RESTORATION PROVIDES HOPE FOR FAUNAL RECOVERY: CHANGES IN PRIMATE ABUNDANCE OVER 45 YEARS IN KIBALE NATIONAL PARK, UGANDA

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Commentary

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Abstract

In much of the tropics, the proportion of the land covered by regenerating forest surpasses than in primary forest, thus protecting regenerating forest could offer a valuable conservation opportunity, but only if those lands promote faunal recovery. Chapman et al. documented the recovery of populations of six primate species over up to 45 years in Kibale National Park, Uganda and discovered that in preexisting forest, populations of all species grew, except blue monkeys. Populations (except blue monkeys) also increased by colonizing regenerating forests at previously cleared sites. In many cases, populations in these regenerating areas were of comparable size to those in old-growth forest, and there was little evidence that this population increase corresponded with a decline in neighboring old-growth forests. This research demonstrates the potential for management of regenerating forest to be an effective conservation tool and illustrates the importance of conducting and funding long-term monitoring.

Keywords

population change, global change, primate conservation, regeneration, logging, population recovery, long-term monitoring

Commentary to: Chapman CA, Bortolamiol S, Matsuda I, Omeja PA, Paim FP, Sengupta R, Skorupa JP, Valenta K. (2018). Primate population dynamics: Variation over space and time. *Biodiversity and Conservation*.

The loss of tropical forest is causing the extinction and endangerment of many species (Estrada et al., 2017; Pimm et al., 2014). Between 2000 and 2012, 2.3 million km^2 of forest was lost globally (Hansen et al., 2013). To put this in perspective, this is an area approximately the size of Mexico. However, deforested land does not always remain deforested. With the trend for increasing urbanization, people are moving off previously deforested land, and many areas are regenerating to secondary forest (Jacob, Vaccaro, Sengupta, Hartter, & Chapman, 2008; Wright & Muller-Landau, 2006;). In fact, the United Nations Population Division (2008) estimated that 90% of the world's population growth between 2000 and 2030 will occur in cities of the developing world. As a result, throughout the tropics, degraded forests now cover substantial areas. In fact, in most countries, they now exceed the area covered by primary forests (Food and Agriculture Organization, 2005). It is estimated that in the 1990s, secondary forests replaced at least one of each 6 ha of primary forest deforested (Wright & Muller-Landau, 2006) and that secondary forests now represent 35% of all remaining tropical forests (Emrich,

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Pokorny, & Sepp, 2000), and the only viable populations of some species are found in degraded areas.

Yet, there are many questions that must be addressed to understand the long-term value of such secondary forests for wildlife. Will animal populations remain viable and grow as the forest regenerates? If populations do grow, is this largely a result of immigration from less disturbed forest, resulting in little overall recovery on a larger scale? Or, are these regenerating forests actually population sinks where mortality rates are greater than usual? With long-lived mammals, such questions are very difficult to address, as they require long-term monitoring spanning decades, at a scale large enough to represent a suitable management unit for conservation and such monitoring is rare, particularly in the tropics. These are some of the questions addressed by Chapman et al. (2018) using data they collected and collated for a period of 45 years in Kibale National Park, Uganda (hereafter Kibale).

Kibale is a moist midelevational tropical forest that was a forest reserve from 1932 until 1993, when it became a national park. While a reserve, the forest was disturbed by logging at various intensities, the establishment of *Pinus* plantations on former grasslands, and cleared for encroaching agriculture. On becoming a national park, the logging stopped, the pine plantations were cleared, and disturbed areas were left to passively recover. Much of the agricultural encroachment was replanted from 1995 onward by a carbon sequestration project (Chapman et al., 2010; Wheeler et al., 2016).

Chapman et al.'s (2018) study is based on the data collected between September 1970 and July 2015. The data from 1970 to 1987 were collected by Tom Struhsaker and Joe Skorupa. Primate census data for some sites were collected for 45 years, while in others, monitoring spanned the more recent 19 years. Data were collected from transects walks using the same method and routes once a month. Since 1989, the same observers were used. Chapman et al. (2018) documented primate population dynamics in old-growth forest, lightly and heavily logged forests, regenerating forests in former pine plantations, and forests planted on abandoned agricultural land. Comparisons were made between regenerating and neighboring old-growth forest to determine whether any increases in primate abundance in regenerating forest corresponded to concomitant declines in abundance in old-growth forest. Primate species monitored were redtail monkeys (*Cercopithecus ascanius*), blue monkeys (*Cercopithecus mitis*), mangabeys (*Lophocebus albigena*), baboons (*Papio anubis*), red colobus (*Procolobus rufomitratus*), and black-and-white colobus (*Colobus guereza*). Other species, such as l'hoesti monkeys (*Cercopithecus l'hoesti*) and chimpanzees (*Pan troglodytes*), were too rare or secretive to obtain accurate estimates, and nocturnal primates were censused.

The Results and Significance of Chapman et al.'s Study

The change in primate abundance was complex with the magnitude of change dependent on site and species. Primate populations were affected by logging, changes in food availability, increased diffuse competition from animals fleeing disturbed areas (Chapman, Balcomb, Gillespie, Skorupa, & Struhsaker, 2000; Osazuwa-Peters, Chapman, & Zanne, 2015; Osazuwa-Peters, Jiménez, Oberle, Chapman, & Zanne, 2015), climate change (Chapman, Hou, & Kalbitzer, Submitted; Rothman et al., 2015), exponentially rising elephant numbers disturbing vegetation (Omeja et al., 2014), changing forest tree community structure (Chapman et al., 2010; Omeja, Obua, Rwetsiba, & Chapman, 2012), and invasive plant species (*Lantana camera*; Omeja et al., 2016). None of these processes had a strictly linear affect; they caused change at different rates with different and sometimes unexpected synergies between them. However, population changes in Kibale occurred primarily in two environments: (a) in preexisting forest (either logged or old growth) and (b) in new regenerating forest habitat at previously deforested sites. In preexisting forest, populations of all monkey species grew except blue monkeys. Red colobus populations have been studied in most detail. Based on data from 1996 and before, a conservative density estimate is 37.5 red colobus/km^2. To determine the park-wide population numbers, this value is multiplied by the area of suitable habitat as determined from the analysis of satellite images, which is 60% of the 795 km^2 total area of the park. Thus, we consider that a conservative estimate for 1996 is approximately 17,000 (see also Struhsaker, 2005). Since 1996, the size of red colobus groups has increased park-wide (Gogarten et al., 2015). A yearlong study in 1996 where 55 groups of red colobus were located and repeatedly counted determined that the average red colobus group contained 28.4 members. A similar study conducted in 2011 revealed that the average group size had increased to 46.6 members—a 61% increase, which would suggest that Kibale now contains ~27,000 red colobus monkeys.

The second way in which monkey populations increased (except blue monkeys) was by colonizing regenerating forests at previously cleared sites. In many cases, populations in these regenerating areas were of comparable size to those in old-growth forest. Former pine plantation covered 8 km^2 (Chapman & Lambert, 2000) and, while the aim of the carbon offset project is to replant 100 km^2 of forest, to date 35 km^2 has regenerated sufficiently to support primate populations (Omeja et al., 2016; Wheeler et al., 2016). These regenerating areas support approximately 2,000 red colobus, increasing the park-wide estimate to 29,000; a 63% increase since the mid-1990s and a 3.5% annual increase in the red colobus population.

Blue monkeys are an exception to the general pattern of population growth. Their low abundance in the forests of Western Uganda cannot easily be explained. Blue monkeys are habitat generalists occupying diverse habitats, and they have a very large geographical range and altitudinal distribution across Africa (Lawes, 1990). Despite this, their distribution in Kibale is unusual—they are relatively abundant in the north but gradually decline in abundance toward the south and eventually disappearing. They do not colonize the regenerating forests, they are not found in neighboring forest fragments, and their numbers are declining at each of the sites where their abundance could be estimated. Baboons, on the other hand, increased in abundance park-wide and expanded into northern areas of the park where they were largely absent a decade ago (Colin Chapman, unpublished data, April 25, 2018; Richard Wrangham, Personal communications, January 2017). Factors causing this northern expansion are unknown.

With new regenerating forests becoming available to the primates either their abundances in the adjacent old-growth forest could have declined, as individuals moved into the regenerating forests, or old-growth populations could remain stable with only "surplus" animals migrating. The latter scenario was supported, with the possible exception of mangabeys at one site.

Censuses conducted in logged forest since 1970 demonstrated that for all species, except black-and-white colobus, the encounter rate was higher in the old-growth forest and lightly logged forest than in the heavily logged forest. Black-and-white colobus generally showed the opposite trend and were most common in the heavily logged forest in all but the first year of monitoring after logging, when they were most common in the lightly logged forest. Overall, except for blue monkey populations which are declining, primate populations in Kibale National Park are growing; in fact, the endangered red colobus populations have an annual growth rate of 3.5%.

Long-term research was essential for identifying population growth trends for these relatively long-lived primates, which enables useful conservation outcomes in three ways. First, the conservation value of regenerating forest to primates is demonstrated. Restoration, either passive or active, is clearly a viable conservation strategy that can yield positive results for primates in less than 19 years. In fact, regenerating forests were used extensively by two endangered species: red colobus and chimpanzees. We advocate that with current deforestation rates and biodiversity loss, restoration is an essential

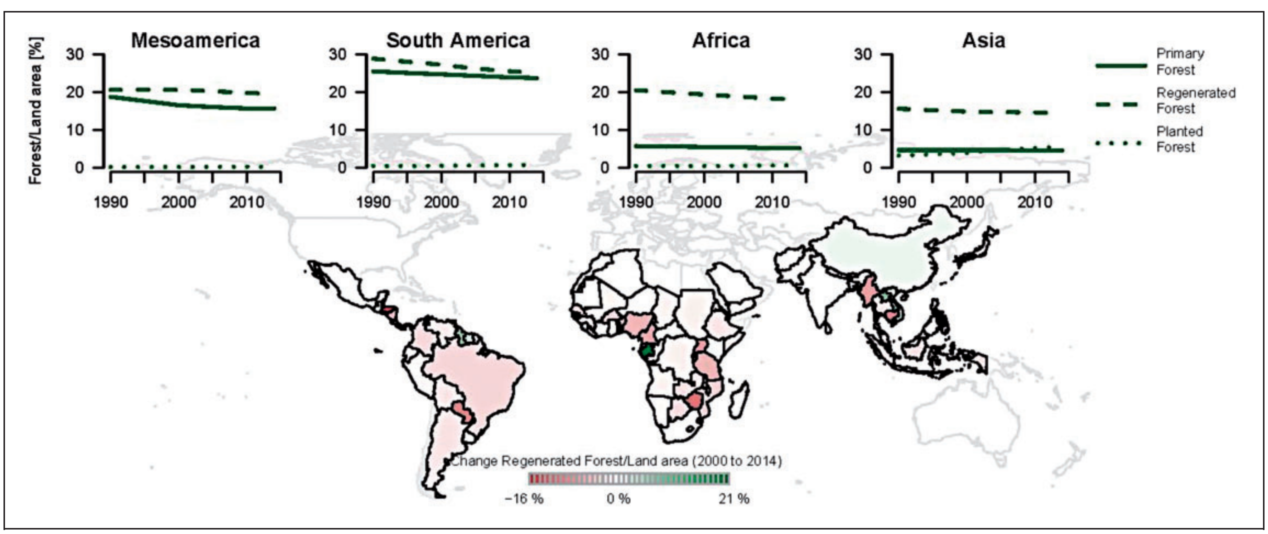

Figure 1. Top panel—Changes in the proportion of land area covered by primary, regenerated, and planted forests for primate range countries summarized by continents from 1990 to 2014. Lower panel—Changes in the percentage of land area covered by regenerated forest between 2000 and 2014 for primate range countries. For the specific definitions of forest types, see the FAOSTAT Database (Food and Agriculture Organization [FAO], 2017), from which the data for forest cover and land area were taken from. Note that this database has also been used for the latest FAO Global Forest Resources Assessment (FAO, 2016). A country was considered a primate range country if its boundaries were spatially intersecting with the global distribution of primates according to the IUCN Red List of Threatened Species (IUCN, 2016). The world map was downloaded from Natural Earth (https://www.naturalearthdata.com/) using the R package Rnaturalearth (South, 2017). Caution must be taken when evaluating individual countries (e.g., Gabon), as indices used may change or interpretations of data maybe difficult as categorizing an area as regenerating forest, and so on, can be confounded by unrelated factors (Abernethy, Maisels, & White, 2016).

conservation tool. Restoration is a particularly important to primate conservation, as 60% of primate species are currently threatened with extinction (Estrada et al., 2017). For example, an analysis considering 22 of the China's 27 primate species indicate that 15 of the species have populations of less than 3,000 individuals (Estrada et al., 2017). Habitat restoration will be the key to ensure the long-term viability of these 15 species. However, while the percentage of the total forested area in regenerating forest is greater than that of primary forest, it is generally declining globally (Figure 1). Such global patterns viewed in combination with the results of the Chapman et al.'s (2018) study suggest that to meet conservation goals it is important to protect regenerating forest.

Second, Chapman et al.'s study verifies that with effective management, control of hunting, and habitat protection, primate populations can be very resilient and can recover from a variety of habitat disturbances. The Uganda Wildlife Authority has successfully protected the forest and the animals of Kibale, despite having very limited resources. However, as the human population outside of the park grows and economic stresses for the local communities mount, there are still challenges, particularly the elimination of snare trapping (Kirumira et al., in press).

Third, it would not have been possible to document the positive response to forest recovery or the effectiveness of the management of the park, without long-term monitoring. For conservation to advance, it is essential to evaluate the effectiveness of different management strategies. Given the long generation times of many species and the complex web of their interactions within the ecosystem, long-term research is essential. However, it is ironic that at a time when there is such a clear need for effective conservation action, funding for long-term research is becoming increasingly difficult to obtain (Hayes & Carsten, 2017). Long-term monitoring also often produces surprises. For example, the slow population decline and reduced distribution of blue monkeys (Chapman et al., 2018), the dramatic increase in population size of elephants (Omeja et al., 2014), or the foraging by folivorous primates can alter the composition of the tree community (Chapman et al., 2013),—none of this would have been detected without long-term monitoring in Kibale.

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References

Abernethy, K., Maisels, F., & White, L. J. T. (2016). Environmental issues in Central Africa. *Annual Review Environment and Resources*, *41*, 1–33.

Chapman, C. A., Balcomb, S. R., Gillespie, T., Skorupa, J., & Struhsaker, T. T. (2000). Long-term effects of logging on African primate communities: A 28 year comparison from Kibale National Park, Uganda. *Conservation Biology*, *14*, 207–217.

Chapman, C. A., Bonnell, T. R., Gogarten, J. F., Lambert, J. E., Omeja, P. A., Twinomugisha, D., . . . Rothman, J. M. (2013). Primates as ecosystem engineers. *International Journal of Primatology*, *34*, 1–14.

Chapman, C. A., Bortolamiol, S., Matsuda, I., Omeja, P. A., Paim, F. P., Reyna-Hurtado, R., Sengupta, R. & Valenta, K. (2018). Primate population dynamics: variation in abundance over space and time. *Biodiversity and Conservation*, *27*, 1221–1238.

Chapman, C. A., Chapman, L. J., Jacob, A. L., Rothman, J. M., Omeja, P. A., Reyna-Hurtado, R., . . . Lawes, M. J. (2010). Tropical tree community shifts: Implications for wildlife conservation. *Biological Conservation*, *143*, 366–374.

Chapman, C. A., & Lambert, J. E. (2000). Habitat alteration and the conservation of African primates: Case study of Kibale National Park, Uganda. *American Journal of Primatology*, *50*, 169–185.

Emrich, A., Pokorny, B., & Sepp, C. (2000). *The significance of secondary forest management for development policy*. Eschborn, Germany: GTZ.

Estrada, A., Garber, P. A., Rylands, A. B., Roos, C., Fernandez-Duque, E., Di Fiore, A., . . . Lambert, J. E. (2017). Impending extinction crisis of the world's primates: Why primates matter. *Science Advances*, *3*, e1600946.

Food and Agriculture Organization. (2005). *Global Forest Resources Assessment 2005: Progress towards sustainable forest management* (FAO Forestry Paper 147). Rome, Italy: Author.

Food and Agriculture Organization. (2016). *Global Forest Resources Assessment 2015: How are the world's forest changing?* Rome, Italy: Author.

Food and Agriculture Organization. (2017). *Food and Agriculture Organization of the United Nations—FAOSTAT Database*. Rome, Italy: Author.

Gogarten, J. F., Jacob, A. L., Ghai, R. R., Rothman, J. M., Twinomugisha, D., Wasserman, M. D., & Chapman, C. A. (2015). Group size dynamics over 15+ years in an African forest primate community. *Biotropica*, *47*, 101–112.

Hansen, M. C., Potapov, P. V., Moore, R., Hancher, M., Turubanova, S. A., Tyukavina, A., . . . Townshend, J. R. G. (2013). High-resolution global maps of 21st-century forest cover change. *Science*, *342*, 850–853.

Hayes, L. D., & Carsten, S. (2017). Long-term field studies of mammals: What the short-term study cannot tell us. *Journal of Mammalogy*, *98*, 600–602.

IUCN (2016, May). Retrieved from http://www.iucnredlist.org/.

Jacob, A. L., Vaccaro, I., Sengupta, R., Hartter, J., & Chapman, C. A. (2008). How can conservation biology best prepare for declining rural population and ecological homogenization? *Tropical Conservation Science*, *1*, 307–320.

Kirumira, D., Baranga, D., Hartter, J., Valenta, K., Tumwesigye, C., Kagoro, W., & Chapman, C. A. (in press). Evaluating a union between health care and conservation: A mobile clinic improves park-people relations, yet poaching increases. *Conservation and Society*.

Lawes, M. J. (1990). The distribution of the samango monkey (*Cercopithecus mitis erythrarchus* Peters, 1985 and *Cercopithecus mitis labiatus* I. Geoffroy, 1843) and forest history in southern Africa. *Journal of Biogeography*, *17*, 669–680.

Omeja, P. A., Jacob, A. L., Lawes, M. J., Lwanga, J. S., Rothman, J. M., Tumwesigye, C., & Chapman, C. A. (2014). Changes in elephant density affect forest composition and regeneration? *Biotropica*, *46*, 704–711.

Omeja, P. A., Lawes, M. J., Corriveau, A., Valenta, K., Paim, F. P., & Chapman, C. A. (2016). Recovery of the animal and plant communities across large scales in Kibale National Park, Uganda. *Biotropica*, *48*, 770–729.

Omeja, P. A., Obua, J., Rwetsiba, A., & Chapman, C. A. (2012). Biomass accumulation in tropical lands with different disturbance histories: Contrasts within one landscape and across regions. *Forest Ecology and Management*, *269*, 293–300.

Osazuwa-Peters, O. L., Chapman, C. A., & Zanne, A. E. (2015). Selective logging: Does the imprint remain on tree structure and composition after 45 years? *Conservation Physiology*, *3*, cov012.

Osazuwa-Peters, O. L., Jiménez, I., Oberle, B., Chapman, C. A., & Zanne, A. E. (2015). Selective logging: Do rates of forest turnover in stems, species composition and functional traits decrease with time since disturbance?—A 45 year perspective. *Forest Ecology and Management*, *357*, 10–21.

Pimm, S. L., Jenkins, C. N., Abell, R., Brooks, T. M., Gittleman, J. L., Joppa, L. N., . . . Sexton, J. O. (2014). The biodiversity of species and their rates of extinction, distribution, and protection. *Science*, *344*, 1246752.

Rothman, J. M., Chapman, C. A., Struhsaker, T. T., Raubenheimer, D., Twinomugisha, D., & Waterman, P. G. (2015). Long-term declines in nutritional quality of tropical leaves. *Ecology*, *96*, 873–878.

South, A. (2017). *R natural earth: World map data from natural earth*. https://CRAN.R-project.org/package=rnaturalearth.

Struhsaker, T. T. (2005). Conservation of red colobus and their habitats. *International Journal of Primatology*, *26*, 525–538.

United Nations Population Division. (2008). *World urbanization prospects: The 2007 revision*. https://www.un.org/development/desa/publications/2018-revision-of-world-urbanization-prospects.html.

Wheeler, C. E., Omeja, P. A., Chapman, C. A., Glipin, M., Tumwesigye, C., & Lewis, S. L. (2016). Carbon sequestration and biodiversity following 18 years of active tropical forest restoration. *Forest Ecology and Management*, *373*, 44–55.

Wright, S. J., & Muller-Landau, H. C. (2006). The future of tropical forest species. *Biotropica*, *38*, 287–301.