poachers in action: Augmenting conservation drones with automatic detection in near real time." *Association for the Advancement of Artificial Intelligence*. https://www.cais.usc.edu/wp-content/uploads/2017/11/spot-camera-ready.pdf.

Borchers, C., C. Boesch, J. Riedel, H. Guilahoux, D. Ouattara, and C. Randler. 2014. "Environmental education in Côte d'Ivoire/West Africa: Extra-curricular primary school teaching shows positive impact on environmental knowledge and attitudes." *International Journal of Science Education, Part B* 4 (3): 240–59.

Brashares, J. S., P. Arcese, and M. K. Sam. 2001. "Human demography and reserve size predict wildlife extinction in West Africa." *Proceedings of the Royal Society of London B* 268 (1484): 2473–78.

Breuer, T., and F. B. Mavinga. 2010. "Education for the conservation of great apes and other wildlife in Northern Congo—The importance of nature clubs." *American Journal of Primatology* 72 (5): 454–61.

Brockington, D. 2004. "Community conservation, inequality and injustice: Myths of power in protected area management." *Conservation and Society* 2 (2): 411–32.

Browne, C., K. Stafford, and R. Fordham. 2006. "The use of scent-detection dogs." *Irish Veterinary Journal* 59 (2): 97–104.

Bruner, A. G., R. E. Gullison, R. E. Rice, and G. A. B. Da Fonseca. 2001. "Effectiveness of parks in protecting tropical biodiversity." *Science* 291 (5501): 125–28.

Butchart, S. H. M., M. Walpole, B. Collen, A. Van Strien, J. P. W. Scharlemann, R. E. A. Almond, J. E. M. Baillie, B. Bomhard, C. Brown, J. Bruno, K. E. Carpenter, G. M. Carr, J. Chanson, A. M. Chenery, J. Csirke, N. C. Davidson, F. Dentener, M. Foster, A. Galli, J. N. Galloway, P. Genovesi, R. D. Gregory, M. Hockings, V. Kapos, J. F. Lamarque, F. Leverington, J. Loh, M. A. McGeoch, L. McRae, A. Minasyan, M. Hernández Morcillo, T. E. E. Oldfield, D. Pauly, S. Qader, C. Revenga, J. R. Sauer, B. Skolnik, D. Spear, D. Stanwell-Smith, S. N. Stuart, A. Symes, M. Tierney, T. D. Tyrrell, J. C. Vie, and R. Watson. 2010. "Global biodiversity: Indicators of recent declines." *Science*: 1187512.

Bwambale, T. 2012. "Uganda has the youngest population in the world." *New Vision*, December 14. https://www.newvision.co.ug/new_vision/news/1311368/uganda-population-world.

Campbell, G., and M. Houngbedji. 2015. "Conservation status of the West African chimpanzee (*Pan troglodytes verus*) in Togo and Benin." Unpublished report to Primate Action Fund.

Campbell, G., H. Kuehl, A. Diarrassouba, P. K. N'Goran, and C. Boesch. 2011. "Long-term research sites as refugia for threatened and over-harvested species." *Biology Letters* 7 (5): 723–26.

Campbell, G., H. Kuehl, P. N'Goran Kouamé, and C. Boesch. 2008. "Alarming decline of West African chimpanzees in Côte d'Ivoire." *Current Biology* 18 (19): R903–4.

Chapman, C. A., and R. W. Wrangham. 1993. "Range use of the forest chimpanzees of Kibale: Implications for the understanding of chimpanzee social organization." *American Journal of Primatology* 3 (4): 263–73.

Chawla, L. 2007. "Childhood experiences associated with care for the natural world: A theoretical framework for empirical results." *Children Youth and Environments* 17 (4): 144–70.

Climate, Community, and Biodiversity (CCB). 2015. "Natural high forest rehabilitation project on degraded land of Kibale National Park." Project Design Document, V2.1.

Cohen, J. 2010. "A matter of life and limb." *Science* 328 (5974): 33.

Collins, A., and J. Goodall. 2008. "Long-term research and conservation in Gombe National Park, Tanzania." In *Science and Conservation in African Forests: Benefits from Long-Term Research*, edited by R. W. Wrangham and E. A. Ross, 158–72. Cambridge: Cambridge University Press.

Cowlishaw, G., and R. I. M. Dunbar. 2000. *Primate Conservation Biology*. Chicago: University of Chicago Press.

Critchlow, R., A. J. Plumptre, M. Driciru, A. Rwetsiba, E. J. Stokes, C. Tumwesigye, F. Wanyama, and C. M. Beale. 2015. "Spatiotemporal trends of illegal activities from ranger-collected data in a Ugandan national park." *Conservation Biology* 29 (5): 1458–70.

Damerell, P., C. Howe, and E. J. Milner-Gulland. 2013. "Child-orientated environmental education influences adult knowledge and household behaviour." *Environmental Research Letters* 8 (1): 015016.

Dowie, M. 2011. *Conservation Refugees: The Hundred-Year Conflict between Global Conservation and Native Peoples*. Cambridge, MA: MIT Press.

Estrada, A., P. A. Garber, A. B. Rylands, C. Roos, E. Fernandez-Duque, A. Di Fiore, K. A. I. Nekaris, V. Niijman, E. W. Heymann, J. E. Lambert, F. Rovero, C. Barelli, J. M. Setchell, T. R. Gillespie, R. A. Mittermeier, V. Verde Arregoitia, M. de Guinea, S. Gouveia, R. Dobrovolski, S. Shanee, N. Shanee, S. A. Boyle, A. Fuentes, K. C. MacKinnon, K. R. Amato, A. L. S. Meyer, S. Wich, R. W. Sussman, R. Pan, I. Kone, and B. Li. 2017. "Impending extinction crisis of the world's primates: Why primates matter." *Science Advances* 3: e1600946.

Fashing, P. J., and M. Cords. 2000. "Diurnal primate densities and biomass in the Kakamega Forest: An evaluation of census methods and a comparison with other forests." *American Journal of Primatology* 50 (2): 139–52.

Fiallo, E. A., and S. K. Jacobson. 1995. "Local communities and protected areas: Attitudes of rural residents towards conservation and Machalilla National Park, Ecuador." *Environmental Conservation* 22 (3): 241–49.

Fitzgerald, M., R. Coulson, A. M. Lawing, T. Matsuzawa, and K. Koops. 2018. "Modeling habitat suitability for chimpanzees (*Pan troglodytes verus*) in the Greater Nimba Landscape, Guinea, West Africa." *Primates*: 1–15.

Garriga, R. M., I. Marco, E. Casas-Díaz, B. Amarasekaran, and T. Humle. 2017. "Perceptions of challenges to subsistence agriculture, and crop foraging by wildlife and chimpanzees *Pan troglodytes verus* in unprotected areas in Sierra Leone." *Oryx* 52 (4): 761–74.

Ginn, L. P., J. Robison, I. Redmond, and K. A. I. Nekaris. 2013. "Strong evidence that the West African chimpanzee is extirpated from Burkna Faso." *Oryx* 47: 325–26.

Glennon, E. 2011. "The effect of conservation education programs on students' wildlife knowledge and attitudes toward conservation in primary schools Surrounding Kibale National Park, Uganda." Senior thesis, Bates College.

Goldman, A., J. N. Hartter, J. Southworth, and M. W. Binford. 2008. "The human landscape around the island park: Impacts and responses to Kibale National Park." In *Science and Conservation in African Forests: Benefits from Long-Term Research*, edited by R. W. Wrangham and E. A. Ross, 158–72. Cambridge: Cambridge University Press.

Greengrass, E. J. 2009. "Chimpanzees are close to extinction in southwest Nigeria." *Primate Conservation* 24: 77–83.

Hockings, K. J. 2009. "Living at the interface: Human–chimpanzee competition, coexistence and conflict in Africa." *Interaction Studies* 10 (2): 183–205.

Hossain, A. N. M., A. Barlow, C. Greenwood Barlow, A. J. Lynam, S. Chakma, and T. Savini. 2016. "Assessing the efficacy of camera trapping as a tool for increasing detection rates of wildlife crime in tropical protected areas." *Biological Conservation* 201: 314–19.

Humle, T., F. Maisels, J. F. Oates, A. Plumptre, and E. A. Williamson. 2016. "*Pan troglodytes* (errata version published in 2018)." *The IUCN Red List of Threatened Species 2016*: e.T15933A129038584.

Hurt, A., and D. A. Smith. 2009. "Conservation dogs." In *Canine Ergonomics: The Science of Working Dogs*, edited by W. S. Helton, 175–94. Boca Raton: CRC Press.

Kablan, Y. A., A. Diarrassouba, R. Mundry, G. Campbell, E. Normand, H. S. Kühl, I. Koné, and C. Boesch. 2017. "Effects of anti-poaching patrols on the distribution of large mammals in Taï National Park, Côte d'Ivoire." *Oryx* 53 (3): 469–78.

Kasenene, J. M., and E. A. Ross. 2008. "Community benefits from long-term research programs: A case study from Kibale National Park, Uganda." In *Science and Conservation in African Forests: Benefits from Long-Term Research*, edited by R. W. Wrangham and E. A. Ross, 158–72. Cambridge: Cambridge University Press.

Kideghesho, J. R., E. Røskaft, and B. P. Kaltenborn. 2007. "Factors influencing conservation attitudes of local people in Western Serengeti, Tanzania." *Biodiversity and Conservation* 16 (7): 2213–30.

Knapp, E. J., N. Peace, and L. Bechtel. 2017. "Poachers and poverty: Assessing objective and subjective measures of poverty among illegal hunters outside Ruaha National Park, Tanzania." *Conservation and Society* 15 (1): 24.

Kormos, R., C. Boesch, M. I. Bakarr, and T. M. Butynski. 2003. *West African Chimpanzees: Status Survey and Conservation Action Plan*. Gland, Switzerland: IUCN.

Kouassi, J. A. K., E. Normand, I. Koné, and C. Boesch. 2017. "Bushmeat consumption and environmental awareness in rural households: A case study around Taï National Park, Côte d'Ivoire." *Oryx* 53 (2): 293–99.

Kühl, H. S., T. Sop, E. A. Williamson, R. Mundry, D. Brugière, G. Campbell, H. Cohen, E. Danquah, L. Ginn, I. Herbinger, S. Jones, J. Junker, R. Kormos, C. Y. Kouakou, P. N'Goran, E. Normand, K. Shutt-Phillips, A. Tickle, E. Vendras, A. Welsh, E. G. Wessling, and C. Boesch. 2017. "The critically endangered western chimpanzee declines by 80%." *American Journal of Primatology* 79 (9): e22681.

Lamarque, F., J. Anderson, R. Fergusson, M. Lagrange, Y. Osei-Owusu, and L. Bakker. 2009. *Human-Wildlife Conflict in Africa: Causes, Consequences and Management Strategies*. FAO Forestry Paper no. 157. Rome: Food and Agriculture Organization of the United Nations.

Lambert, J. E. 2011. "Primate seed dispersers as umbrella species: A case study from Kibale National Park, Uganda, with implications for Afrotropical forest conservation." *American Journal of Primatology* 73 (1): 9–24.

Lee, P. C., and N. E. C. Priston. 2005. "Human attitudes to primates: Perceptions of pests, conflict and consequences for primate conservation." In *Commensalism and Conflict: The*

Human-Primate Interface, edited by J. D. Paterson and J. Wallis, 1–23. Norman, OK: American Society of Primatologists.

Leeds, A., K. E. Lukas, C. J. Kendall, M. A. Slavin, E. A. Ross, M. M. Robbins, D. van Weeghel, and R. A. Bergl. 2017. "Evaluating the effect of a year-long film focused environmental education program on Ugandan student knowledge of and attitudes toward great apes." *American Journal of Primatology* 79 (8): e22673.

Leigh, K. A., and M. Dominick. 2015. "An assessment of the effects of habitat structure on the scat finding performance of a wildlife detection dog." *Methods in Ecology and Evolution* 6 (7): 745–52.

Lonsdorf, E., D. Travis, R. Ssuna, E. Lantz, M. Wilson, K. Gamble, K. Terio, F. Leendertz, B. Ehlers, B. Keele, B. Hahn, T. Gillespie, J. Pond, J. Raphael, and A. Collins. 2014. "Field immobilization for treatment of an unknown illness in a wild chimpanzee (*Pan troglodytes schweinfurthii*) at Gombe National Park, Tanzania: Findings, challenges, and lessons learned." *Primates* 55 (1): 89–99.

Lukasik, M. 2002. "Establishing a long-term veterinary project for free-ranging chimpanzees in Tanzania." *Pan Africa News* 9 (2): 13–17.

Lwanga, J. S., and G. Isabirye-Basuta. 2008. "Long-term perspectives on forest conservation: Lessons from research in Kibale National Park." In *Science and Conservation in African Forests: Benefits from Long-Term Research*, edited by R. W. Wrangham and E. A. Ross, 158–72. Cambridge: Cambridge University Press.

MacKenzie, C. A., and P. Ahabyona. 2012. "Elephants in the garden: Financial and social costs of crop raiding." *Ecological Economics* 75: 72–82.

MacKenzie, C. A., S. P. Moffatt, J. Ogwang, P. Ahabyona, and R. R. Sengupta. 2017a. "Spatial and temporal patterns in primary school enrollment and exam achievement in rural Uganda." *Children's Geographies* 15 (3): 334–48.

MacKenzie, C. A., J. Salerno, J. Hartter, C. A. Chapman, R. R. Reyna, D. Mwesigye Tumusiime, and M. Drake. 2017b. "Changing perceptions of protected area benefits and problems around Kibale National Park, Uganda." *Journal of Environmental Management* 200: 217–28.

Matsuzawa, T., T. Humle, and Y. Sugiyama. 2011. *The Chimpanzees of Bossou and Nimba*. Tokyo: Springer.

Matsuzawa, T., and M. Kourouma. 2008. "The Green Corridor Project: Long-term research and conservation in Bossou, Guinea." In *Science and Conservation in African Forests: Benefits from Long-Term Research*, edited by R. W. Wrangham and E. A. Ross, 201–12. Cambridge: Cambridge University Press.

McCarthy, M. S., J. D. Lester, E. J. Howe, M. Arandjelovic, C. B. Stanford, and L. Vigilant. 2015. "Genetic censusing identifies an unexpectedly sizeable population of an endangered large mammal in a fragmented forest landscape." *BMC Ecology* 15 (1): 21.

McLennan, M. R. 2010. "Chimpanzee ecology and interactions with people in an unprotected human-dominated landscape at Bulindi, Western Uganda." PhD diss., Oxford Brookes University.

McLennan, M. R., and C. Asiimwe. 2016. "Cars kill chimpanzees: Case report of a wild chimpanzee killed on a road at Bulindi, Uganda." *Primates* 57 (3): 377–88.

McLennan, M. R., and C. M. Hill. 2012. "Troublesome neighbours: Changing attitudes towards chimpanzees (*Pan troglodytes*) in a human-dominated landscape in Uganda." *Journal for Nature Conservation* 20 (4): 219–27.

McLennan, M. R., D. Hyeroba, C. Asiimwe, V. Reynolds, and J. Wallis. 2012. "Chimpanzees in mantraps: Lethal crop protection and conservation in Uganda." *Oryx* 46 (4): 598–603.

Mittermeier, R. A., P. R. Gil, M. Hoffman, J. Pilgrim, T. Brooks, C. G. Mittermeier, J. Lamoreux, and G. A. B. da Fonseca. 2005. *Hotspots Revisited: Earth's Biologically Richest and Most Endangered Terrestrial Ecoregions*. Arlington, VA: Conservation International.

Morgan, B. J., A. Adeleke, T. Bassey, R. Bergl, A. Dunn, R. Fotso, E. Gadsby, K. Gonder, E. Greengrass, D. Koutou Koulagna, G. Mbah, A. Nicholas, J. Oates, F. Omeni, Y. Saidu, V. Sommer, J. Sunderland-Groves, J. Tiebou, and E. Williamson. 2011. "Regional action plan for the conservation of the Nigeria–Cameroon chimpanzee (*Pan troglodytes ellioti*)." IUCN/SSC Primate Specialist Group and Zoological Society of San Diego.

Morgan, D., C. Sanz, D. Greer, T. Rayden, F. Maisels, and E. Williamson. 2013. "Great apes and FSC: Implementing 'ape friendly' practices in Central Africa's logging concessions." Gland, Switzerland: IUCN/SSC Primate Specialist Group.

Muller, M. N., and R. W. Wrangham. 2014. "Mortality rates among Kanyawara chimpanzees." *Journal of Human Evolution* 66: 107–14.

Mwesigwa, A. 2015. "Uganda's success in universal primary education falling apart." *Guardian*, April 23.

Naughton-Treves, L. I. S. A. 1997. "Farming the forest edge: Vulnerable places and people around Kibale National Park, Uganda." *Geographical Review* 87 (1): 27–46.

Nelleman, C., and A. Newton. 2002. "Great apes—The road ahead. An analysis of great ape habitat, using GLOBIO methodology." Nairobi: UNEP.

N'Goran, P. K., C. Boesch, R. Mundry, E. K. N'Goran, I. Herbinger, F. A. Yapi, and H. S. Kuehl. 2012. "Hunting, law enforcement, and African primate conservation." *Conservation Biology* 26 (3): 565–71.

Nishida, T., and M. Nakamura. 2008. "Long-term research and conservation in the Mahale Mountains, Tanzania." In *Science and Conservation in African Forests: Benefits from Long-Term Research*, edited by R. W. Wrangham and E. A. Ross, 173–83. Cambridge: Cambridge University Press.

Nishida, T., R. W. Wrangham, J. H. Jones, A. Marshall, and J. Wakibara. 2000. "Do chimpanzees survive the 21st century." In *The Apes: Challenges for the 21st Century, Conference Proceedings*, edited by Brookfield Zoo, 43–51. Brookfield, IL: Chicago Zoological Society.

Oates, J. F., G. H. Whitesides, A. G. Davies, P. G. Waterman, S. M. Green, G. L. Dasilva, and S. Mole. 1990. "Determinants of variation in tropical forest primate biomass: New evidence from West Africa." *Ecology* 71 (1): 328–43.

Omeja, P. A., M. J. Lawes, A. Corriveau, K. Valenta, D. Sarkar, F. Pozzan Paim, and C. A. Chapman. 2016. "Recovery of tree and mammal communities during large-scale forest regeneration in Kibale National Park, Uganda." *Biotropica* 48 (6): 770–79.

Parker, M. 2015. "Assessment of detection and tracking dog programs in Africa. Working Dogs for Conservation." https://wd4c.org/

Parsons, M. B., T. R. Gillespie, E. V. Lonsdorf, D. Travis, I. Lipende, B. Gilagiza, S. Kamenya, L. Pintea, and G. M. Vazquez-Prokopec. 2014. "Global positioning system data-loggers: A tool to quantify fine-scale movement of domestic animals to evaluate potential for zoonotic transmission to an endangered wildlife population." *PLoS One* 9 (11): e110984.

Piel, A. K., A. Lenoel, C. Johnson, and F. A. Stewart. 2015. "Deterring poaching in western Tanzania: The presence of wildlife researchers." *Global Ecology and Conservation* 3: 188–99.

Plumptre, A. J., T. R. B. Davenport, M. Behangana, R. Kityo, G. Eilu, P. Ssegawa, C. Ewango, D. Meirte, C. Kahindo, M. Herremans, J. K. Peterhans, J. D. Pilgrim, M. Wilson, M. Languy, and D. Moyer. 2007. "The biodiversity of the Albertine rift." *Biological Conservation* 134 (2): 178–94.

Plumptre, A. J., R. Rose, G. Nangendo, E. A. Williamson, K. Didier, J. Hart, F. Mulindahabi, C. Hicks, B. Griffin, H. Ogawa, S. Nixon, L. Pintea, A. Vosper, M. McLennan, F. Amsini, A. McNeilage, J. R. Makana, M. Kanamori, A. Hernanex, A. Piel, F. Stewart, J. Moore, K. Zamma, M. Nakamura, S. Kamenya, G. Idani, T. Sakamaki, M. Yoshikawa, D. Greer, S. Tranquilli, R. Beyers, C. Hashimoto, T. Furuichi, and E. Bennett. 2010. "Eastern chimpanzee (*Pan troglodytes schweinfurthii*): Status survey and conservation action plan 2010–2020." Gland, Switzerland: IUCN.

Population Reference Bureau (PRB). 2017. "2017 World Population Data Sheet." https://www.prb.org/2017-world-population-data-sheet/.

Pusey, A. E., L. Pintea, M. L. Wilson, S. Kamenya, and J. Goodall. 2007. "The contribution of long-term research at Gombe National Park to chimpanzee conservation." *Conservation Biology* 21 (3): 623–34.

Reynolds, V. 2005. *The Chimpanzees of the Budongo Forest: Ecology, Behaviour and Conservation.* New York: Oxford University Press.

Rolland, R. M., P. K. Hamilton, S. D. Kraus, B. Davenport, R. M. Gillett, and S. K. Wasser. 2006. "Faecal sampling using detection dogs to study reproduction and health in north Atlanta right whales (*Eubalaena glacialis*)." *Journal of Cetacean Research and Management* 8 (2): 121–25.

Scully, E. J., S. Basnet, R. W. Wrangham, M. N. Muller, E. Otali, D. Hyeroba, K. A. Grindle, T. E. Pappas, M. Emery Thompson, Z. Machanda, K. E. Watters, A. C. Palmenberg, J. E. Gern, and T. L. Goldberg. 2018. "Lethal respiratory disease associated with human rhinovirus C in wild chimpanzees, Uganda, 2013." *Emerging Infectious Diseases* 24 (2): 267–74.

Shaffer, C. A., M. S. Milstein, C. Yukuma, E. Marawanaru, and P. Suse. 2017. "Sustainability and comanagement of subsistence hunting in an indigenous reserve in Guyana." *Conservation Biology* 31 (5): 1119–31.

Struhsaker, T. T., P. J. Struhsaker, and K. S. Siex. 2005. "Conserving Africa's rain forests: Problems in protected areas and possible solutions." *Biological Conservation* 123 (1): 45–54.

Tranquilli, S., M. Abedi-Lartey, K. Abernethy, F. Amsini, A. Asamoah, C. Balangtaa, S. Blake, E. Bouanga, T. Breuer, T. M. Brncic, G. Campbell, R. Chancellor, C. A. Chapman, T. R. B. Davenport, A. Dunn, J. Dupain, A. Ekobo, M. Eno-Nku, G. Etoga, T. Furuichi, S. Gatti, A. Ghiurghi, C. Hashimoto, J. A. Hart, J. Head, M. Hega, I. Herbinger, T. C. Hicks, L. H. Holbech, B. Huijbregts, H. S. Kuhl, I. Imong, S. Le-Duc Yeno, J. Linder, P. Marshall, P. Minasoma Lero, D. Morgan, L. Mubalama, P. K. N'Goran, A. Nicholas, S. Nixon, E. Normand, L. Nziguyimpa, Z. Nzooh-Dongmo, R. Ofori-Amanfo, B. G. Ogunjemite, C. A. Petre, H. J. Rainey, S. Regnaut, O. Robinso, A. Rundus, C. M. Sanz, D. Tiku Okon, A. Todd, Y. Warren, and V. Sommer. 2014. "Protected areas in tropical Africa: Assessing threats and conservation activities." *PLoS One* 9 (12): e114154.

Tranquilli, S., M. Abedi-Lartey, F. Amsini, L. Arranz, A. Asamoah, O. Babafemi, N. Barakabuye, G. Campbell, R. Chancellor, T. R. B. Davenport, A. Dunn, J. Dupain, C. Ellis, G. Etoga, T. Furuichi, S. Gatti, A. Ghiurghi, E. Greengrass, C. Hashimoto, J. Hart, I. Herbinger, T. C. Hicks, L. H. Holbech, B. Huijbregts, I. Imong, N. Kumpel, F. Maisels, P. Marshall, S. Nixon, E. Normand, L. Nziguyimpa, Z. Nzooh-Dogmo, D. Tiku Okon, A. Plumptre, A. Rundus, J. Sunderland-Groves, A. Todd, Y. Warren, R. Mundry, C. Boesch, and H. Kuehl. 2011. "Lack of conservation effort rapidly increases African great ape extinction risk." *Conservation Letters* 5 (1): 48–55.

Tumusiime, D. M., and P. Vedeld. 2015. "Can biodiversity conservation benefit local people? Costs and benefits at a strict protected area in Uganda." *Journal of Sustainable Forestry* 34 (8): 761–86.

Tweheyo, M., C. M. Hill, and J. Obua. 2005. "Patterns of crop raiding by primates around the Budongo Forest Reserve, Uganda." *Wildlife Biology* 11 (3): 237–47.

Uganda National Population Council (UNPC). 2017. "Transforming Uganda's economy: Opportunities to harness the demographic dividend for sustainable development." State of Uganda Population Report (SUPRE).

UNEP-WCMC and IUCN. 2019. "Protected planet: The World Database on Protected Areas (WDPA)." Cambridge: UNEP-WCMC and IUCN. www.protectedplanet.net.

Wasser, S. K., B. Davenport, E. R. Ramage, K. E. Hunt, M. Parker, C. Clark, and G. Stenhouse. 2004. "Scat detection dogs in wildlife research and management: Application to grizzly and black bears in the Yellowhead Ecosystem, Alberta, Canada." *Canadian Journal of Zoology* 82: 475–92.

Wich, S. A. 2015. "Drones and conservation." In *Drones and Aerial Observation: New Technologies for Property Rights, Human Rights, and Global Development*, 63–70. Washington, DC: New America.

Widness, J., and G. P. Aronsen. 2018. "Camera trap data on mammal presence, behaviour and poaching: A case study from Mainaro, Kibale National Park, Uganda." *African Journal of Ecology* 56: 383–89.

Williamson, E. A., and K. Fawcett. 2018. "Long-term research and conservation of the Virunga mountain gorillas." In *Science and Conservation in African Forests: The Benefits of Long-Term Research*, edited by R. W. Wrangham and E. A. Ross, 213–29. Cambridge: Cambridge University Press.

World Population Review (WPR). 2017. "Uganda population." Accessed December 20, 2017. http://worldpopulationreview.com/countries/uganda-population/.

Wrangham, R. W., and S. Mugume. 2000. "Snare removal program in Kibale National Park: A preliminary report." *Pan Africa News* 7 (2).

Wrangham, R. W., and E. A. Ross. 2008. *Science and Conservation in African Forests: The Benefits of Long-Term Research*. Cambridge: Cambridge University Press.

Wrangham, R. W., M. Wilson, B. Hare, and N. D. Wolfe. 2000. "Chimpanzee predation and the ecology of microbial exchange." *Microbial Ecology in Health and Disease* 12 (3): 186–88.

Wright, S. J. 2005. "Tropical forests in a changing environment." *Trends in Ecology & Evolution* 20 (10): 553–60.

Chimpanzees in Context

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With a Foreword by Jane Goodall

The University of Chicago Press
Chicago and London

The University of Chicago Press, Chicago 60637
The University of Chicago Press, Ltd., London

Published 2020
Printed in the United States of America

29 28 27 26 25 24 23 22 21 20 1 2 3 4 5

ISBN-13: 978-0-226-72784-4 (cloth)
ISBN-13: 978-0-226-72798-1 (paper)
ISBN-13: 978-0-226-72803-2 (e-book)
DOI: https://doi. org/10.7208/chicago/9780226728032.001.0001

Library of Congress Cataloging-in-Publication Data

Names: Hopper, Lydia M., editor. | Ross, Stephen R., editor. | Goodall, Jane, 1934- writer of foreword. | Lester E. Fisher Center for the Study and Conservation of Apes, host institution, organizer.
Title: Chimpanzees in context : a comparative perspective on chimpanzee behavior, cognition, conservation, and welfare / edited by Lydia M. Hopper and Stephen R. Ross ; with a foreword by Jane Goodall.
Description: Chicago ; London : The University of Chicago Press, 2020. | Papers from a conference of the same name organized and hosted by the Lester E. Fischer Center for the Study and Conservation of Apes, Lincoln Park Zoo, Chicago in 2016. | Includes bibliographical references and index.
Identifiers: LCCN 2020017311 | ISBN 9780226727844 (cloth) | ISBN 9780226727981 (paperback) | ISBN 9780226728032 (ebook)
Subjects: LCSH: Chimpanzees—Behavior—Congresses. | Chimpanzees—Conservation—Congresses. | Chimpanzees—Ecology—Congresses. | Chimpanzees—Research—Congresses. | Social behavior in animals—Congresses. | Cognition in animals—Congresses. | Animal welfare—Congresses. | LCGFT: Conference papers and proceedings.
Classification: LCC QL737.P94 C56 2020 | DDC 599.885—dc23
LC record available at https://lccn.loc.gov/2020017311

♾ This paper meets the requirements of ANSI/NISO Z39.48-1992 (Permanence of Paper).