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A New Hotspot for Temminck's Red Colobus (*Piliocolobus badius temminckii*) in The Gambia: The Feasibility of a Community Approach to Conservation

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Abstract: The geographic range and abundance of Temminck's red colobus, *Piliocolobus badius temminckii*, in The Gambia is not well documented. In March 2019, line transect surveys were conducted at a number of data deficient forests in The Gambia to establish species presence or absence, contribute to a greater understanding of the species at a national scale and identify priority sites for conservation. One area around Sambel Kunda in the Central River Region was found to be exceptionally productive with an observed Temminck's red colobus population of 587 individuals, a maximum group size of 60, and connectivity to robust populations along a riparian corridor to the east. Surveys were supported by the collation of community perceptions using principles of Rapid Assessment Program (RAP) methodology to evaluate the feasibility of an integrated community development and primate conservation project. The results of interviews and meetings in the Sambel Kunda area revealed an absence of hunting and increasing population trends for all primate species, including red colobus. Excepting the Central River Region, Temminck's red colobus populations were otherwise in decline or locally extinct, predominantly as a result of indiscriminate hunting to protect agricultural crops. Meetings with the Village Development Committees confirmed that the greatest proximal threat to red colobus in the study area was the rapid escalation in forest clearance to produce charcoal for local markets and timber for export to offset climate-change-induced declines in agricultural revenues. Local Gambians are aware that they urgently need to adopt sustainable forestry practices to mitigate climate change impacts and protect timber and non-timber resources but are currently unsure how they would develop and implement such a model. Given the uncertainty and complex nature of the range-wide threats facing the red colobus populations, we suggest prioritizing the Sambel Kunda area as a site of international importance for the protection and recovery of this Critically Endangered species. A community approach to the conservation of red colobus in the Sambel Kunda area should be implemented without delay through site designation, capacity building for biodiversity monitoring, sustainable forestry practices, community engagement and education and by growing awareness of Temminck's red colobus as a flagship species.

Keywords: *Piliocolobus badius temminckii*, red colobus, habitat, distribution, population, The Gambia, Sambel Kunda

Introduction

The six taxa of West African folivorous red colobus monkeys (*Piliocolobus*) are all Critically Endangered, characterized by rapidly declining populations, and are in urgent need of conservation action (Linder *et al*. in press). Miss Waldron's red colobus (*Piliocolobus waldroni*) has not been seen since 1978, despite photographic evidence in 2002 of a hunted individual from the Ehy forest in south-east Ivory Coast (Oates *et al.* 2000; McGraw 2005). The range of Temminck's red colobus extends from the dry forest of Fathala in Senegal (Galat-Luong and Galat 2005) to The Gambia, Guinea Bissau (Butynski *et al.* 2013) and north-west Guinea (Galat-Luong *et al*. 2016). The global population size is unknown (Linder *et al.* in press). The Gambian distribution of the species extends from the Atlantic coast to the eastern border with Senegal in an increasingly fragmented network of dry savannah woodland, gallery forest, and mangrove habitats (M. Mayhew pers. obs.).

The drivers of population decline in West African red colobus are habitat loss through deforestation, agricultural conversion and infrastructure development (Grubb and Powell 1999; Werre 2000), hunting for bushmeat and crop protection (Oates *et al.* 2000; McGraw 2005) and emerging diseases such as yaws (*Treponema pallidum pertenue*) (M. Mayhew pers. obs.; Dux *et al.* 2017). The greatest proximal threat to

Figure 1. Adult Temminck's red colobus, south bank, River Gambia, near Bansang, Central River Region. March 2019. Photo by Michael Mayhew.

Temminck's red colobus in The Gambia is forest clearance for fuelwood, charcoal production and timber export. Between 1940 and 2001, woodland ecosystems were reduced from 80% to 42% of their landcover (Jaiteh and Sarr 2010), and the national forest inventory in 2009/2010 recorded a 7% loss of forest cover compared to the 1981/1982 forest inventory (Nget 2010). Deforestation in The Gambia is compounding the deleterious impacts of climate change, which include a 30% reduction in rainfall between 1950 and 2000 (Urquhart 2016) and an increase in annual mean temperature of half a degree Celsius per decade from the 1940s (Njie 2007).

Given the geographical extent, urgency and complexity of the threats facing red colobus, a *Red Colobus Conservation Action Plan 2019–2021* (ReCAP) was drafted in 2018 to mitigate the risk of extinction, by coordinating a range-wide, multidisciplinary conservation and research effort, implemented locally through site- and species-specific actions (Linder *et al.* in press). Range-wide priority actions for Temminck's red colobus include surveys of data deficient forested areas, such as Kiang West National Park in The Gambia, reinstatement and equipping of forest patrols in Cantanhez Forest National Park in Guinea-Bissau, and the development of community-led ecotourism initiatives (Linder *et al.* in press).

This paper describes the first phase of ReCAP implementation for Temminck's red colobus in The Gambia, during two field visits in March and June 2019. Study objectives included rapid surveys of data deficient forest areas to establish species presence/absence, the collection of demographic data relating to Temminck's red colobus groups, and the delivery of community engagement activities to gather perceptions on key themes relating to primate conservation and the use of natural resources. One area around Sambel Kunda in the Central River Region was found to have an exceptionally high red colobus population, with a minimum of 587 individuals observed and connectivity to robust populations along a riparian corridor to the east.

Rapid Assessment Programme (RAP) methodology was developed in 1990 by Conservation International to support conservation planning and action through the rapid collection of data on species, habitat and social aspects of locations in

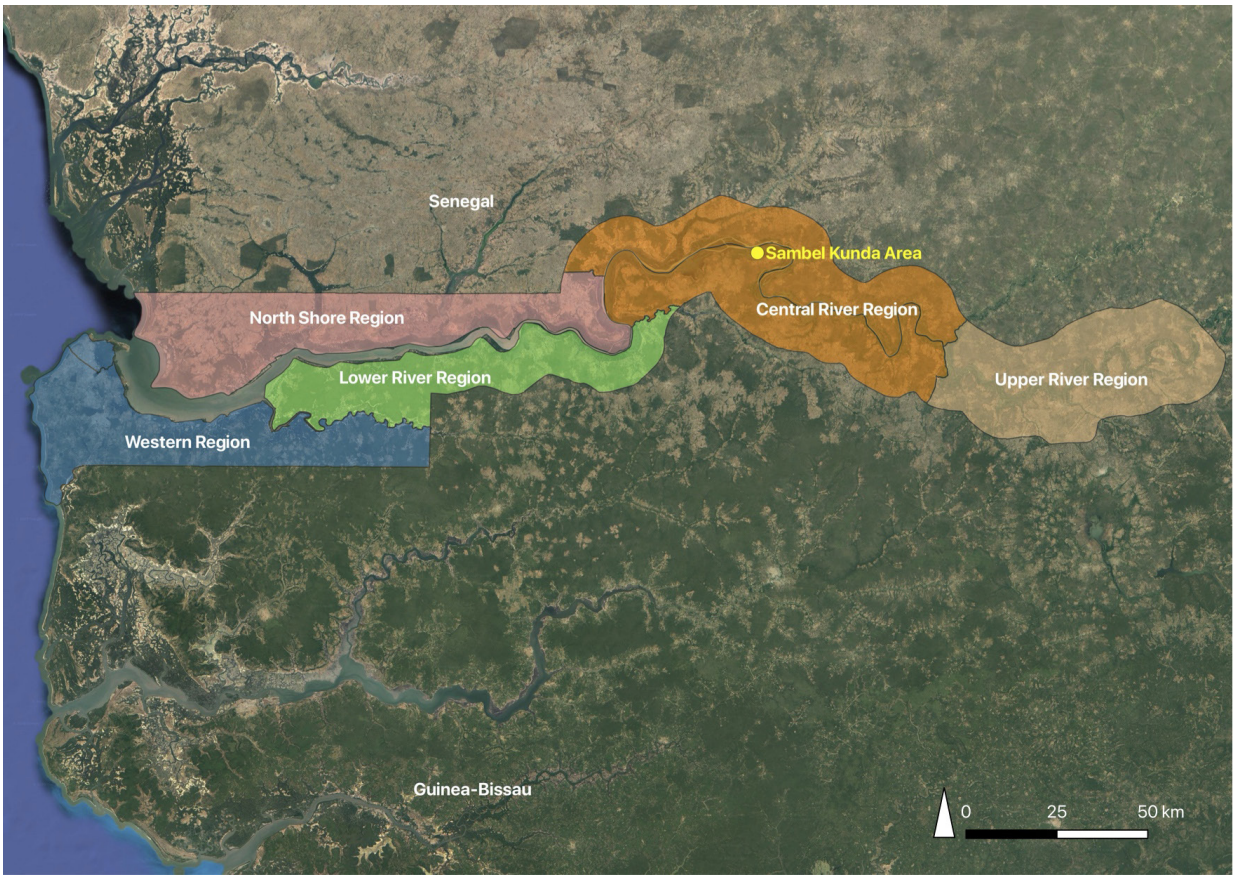
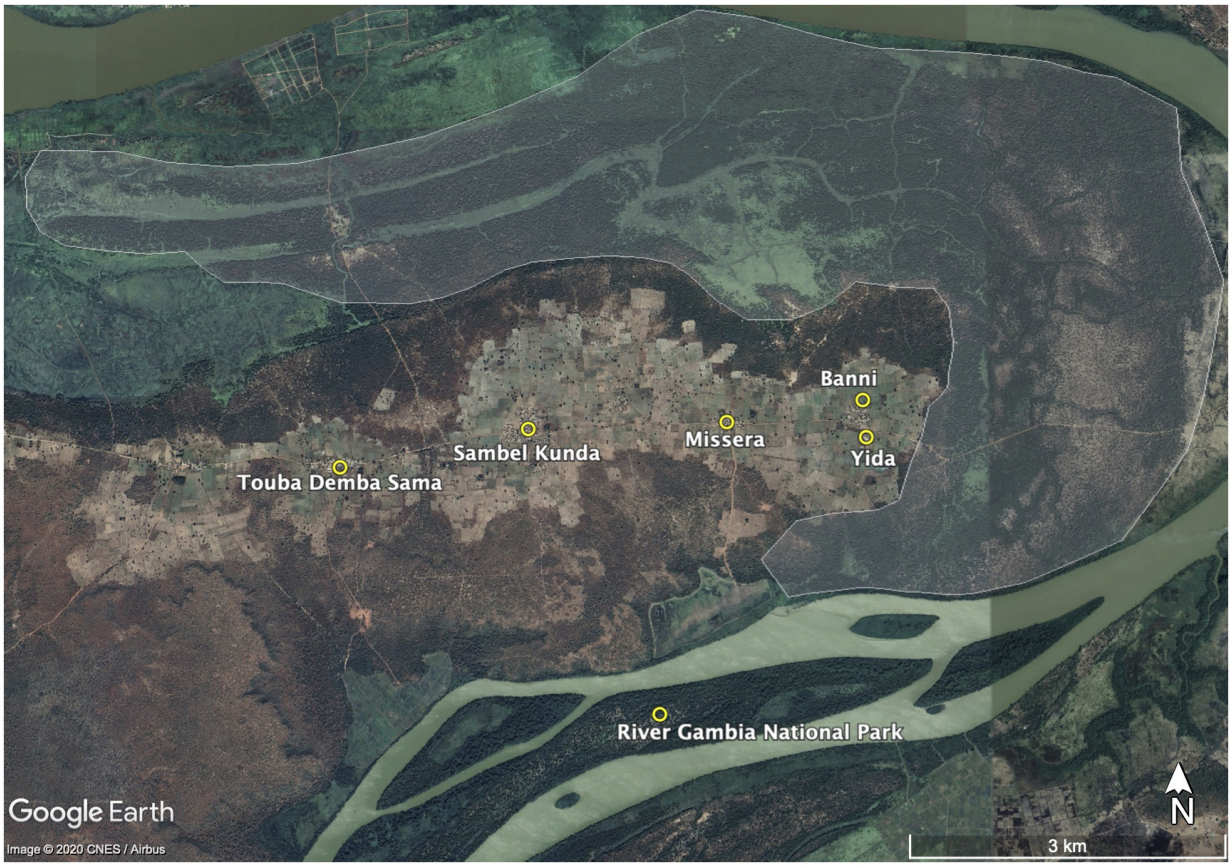


Figure 2a. Regions of The Gambia and **2b** (below) the study area around Sambel Kunda outlined by a shaded polygon.



Biodiversity Hotspots that are exposed to escalating anthropogenic threats (Alonso *et al.* 2005, 2011; Barrie *et al.* 2007). In line with the principles of RAP methodology, here we present the findings of a rapid, objective feasibility study to evaluate the potential for a community-based primate conservation project in the Sambel Kunda area. As such, it constitutes a decision tool for local government agencies, NGOs and funding bodies by providing a site-specific overview of the associated project opportunities and risks.

Methods

Primate survey sites

The Sambel Kunda area was identified as one of a number of data deficient areas on the basis of a literature search of historic red colobus records, local knowledge and the evaluation of forest cover from satellite imagery (Fig. 2a). The area extends to approximately 30 km² of forest and wetlands surrounding the village of Sambel Kunda (13°39'53.73"N, 14°58'32.42"W) in the Nyamina East district of The Gambia with an elevation of between 5 and 15 m above sea level. The site is only accessible by road from the west, as the River Gambia forms a boundary on the northern, eastern and southern aspects. Sambel Kunda is one of five villages—the others are Touba Demba Sama, Missera, Yida and Banni—with a combined human population of 1,657 individuals (The Gambia, GBoS 2013), on an east to west axis in the center of the peninsula. The forests surrounding the five villages (Fig. 2b) form the focus of this paper and are described as the 'study area'.

Each village is surrounded by a zone of agro-pastoral land, which is used to grow crops such as groundnuts, maize and millet. Between the agricultural zone and the river, the landcover changes from dry woodland savannah to seasonally inundated, semi-deciduous forest. The forest blocks are interspersed by a linear network of grassland, marsh and open standing water, which is used by the villagers for the seasonal grazing of cattle. The River Gambia National Park was gazetted in 1978 as an archipelago of five islands (approximately 6 km²), which constitute the southern boundary to the Sambel Kunda area.

Besides the forest transects, primate surveys were also conducted along a connected riparian corridor east of the study area (Fig. 3a) on three consecutive days. The first survey was between Kuntaur (13°40'20.14"N, 14°53'25.63"W) and Sapo (13°32'58.59"N, 14°53'40.12"W), the second between Georgetown (13°32'36.04"N, 14°45'45.52"W) and Bansang (13°26'4.98"N, 14°39'26.37"W) and the third survey was between Bansang and Karantaba (13°33'30.22"N, 14°34'17.11"W).

Surveys

In the Sambel Kunda area, a systematic random design was used to establish a series of parallel equidistant line transects with randomized starting points. Transects were oriented on a north-south axis with a median length of 804.5 m (n = 18, range = 178−1400 m; Fig. 3b). The distance between transects was approximately 400 m with an area surrounding the transect line of approximately 20 to 30 ha. This corresponds to the variation in home range size for the red colobus as described by Starin (1991). The inter-transect distance was based on a maximum distance of 200 m at which groups could be detected perpendicular to the transect route using visual and auditory cues. Surveys were conducted during peak activity times (06:30−11:30 and 16:30−19:00) on the 18, 19, 20 and 24 March 2019 by Mayhew and Fenton with support from two local trackers. Transects conducted on the same day are illustrated as clusters in an identical color in Figure 3b and each transect was walked once with observations made on both sides of the transect.

A group was defined as 2 or more interacting individuals that could be seen from the same vantage point. Upon detection, the survey team took a GPS waypoint and collected data relating to the size of the group using a Garmin eTrex10. Transect lines and group locations were uploaded as GPX files to QGIS version 3.4.3-Madeira. The line measuring tool revealed that the shortest distance between adjacent groups was 200 m which is used as the measurement to define the spatial distribution of separate groups in this paper. Solitary individuals that were encountered between groups were assigned to the nearest neighboring group. To avoid double counting in two adjacent transects, any group that was moving more rapidly than the survey team was followed from a distance until all individuals were observed to be resting or feeding before the survey team moved on to walk the next transect. Only direct sightings of the red colobus contributed to the group counts. Vocalizations without sightings were excluded because it was often impossible to determine the exact location and avoid double counting the individuals. Movements of foliage without sightings were also discounted given the potential for sympatric, non-target species such as green monkeys (*Chlorocebus sabaeus*) to cause such disturbance.

The river surveys (Fig. 3a) were conducted between 06:30 and 11:30 on three consecutive days (21, 22 and 23 March 2019). All individuals that could be positively identified as red colobus were counted along linear transects with no repeats, and separate groups were defined using the spatial criteria that were applied in the study area. Surveys were conducted from a small boat with a single outboard engine. The boat travelled at an estimated average of 10 km per hour and stopped for a few minutes with the engine turned off when a group was detected to collect spatial and abundance data. To avoid double counting, the boatman was asked to remain with the group until resting or feeding behavior had resumed and then travelled on at speed between groups. Due to the width of the River Gambia in the Central River Region, only a single bank could be surveyed during each transect. The Kuntaur to Sapo transect was restricted to one bank whereas the Georgetown to Bansang and Bansang to Karantaba transects were return trips enabling surveys of both banks (Table 1, Fig. 3a).

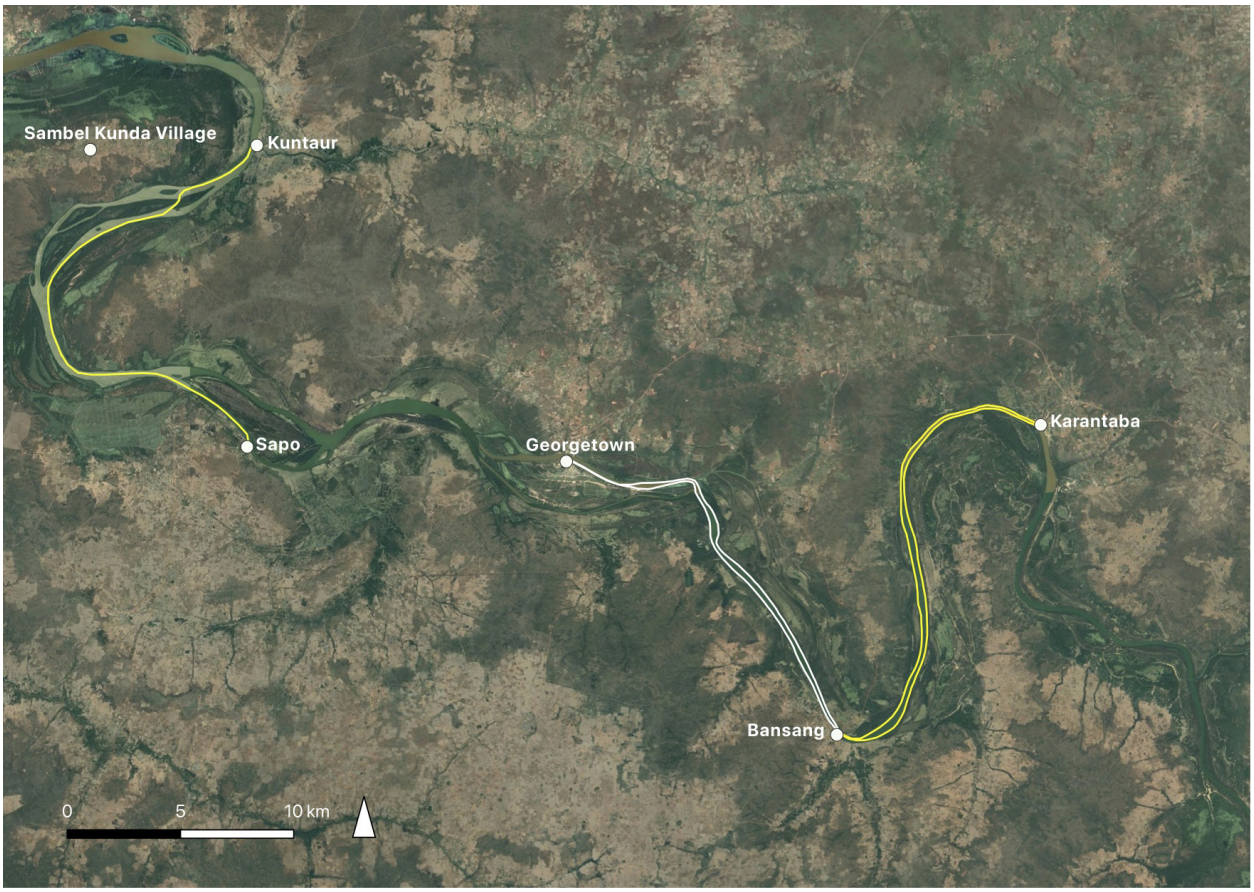
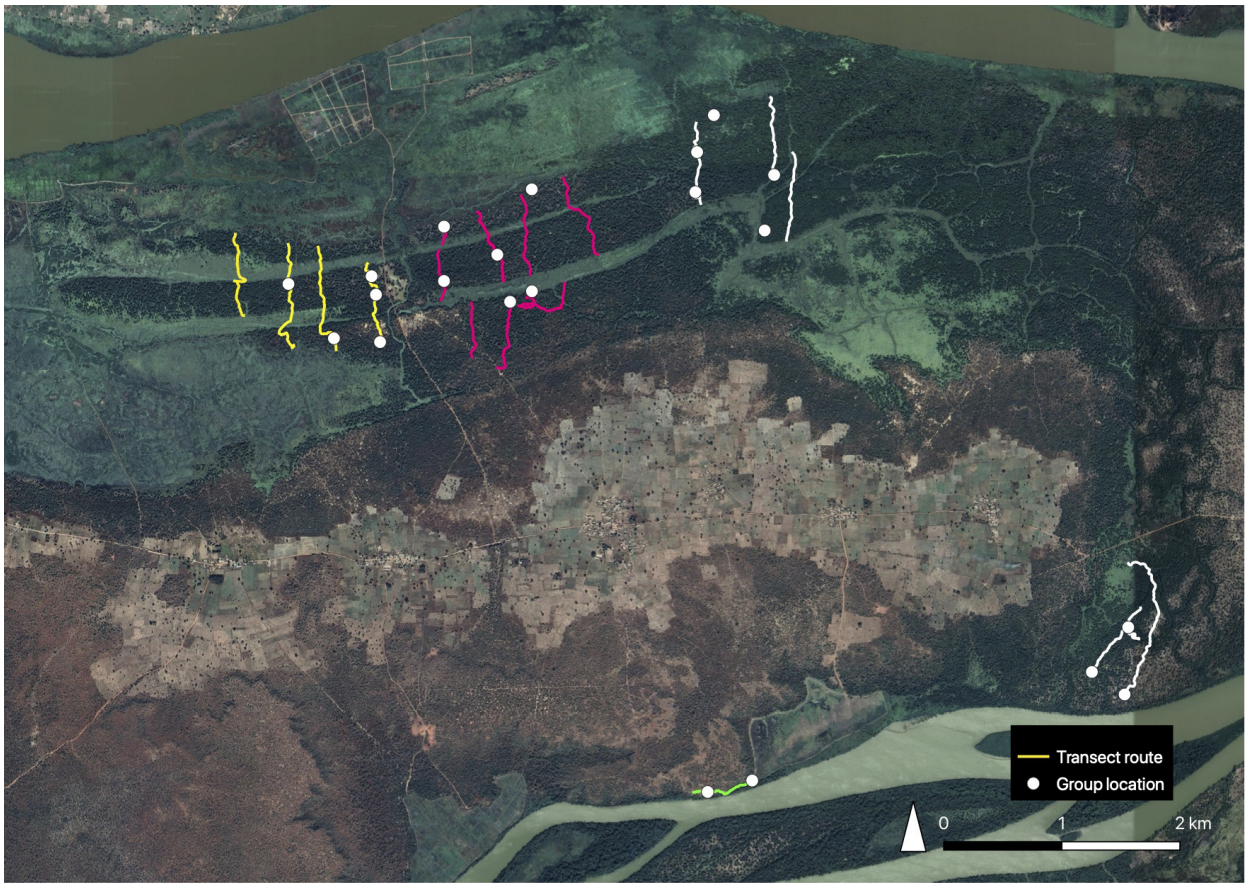


Figure 3a. The three river transects between Kuntaur and Karantaba and **3b** (below) the linear transect routes and locations of Temminck's red colobus groups in the Sambel Kunda study area



Survey work was conducted with ethics clearance from the University of Cumbria and in compliance with the terms of a research permit from the Gambian Department of Parks and Wildlife Management (DPWM). Interviews were conducted with ethics clearance from the American Public University System and with the terms of a research permit from the Gambian DPWM.

Community engagement

Two visits were made in March and June 2019 to collate and compare the views of the local communities and key stakeholder groups in the study area and at data deficient forest sites beyond the study area in the North Shore, Lower River, Central River, and Western Regions of The Gambia. A range of engagement activities, including meetings, semi-structured interviews and informal conversations, were undertaken to engage communities and gauge local knowledge and perceptions of Temminck's red colobus in The Gambia.

In March, Mayhew and Fenton held a meeting with the Village Development Committee in the Sambel Kunda area and conducted several informal interviews with local people at geographically dispersed forest survey sites. Village discussions lasted 30−90 minutes and focused on introductions of the research team and village leadership, discussion of the aims of the project, listening to comments and observations from local participants, and answering questions.

In addition to village discussions, semi-structured, individual interviews were conducted following methods outlined in previous studies focused on community interviews about primate populations (De Jong *et al.* 2008; Ginn and Nekaris 2015). The community feedback from the visit in March 2019 was consolidated into a number of themes which informed 13 semi-structured interviews conducted by Cramer during a second visit in June 2019. These interviews collected baseline qualitative data on a number of key socio-economic and environmental topics identified by participants as relevant to the protection and conservation of red colobus in the area. We used standard ethnographic methods in line with those used successfully in ethnoprimatological studies (see reviews in Fuentes 2012; Dore *et al.* 2017). We used interview questions from Ginn and Nekaris (2015) for face-to-face interviews which were transcribed verbatim with the assistance of a local translator.

Statistical methods

Chi-squared χ^2 tests were used to compare associations between group size categories (groups of: 0−10, 11−20, 21−30, 31−40, 41−50 or 51−60 individuals) at the different locations. All statistics were performed using R (R Core Team 2019). Group size was analyzed as a proxy for habitat size and quality and to draw comparisons with other range-wide studies of Temminck's red colobus populations.

Results

Primate population structures

The observed red colobus population in the Sambel Kunda area was 587, and the combined, observed population along the river corridor was 983 (Table 1). As surveys were restricted to peak activity times each day, and given the scale of the survey effort, it was necessary to conduct observations over consecutive days with the potential to double count individuals. An examination of the spatial distribution of group locations with reference to published home range sizes (Gatinot 1975; Starin 1991), however, suggests that double counting across successive days is very unlikely to have occurred in the study area and along the riparian corridor.

In the Sambel Kunda area the yellow, pink and green transect clusters (Fig. 3b) were surveyed during the peak activity period in the morning, and the white transect cluster was surveyed during the morning and evening peak activity periods on the same day. The shortest distances between the pink and white clusters was 1,400 m, morning and evening white clusters: 4,500 m and white and green clusters: 3,000 m respectively. If we assume a maximum home range size of 33.5 ha (Gatinot 1975; Starin 1991) there is no range overlap between the nearest red colobus group in clusters of different colors. The distance between the nearest red colobus group in the yellow and pink transect clusters is only 600 m, however these populations are separated by a large water hole, a road and a small village. Accounts from the villagers suggest that the red colobus rarely venture to the ground to move through these obstacles between adjacent forest blocks.

The potential to double count across successive days is less likely along the river than in the study area given the physical separation between groups on either bank and the great distances travelled with the boat. The only spatial

Table 1. Observed population size and group size and number in the Sambel Kunda area and along the river transects.

	Sambel Kunda Area	Kuntaur-Sapo	Georgetown-Bansang	Bansang-Karantaba
Total observed population	587	206	317	460
Total number of groups	21	13	18	37
Median group size (range)	31 (3–60)	11 (6–40)	13.5 (2–47)	10 (3–49)
Total transect length (km) (Single bank (S), Both banks (B))	14.6	22.0 (S)	40.0 (B)	42.0 (B)

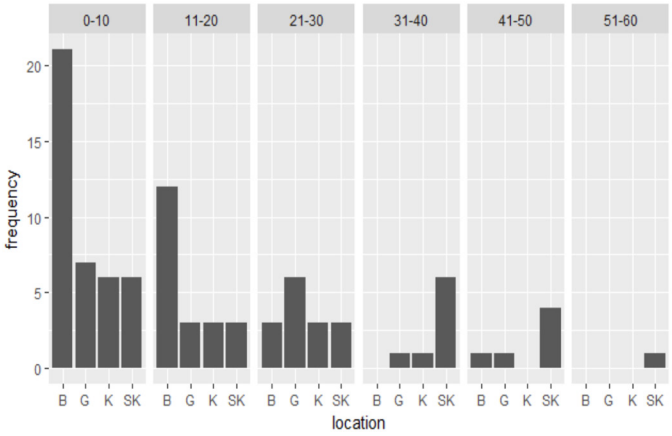


Figure 4. The numbers of groups per each group size category, 0−10 to 51−60, respectively, in each location. Letters denote the transect areas: SK – Sambel Kunda, K – Kuntaur to Sapo, G – Georgetown to Bansang, B – Bansang to Karantaba.

overlap occurs at Bansang between the Georgetown to Bansang transect on the 22 March and Bansang to Karantaba transect on the 23 March 2019. The shortest distance between groups on the same bank across those two consecutive days is 3,200 m. The authors recognize that detailed focal group studies will be required to map home ranges as separate or overlapping and to determine if the size of individual home ranges is significantly larger than the published estimates (Gatinot 1975; Starin 1991).

Sambel Kunda had the greatest median group size of 31 with a range of 3−60 individuals, whereas along the river transects the largest and smallest median group sizes were encountered between Georgetown to Bansang (13.5) and Bansang to Karantaba (10), respectively (Table 1). There was a significant association between the size of the group category and the frequency that these group size categories occurred, with the majority of groups surveyed consisting of less than 10 individuals ($\chi^2 = 46.42$, $p < 0.001$, $df = 5$; Fig. 4.). Across all transect areas, group size categories of 21−30, 31−40, 41−50 and 51−60 were all encountered fewer than six times, for each site. There was also a significant association between group size and location, with greater numbers of large groups, containing more than 30 individuals (n = 11), found at Sambel Kunda, compared to the other sites, where frequencies of these large group sizes typically were less than two ($\chi^2 = 22.0$, $df = 3$, $p < 0.001$; Fig. 4).

Community perceptions of primate populations

We interviewed 13 participants (nine men, four women) at the study site. They included two young adults (ages 18-34), 10 middle aged adults (ages 35-59), and one older adult (age 60+). Interview participants in Sambel Kunda and the adjacent villages of Yida and Banni reported similar perceptions that populations of red colobus as well as patas monkey (*Erythrocebus patas*), guinea baboon (*Papio papio*) and green monkey had increased in recent times. This was echoed by a villager in Sinchu Magai (13°31'10.43"N, 14°54'38.00"W) 17 km south-east of Sambel Kunda, who commented that the populations of all primates in the area were growing. Outside the Central River Region all participants described their perceptions about red colobus populations as declining or locally extinct as a result of combinations of factors, including deforestation, hunting and loss of freshwater sources. In Sankwin (13°27'39.01"N, 15°31'21.18"W), in the Lower River Region, village elders suggested that red colobus were historically abundant but had recently become locally extinct. In the North Shore Region, two interviews were conducted in the forests near Bakalaar (13°25'19.58"N, 16°25'38.42"W) and a further two near Berending (13°29'23.37"N, 16°27'53.40"W); respondents all independently confirmed that red colobus had been extirpated from the local area. In Mandino-Bafuloto (13°24'10.98"N, 16°22'4.18"W), 8 km east of Bakalaar, three independent sources described red colobus populations as extant but rapidly declining.

Threats to Temminck's red colobus: Hunting

Interview results revealed spatial and temporal differences in the presence or absence and proximal causes of primate hunting. Three local people in the study area independently confirmed that primates were not currently being hunted (Banni:1, Sambel Kunda: 2). A participant from Sambel Kunda suggested that the recent increase in primate abundance was related to the cessation of historic culling practices. This statement was corroborated by a participant in Banni who commented that prior to the recent, locally enforced suspension of hunting, all primate species were culled to control their populations and that the meat was fed to the dogs. In Karantaba (13°33'34.70"N, 14°34'19.74"W) at the eastern extent of the river transects, youths confirmed a local tradition of hunting red colobus with dogs and eating the meat. Interviews conducted in Bakalaar and Berending revealed that primates of all species were indiscriminately hunted as crop pests, and in Sankwin village elders confirmed that locals hunted patas monkeys and red colobus to prevent crop raiding but only ate patas monkeys as bushmeat.

Participants shared that preventing loss of agricultural produce due to crop raiding was the most important proximal cause of hunting. The majority of participants differentiated primate species on the extent to which they posed a threat to crops. In Nema (13°38'59.53"N, 14°50'17.13"W), a participant commented that the red colobus ate mango flowers and unripe fruit but did not spoil the crops as did guinea baboons and green monkeys. In Kataba Sambuya, near Faraba (13°53'01.14'N, 14°82'77.20"W) in the Central River Region, a villager suggested that red colobus were not implicated in crop raiding and that the destruction was caused by green monkeys, patas monkeys and guinea baboons. Despite these species-specific differences in community perceptions of crop raiding by primates, there was evidence from several sites beyond the study area that all primate species including red colobus were hunted indiscriminately to protect crops.

Deforestation and climate change

The comments from participants regarding the overexploitation of timber resources for fuelwood, charcoal production and export reflect the documented declines in national forest cover that are described in the National Forest Inventory (Nget 2010). At a meeting of a Village Development Committee in Sambel Kunda, participants explained that climate-change-induced aridity and associated reductions in crop yields had resulted in a rapid expansion of illegal logging in the area in the last three years to offset declining farm incomes. They also confirmed that high value tree species were prioritized for harvest and that the majority of mahogany trees (*Khaya senegalensis*) in the study area had been felled. An understanding and awareness of climate change impacts on forest ecosystems was widespread amongst participants within and beyond the study area. In Sankwin village elders described increasing conflict between monkeys and local farmers driven by reductions in annual rainfall, degradation and loss of forest habitats and the increasing dependence of primate species on crops such as rice and groundnuts. In Kabokorr (13°12'25.11"N, 16°15'31.39"W) in the Western Region, an elderly farmer shared his perception that the local group of red colobus had been protected from hunting in the area for generations but were now declining because of climate-change-induced losses of local freshwater sources.

Community needs and opportunities

Given the likely ongoing impacts of climate change (Urquhart 2016), there was consensus amongst Village Development Committees in the study area with regard to their short-term and long-term needs. Short-term priorities included improvements in village water infrastructure to expand vegetable growing areas, the development of fast-growing tree nurseries and woodlots to establish an alternative source of forest products and the implementation of community-led sustainable forestry practices to restore degraded forest areas. Village Development Committee members agreed that, longer term, there were potential opportunities to develop lasting revenue streams from ecotourism by promoting red colobus as a flagship species and marketing non-timber forest products such as honey and beeswax body creams. They acknowledged, however, that ecotourism initiatives were currently constrained by the lack of tourism infrastructure and the accessibility challenges of the study area from the coastal resorts.

In considering site-appropriate models of ecotourism, it is important to note that at some ecotourism, restaurant, and lodging sites in The Gambia, there are known problems with habituated primates that are hand-fed by tourists. This is a major issue at Bijilo Forest Park (Starin 2009) and is also an issue along the Bijilo and Kololi coastal strip and even Abuko Nature Reserve (Mayhew pers. obs.). Though feeding wildlife is prohibited and these sites have signs to inform tourists, tourists and hired tour guides often do not comply and there is even some business surrounding the sale of nuts to feed to the monkeys. At other sites, such as Makasutu Cultural Forest, Kiang West National Park, and River Gambia National Park, where tourists can visit on day trips, or stay overnight, some monkey groups are well habituated to humans but are not hand-fed (Mayhew pers. obs.). To reduce the risks of disease transmission and increased rates of predation, red colobus will not be habituated at the study site in the Sambel Kunda area. An education program will be provided with appropriate signage to advise visitors not to feed or approach the monkeys. Early discussions have been held with the chiefs and Village Development Committees in the study area towards a model of ecotourism based on a set of guidelines to protect the health and welfare of the red colobus populations and a benefit sharing mechanism as described in a collective memorandum of understanding.

Discussion

A national estimate of red colobus abundance is currently constrained by a lack of reliable survey data at some sites with historic records of the species. Our results, in conjunction with published data of red colobus populations at long-standing study sites in the Western Region (Linder *et al.* in press), fill important knowledge gaps and begin to reveal the current geographic range and abundance of the species in The Gambia. Although the range of Temminck's red colobus extends to all five regions of The Gambia, most populations are small and fragmented. For example, in the Western Region, Bijilo Forest Park, Abuko Nature Reserve and Pirang Community Forest hold an estimated 50, 110 and 20 individuals respectively (Linder *et al.* in press; Mayhew pers. obs.). The study area and contiguous riparian corridor to the east holds the largest known observed red colobus population in The Gambia and compares to internationally important populations in Fathala Forest in Senegal's Delta du Saloum Biosphere Reserve (500 individuals) (Galat-Luong and Galat 2005), Senegal's Niokolo Koba National Park (300 individuals) (Galat-Luong and Galat pers. obs.) and Guinea-Bissau's Cantanhez Forest National Park (300 breeding individuals) (Minhós *et al.* 2016).

Comparisons of population abundance between the Sambel Kunda area and the riparian corridor should be treated with caution given the differences in survey methodology and habitat types. In the Sambel Kunda area, walked transects enabled the survey team to move quietly and survey both sides of the transect simultaneously. During the river surveys, only one bank could be surveyed at a time and the sound of the motorboat could have increased vigilance behavior and reduced detectability. Differences in forest structure between the survey sites could also have influenced detectability; the Sambel Kunda area has a more open vegetation than the riparian corridor, which is characterized by a dense low-lying layer of shrubs such as *Saba senegalensis*.

While the forest habitats in the study area and along the river corridor undoubtedly hold large numbers of red colobus, the survey findings reveal a snapshot in time and do not reflect an estimate of mean population size over a longer period. The

Figure 5. Adult female Temminck's red colobus, Senegambia Hotel, West Coast Region, The Gambia. January 2018. Photo by Michael Mayhew.

surveys were based on single counts from line transects conducted over a week in March 2019 during the dry season and are therefore potentially biased by seasonal changes in birth and mortality rates. Starin (1991) documented a 7-month birth season during a 5-year study at Abuko Nature Reserve in The Gambia and recorded variation in the timing of births between social groups. More survey effort is required to estimate mean population size for a minimum period of two years (inter-birth interval for red colobus) (Struhsaker and Pope 1991) from surveys repeated at regular intervals across a network of stratified linear transects using distance sampling methods (Buckland *et al.* 2010).

The brief survey period also constrained the accurate estimation of median group size, which was calculated following observations of the spatial separation between groups as waypoints uploaded to QGIS. The group size of red colobus in an area relates to the total population size and an interplay of ecological and demographic factors, including habitat size and quality, predation pressure, and the formation of fission-fusion groups (Gatinot 1975; Struhsaker 2010). The extent to which these factors influenced the median group sizes in the study area and river corridor will require long-term studies focused on individual groups to establish population impacts of predators such as Martial eagles (*Polemaeutus bellicosus*) and the inter-group dispersal of individuals from different age-sex class categories. It is possible that calculations of median group size are an underestimate, as some neighboring groups that were treated as distinct (separated by more than 200 m) for the purpose of this study are likely to be part of the same fission-fusion social group. Notwithstanding these methodological caveats, the median group size in Sambel Kunda compares with the mean group size of 29 recorded in Fathala Forest in 1973 prior to the subsequent loss and degradation of habitat (Galat-Luong and Galat 2005) and suggests that large areas of high-quality forest remain in the study area (Gatinot 1975; Struhsaker 2010).

The pattern of unsustainable hunting of red colobus that is driving declines and local extinctions of some populations in The Gambia is widespread across the geographic range of the species (Galat, Galat-Luong and Nizinski 2009; Minhos *et al.* 2013). In Guinea Bissau, molecular studies of primate carcasses at urban markets have revealed a tradition of hunting red colobus for the bushmeat trade (Minhós *et al.* 2013), which is also contributing to the decline of red colobus in Niokolo-Koba National Park in Senegal (Galat, Galat-Luong and Nizinski 2009). In The Gambia there were isolated reports of red colobus being hunted for bushmeat, but interviews conducted in Banni, Sambel Kunda, Sankwin, Berending, Mandino Bafuloto and Bakalaar all confirmed that the historic and contemporary hunting of red colobus was conducted to

Figure 6. Tree felling for charcoal production, Sambel Kunda Community Forest, Central River Region. March 2020. Photo by Michael Mayhew.

Figure 7. Tree felling for charcoal production and cattle grazing, Sambel Kunda Community Forest, Central River Region, The Gambia. March 2019. Photo by Michael Mayhew.

control crop raiding rather than to provide bushmeat for local consumption or sale. Despite the need for more comprehensive engagement of the local communities in the study area, there was a consensus of opinion from members of the Village Development Committees and interview participants that primates were not currently hunted in Sambel Kunda and the surrounding villages of Banni, Missera, Touba Demba Sama and Yida.

Although the apparent absence of hunting in the study area is encouraging, the ongoing clearance and degradation of forest habitats poses the greatest short-term threat to the red colobus (Figs. 6 and 7). Continued habitat fragmentation could further reduce connectivity between groups in the Sambel Kunda area and riparian corridor, contributing to a genetic bottleneck and loss of diversity from the gene pool. The rapid escalation of forest clearance described by the Village Development Committees supports the findings of a recent study that identified a loss of 83.3% of closed canopy forest across the West African region since 1900 (Aleman *et al.* 2018). A sub regional report for West Africa by the Food and Agriculture Organization (FAO) of the United Nations in 2003, estimated that forest and woodland had been reduced to 14% of the land area and current rates of deforestation were 1.2 million ha per year (FAO 2003). Forest clearance and degradation have contributed to the decline and extinction of other red colobus populations across West Africa which demonstrates the need to protect and restore the forests in the study area to secure extant populations of Temminck's red colobus. A 30-year study in Fathala Forest established that a loss of 50% forest cover was associated with an estimated 17% decline in red colobus abundance (Galat-Luong and Galat 2005). Logging also contributed to the population crash of Miss Waldron's red colobus, and surveys conducted between 1993 and 1999 established that most survey sites across its range in southern Ghana and south-eastern Cote D'Ivoire had been impacted by forest clearance and degradation (Oates *et al*. 2000; Zadou *et al.* 2011).

The communities in the study area identified climate-change-induced reductions in agricultural yields as one of the drivers of the rapid escalation of local logging activities. Village Development Committee members in the Sambel Kunda area are aware that they urgently need to adopt more sustainable community led forestry practices to mitigate climate change impacts and protect timber and non-timber resources but are currently unsure how they would develop and implement such a model. Since the early 1990s, The Gambia has pioneered the development of community forestry initiatives through participatory methods following the recognition by the Department of Forestry that state controlled management had failed to reduce the loss of forest cover (Wiley 2002; Thoma and Camara 2005; Nget 2010). Stronger forest policies and the enactment of the Forest Act in 1998, demonstrated a commitment to decentralize forest management and empower local communities to protect forest resources through ownership and user rights (Wiley 2002; Thoma and Camara 2005; Nget 2010).

Another issue identified by communities in the study area and wider region is water availability for red colobus. The farmer in Kabokorr described frequent occasions when the local red colobus group was seen to cross the main highway to gain access to permanent freshwater pools, and voiced concern that climate-change-induced losses of those pools was an important factor in the recent decline of the local red colobus group. At Kiang-West National Park, park rangers reported that they use a borehole to provide a freshwater source for red colobus during the dry season and that the colobus monkeys visit daily at predictable times to make use of it (Cramer, pers. obs.). Historically, drinking events by red colobus have rarely been observed and most of their fluid needs were met through the consumption of fresh green leaves and fruit (Starin 1991; Galat-Luong & Galat 2005; Struhsaker 2010). More recent evidence suggests that populations living in small fragmented degraded forest areas may have a greater physiological requirement to supplement their dietary fluid intake by drinking from terrestrial water sources (Hillyer *et al.* 2015). In April 2013, towards the end of the dry season, Hillyer *et al*. (2015) documented eight drinking events in two protected areas (Bijilo Forest Park and Abuko Nature Reserve), despite increased risks, at both sites, of predation from feral dogs and disease transmission as a result of drinking from terrestrial man-made watering holes.

Recommendations

The 30 km² of seasonally inundated forest habitat in the study area is relatively inaccessible by road, and benefits from low primate hunting pressure. This creates an opportunity for an integrated community development and primate conservation initiative, which should be prioritized with some urgency given the current rate of deforestation. By contrast, the protection of the connected red colobus populations along the riparian corridor to the east is logistically challenging, as it extends to over 100 km (both banks of the river), crosses administrative boundaries, and lies adjacent to many small villages and two small towns (Georgetown: 3789 inhabitants, Bansang: 7938 inhabitants; GBoS 2013). Community conservation projects have been successful and unsuccessful, with no one model working across, or even within, specific species or geographic areas (see reviews in Wells and McShane, 2004; Mcshane and Wells, 2004). As a best practice in primate conservation, local communities are key stakeholders in conservation efforts, and recognizing and leveraging the value of local knowledge, expertise, and buy-in is critically important (see reviews Fuentes, 2012; Horwich, 2016). In the short to medium term, the authors recommend the following specific objectives to be implemented in the study area around Sambel Kunda:

1. Designate the study site as a Community Protected Area to promote it as a primate hotspot and increase enforcement and community engagement capacity through the permanent relocation of the Department of Parks and Wildlife Management (DPWM) rangers to the project area.

2. Recruit a team of rangers with responsibility to a project manager to conduct regular transect surveys for red colobus and collect abundance and spatial data across the whole study area, using standardized methods as part of an ongoing biodiversity monitoring program. Data would be evaluated annually by the site's principal investigator to ensure data validity and reliability. Data would contribute to a Gambian Red Colobus Action Plan developed in collaboration with the IUCN SSC Primate Specialist Group.

3. Design a forest management plan to map and quantify forest resources, establish per capita use of timber and non-timber products and develop utilization categories through forest zonation. Build tree nurseries and woodlots to provide a sustainable alternative source of timber and to support the restoration of degraded forest areas.

4. Develop a community engagement and education program to grow awareness and understanding of primate species and their conservation needs and empower the local communities through the provision of knowledge and skills. The education program would be evaluated for effectiveness.

5. Support the generation of enduring revenue streams by developing small-scale ecotourism infrastructure and improvements to the existing network of boreholes to enable the expansion of vegetable growing areas in the villages. Develop online resources to raise awareness and embed the value of Temminck's red colobus as a charismatic flagship species in government agencies, NGOs and the tourist sector.

6. Use the ranger team to recruit and train community volunteers to build capacity in the medium to long term for primate surveys, community forestry, and livelihood projects such as site-specific ecotourism.

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