

1 **Camera Traps Confirm the Presence of the White-naped Mangabey *Cercocebus***
2 ***lunulatus* in Cape Three Points Forest Reserve, Western Ghana**

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14 **Abstract:** The white-naped mangabey *Cercocebus lunulatus* is severely threatened by
15 logging, mining, and hunting. In the last decade, wild populations have been confirmed
16 in just three forested areas in Ghana and a handful of sites in neighboring Côte d'Ivoire
17 and Burkina Faso. Sightings of this species were recently reported in a fourth area in
18 Ghana, the Cape Three Points Forest Reserve, a forest patch in western Ghana, 60 km
19 from the nearest recorded wild population, which is in the Ankasa Conservation Area.
20 We deployed 14 camera traps across 21 different locations throughout the reserve, with
21 the intention of confirming the presence of this species. Images of the white-naped
22 mangabey were captured at four locations, confirming the existence of a fourth sub-
23 population of this species in Ghana and providing only the second-ever photograph of
24 a wild member of this species in the country. We observed evidence of numerous
25 illegal anthropogenic activities in the reserve, which threaten these mangabeys, and we
26 make recommendations for the protection of the reserve, essential for the conservation
27 of this highly endangered species.

28
29 **The White-naped Mangabey and its Forests**

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31 The white-naped mangabey *Cercocebus lunulatus* (Temminck, 1853) is endemic to
32 the Upper Guinean rain forest of West Africa (Oates *et al.* 2016). Listed as a
33 biodiversity hotspot, the rainforest is regarded as one of the world's top priority areas
34 for conservation (Myers *et al.* 2000; Bakarr *et al.* 2004; Mittermeier and Rylands 2017);

35 however, around 10 million hectares of rainforest have been lost during the last century
36 through anthropogenic activities (Norris *et al.* 2010). Around 80% of the original
37 forested area is now an agriculture-forest mosaic—a socio-ecological system of over
38 200 million people living adjacent to countless, small and diminished rainforest patches
39 (Tallis and Kareiva 2006; Norris *et al.* 2010).

40 Forest fragmentation and degradation, along with hunting for bush meat, threaten
41 the remaining populations of the white-naped mangabey and the species is now
42 believed to be absent from several reserves and national parks with historical records
43 of its presence (Oates 2006). Whilst currently listed as Endangered by the IUCN (Oates
44 *et al.* 2016), a potential upgrade to Critically Endangered status is currently being
45 considered by the IUCN SSC Primate Specialist Group and the IUCN Red List
46 Programme. Sightings of the white-naped mangabey, though rare, have been reported
47 in Ghana and south-eastern Côte d’Ivoire within the last decade (Gatti 2010; Gonodele
48 Bi *et al.* 2013; Osei *et al.* 2015; Danquah and Tetteh 2016). A recent camera-trap study
49 resulted in the discovery of a new sub-population of this species in Atewa Forest and
50 the first photographic evidence of the species in Ghana (A Rocha International 2017).
51 This brought the total number of confirmed sub-populations of this species to nine;
52 three in Ghana (Ankasa Conservation area – Gatti (2010); Atewa Forest – A Rocha
53 International (2017); Kwabre forest – Osei *et al.* (2015), five in Côte d’Ivoire (McGraw
54 1998; McGraw and Oates 2002; Kone 2004; Galat and Galat-Luong 2006; McGraw *et*
55 *al.* 2006) and one in Burkina Faso (Galat and Galat-Luong 2006).

56 There have been a number of primate surveys in the Cape Three Points Forest
57 Reserve in recent years. The reserve is more than 60 km from the nearest known
58 population of white-naped mangabeys (in the Ankasa Conservation Area), but the
59 Cape Three Points Forest Reserve is within the historic range of the species. After a
60 three-day survey with John F. Oates in 1987 (10 km walked in 11 hr and 45 minutes),
61 Abedi-Lartey (1998) was able to report only that hunters indicated that it was still
62 present (and reportedly the second most abundant monkey in the reserve). Abedi-
63 Lartey (1998) saw evidence of heavy hunting and noted that the forest reserve was
64 easily accessible, under intense pressure from local communities and itinerant illegal
65 mineral prospectors, and that old and new farms cultivating oil palm ran right up to
66 the reserve boundary. A survey by Gatti (2010) covered 50 km (36 hours and 30
67 minutes) and yet failed to see this species, but he noted that an ornithologist, Ben
68 Phalan, had heard a group calling (see Holbech *et al.*, 2018), that a captive juvenile

69 had been confiscated in a nearby village, and that his team had seen them prior to his
70 survey. However, an unpublished survey carried out in September/October 2011,
71 organised by the NGO West African Primate Conservation Action (WAPCA) and led
72 by David Osei, did record the presence of white-naped mangabeys in the reserve
73 (WAPCA, WD & CRC, 2011). It was observed six times in groups of between eight
74 and 25 individuals. In addition, an unpublished survey carried out in the reserve in
75 August 2017 by Edward Wiafe, and covering 101km, resulted in the sighting of a
76 group of around five white-naped mangabeys (Wiafe 2017). The aim of our study was
77 to confirm the presence of this species in this reserve by using camera traps.

78

79 **The Cape Three Points Forest Reserve and the Camera-trap Survey**

80

81 The study took place between 25th January and 19th April 2018 in Cape Three
82 Points Forest Reserve, an isolated forest fragment in the Western Region of Ghana
83 (4°49'46.6"N, 2°02'58.5"W; Fig. 1.). The 51-km² reserve is an area of seasonal tropical
84 forest that lies in the moist evergreen zone near the coast of Ghana (Hawthorne and
85 Abu-Juam 1995; Gatti 2010). It has been designated as a Globally Significant
86 Biodiversity Area (GSBA) by the Forestry Commission of Ghana and as an Important
87 Bird and Biodiversity Area (IBA) by BirdLife International. The reserve is
88 characterized by a series of irregular hills with elevations ranging from 90–150 m.
89 Annual rainfall in the area is around 1400 mm (Adebi-Lartey 1998; Gatti 2010; Birdlife
90 International 2018). The reserve is surrounded by small communities, farms and
91 extensive rubber plantations, with some farms located in the reserve itself (Gatti 2010).

92 For the survey, the reserve was split into three, approximately equal-sized areas
93 (north, central and south) where we placed the camera traps during non-overlapping
94 time periods. Using a 1.2-km² grid system, each of the three areas was split into 14
95 grid squares. Of these 14 grid squares, seven were randomly selected as camera trap
96 locations, yielding a total of 21 camera trap locations across the reserve (Fig. 1). Two
97 camera traps were deployed at each sampling location; one camera trap was set at 50
98 cm above ground and one as close to the tree canopy as possible. This positioning
99 ensured that both the arboreal and terrestrial movement of the white-naped mangabey
100 could be sampled (McGraw *et al.* 2006). Ground camera traps were placed facing areas
101 where vegetation did not obstruct their view, and canopy cameras were placed either in

102 the same tree or on a neighboring tree large enough for a trained tree climber to reach
103 the canopy. Canopy cameras were placed between 7.8 m and 18.1 m above the ground
104 (\bar{x} =14.1m, SD \pm 2.9; Table 1), and were directed towards branches or vines that arboreal
105 mammals may use as routes through the canopy (Bowler *et al.* 2007). Once set up,
106 camera traps were left undisturbed for 20 days, with the exception of four locations in
107 the central area where some cameras had to be reset once due to malfunctions (Table
108 1). Camera traps (Bushnell Trophy Cam HD, #119677) were programmed to take
109 bursts of three pictures, with an interval of 60 seconds between bursts, once triggered
110 by any movement within their detection range. Captures of species were considered
111 independent events when a minimum of 30 minutes had elapsed between three-
112 photograph bursts.

113 In total, camera traps were deployed for 778 camera trapping days. During this
114 time, images of the white-naped mangabey were captured on four separate occasions,
115 once each in the north and south areas and twice in the central area of the reserve (Fig.
116 1). In the images captured in the north and south of the reserve, one individual can be
117 seen passing in front of the camera in the foreground (Figs. 2a and 2b). Numerous
118 pieces of evidence of illegal anthropogenic activity were observed in the reserve whilst
119 conducting the study, including bullet shells and snares (Fig. 3a) for hunting, as well as
120 active logging sites (Fig. 3b) and illegal galamsey mines (the Ghanaian term for gold
121 mines). Although camera traps captured images of the white-naped mangabey's
122 terrestrial behavior, no images of primates were captured by the canopy cameras. This
123 was despite visual and audible evidence of the presence of other primate species in the
124 reserve. In order to survey arboreal primates, it is important that cameras are placed as
125 close to the canopy as possible as detection probabilities increase with height of
126 placement (Bowler *et al.* 2017); in practice, however, this was not possible due to the
127 limited height our tree climber could safely reach.

128 Surveys in the late 1990s failed to obtain sightings of monkeys (only Bosman's
129 potto *Perodicticus potto*) in the reserve (Abedi-Lartey 1998; Oates *et al.* 2000). A more
130 recent survey by Gatti (2010) resulted in sightings of Lowe's monkeys *Cercopithecus*
131 *lowei* and spot-nosed monkeys *Cercopithecus petaurista*, but again only reports of
132 black-and-white colobus *Colobus vellerosus* and white-naped mangabeys. Another
133 survey, in 2011, obtained sightings of white-naped mangabeys, along with olive
134 colobus *Procolobus verus* and black-and-white colobus (WAPCA, WD & CRC, 2011),
135 and a 2017 survey recorded observations of spot-nosed monkeys, Lowe's monkeys,

136 black-and-white colobus, olive colobus and a group of white-naped mangabeys (Wiafe
137 2017). Ours is the first published study to confirm the presence of the white-naped
138 mangabey in Cape Three Points Forest Reserve by providing camera trap photographs
139 as evidence. As is the case in other Ghanaian forests (for example, Atewa forest, A
140 Rocha International, 2017) this primate sub-population is threatened by significant
141 anthropogenic activity.

142 We recommend that further protection should be considered immediately. This
143 could include upgrading the forest reserve to a national park or conservation area (Oates
144 2006), thereby increasing protection of the forest through a greater authoritative
145 presence (ranger patrols are currently required under the reserve's GSBA and IBA
146 statuses, but are infrequent) and reducing illegal activities. Community-based
147 initiatives could also be adopted as these have been found to be extremely successful
148 in other areas of high biodiversity in Ghana (for example, reforestation activities,
149 patrols and green value chains in the Tano-Ankasa Community Forest Project; Osei *et*
150 *al.* 2015, WAPCA 2019). Community Resource Management Areas (CREMAs) are
151 frequently deployed by the Wildlife Division of the Ghana Forestry Commission to
152 manage natural resources; these involve the development of a constitution, bylaws and
153 a natural resource management plan with local communities, giving them the authority
154 to apprehend those conducting illegal activities (WAPCA 2019). Although a CREMA
155 was previously set up for the Cape Three Points Forest Reserve, this is no longer
156 operational; one approach could be to reinstate this agreement. In addition, this sub-
157 population's extreme isolation from other breeding populations should be considered
158 in any conservation plans. Dispersal corridors are unlikely to be feasible due to the
159 distance from other populations, meaning translocations could be required to maintain
160 genetic diversity.

161

162 **Author Contributions**

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164 All authors contributed to the study design and provided feedback on the manuscript.
165 Writing the article: RN and CS; fieldwork: RN and AW; camera trap image analysis:
166 AW; assistance with fieldwork: JM, DO and AD; obtaining funding: MH.

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170 **Ethical Standards**

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172 Prior to conducting the study, ethical approval was granted by The University of
173 Chester Faculty of Medicine, Dentistry and Life Sciences Research Ethics Committee
174 (1373/17/RN/BS), and research permits were obtained from the Forestry Commission
175 of Ghana (FCWD/GH-01 18/01/18).

176

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178

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185

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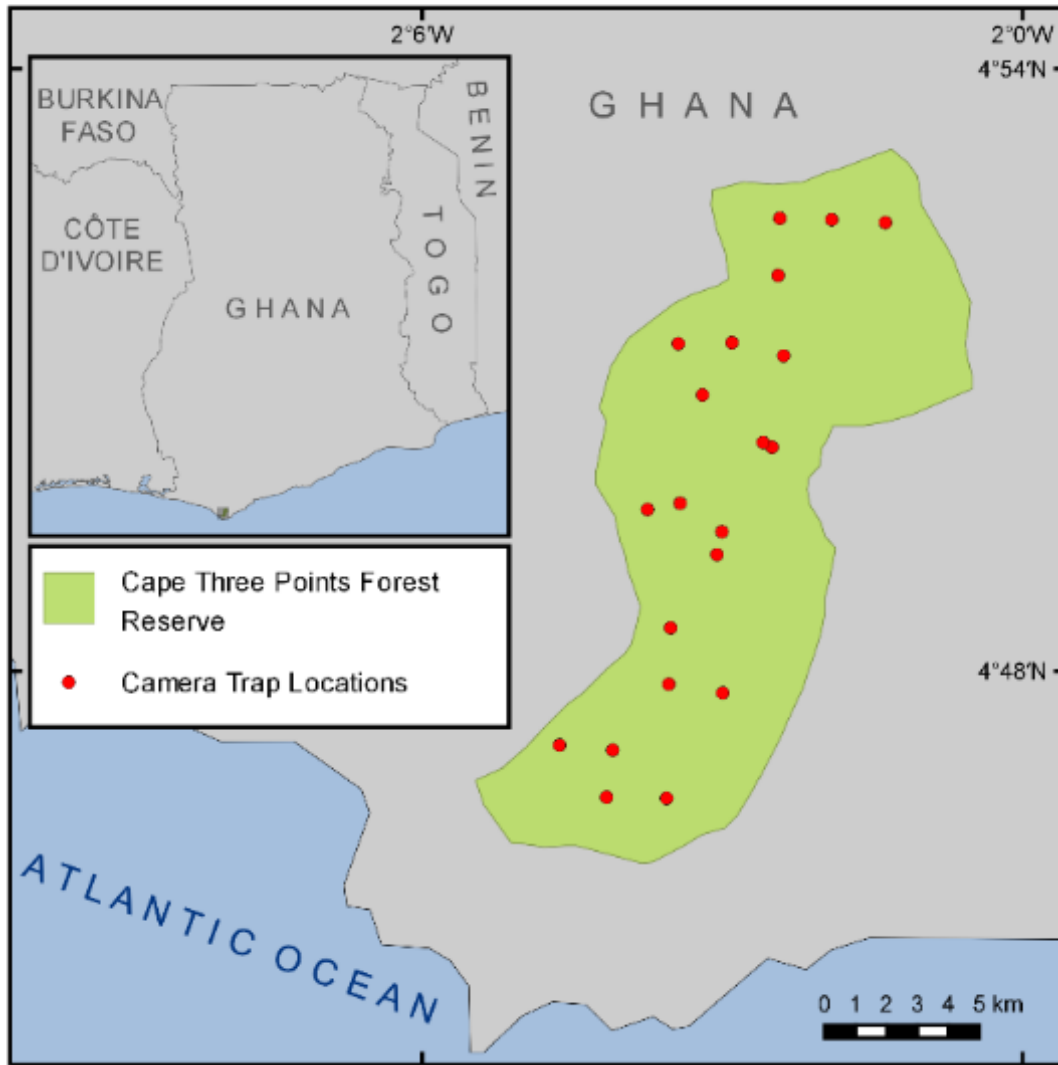
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Table 1. Camera trap locations, heights and the dates they were active during the survey of Cape Three Points Forest Reserve, Ghana.

Location	Dates trap was active	Height (m)	Notes
North			
1	25 February – 18 March	11.8	
2	25 February – 18 March	11.3	
3	25 February – 18 March	13.0	
4	25 February – 18 March	19.8	
5	26 February – 19 March	12.2	
6	26 February – 19 March	12.9	
7	26 February – 19 March	18.0	
Central			
1	3 February – 23 February	15.9	Canopy camera malfunctioned 3 February – 17 February
2	3 February – 23 February	18.1	
3	3 February – 23 February	14.9	Ground and canopy cameras malfunctioned 3 February – 17 February
4	3 February – 23 February	7.8	
5	4 February – 24 February	14.1	
6	4 February – 24 February	14.3	Canopy camera malfunctioned 4 February – 14 February
7	4 February – 24 February	12.0	Ground camera malfunctioned 4 February– 14 February
South			
1	20 March – 9 April	17.6	
2	20 March – 9 April	15.7	
3	20 March – 9 April	15.9	
4	20 March – 9 April	17.4	
5	21 March – 10 April	12.4	
6	21 March – 10 April	12.9	
7	21 March – 10 April	17.9	



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Figure 1. Map of camera trap locations used for this survey in Cape Three Points Forest Reserve, Ghana.



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(a)



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(b)

Figure 2. Camera trap images of white-naped mangabey *Cercocebus lunulatus* captured in the North (a) and South (b) areas of Cape Three Points Forest Reserve, Ghana.

295

(a)



296

(b)



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Figure 3. Images of illegal anthropogenic activity observed in Cape Three Points Forest Reserve, Ghana, during this study; (a) a hunting snare and (b) an active logging site.