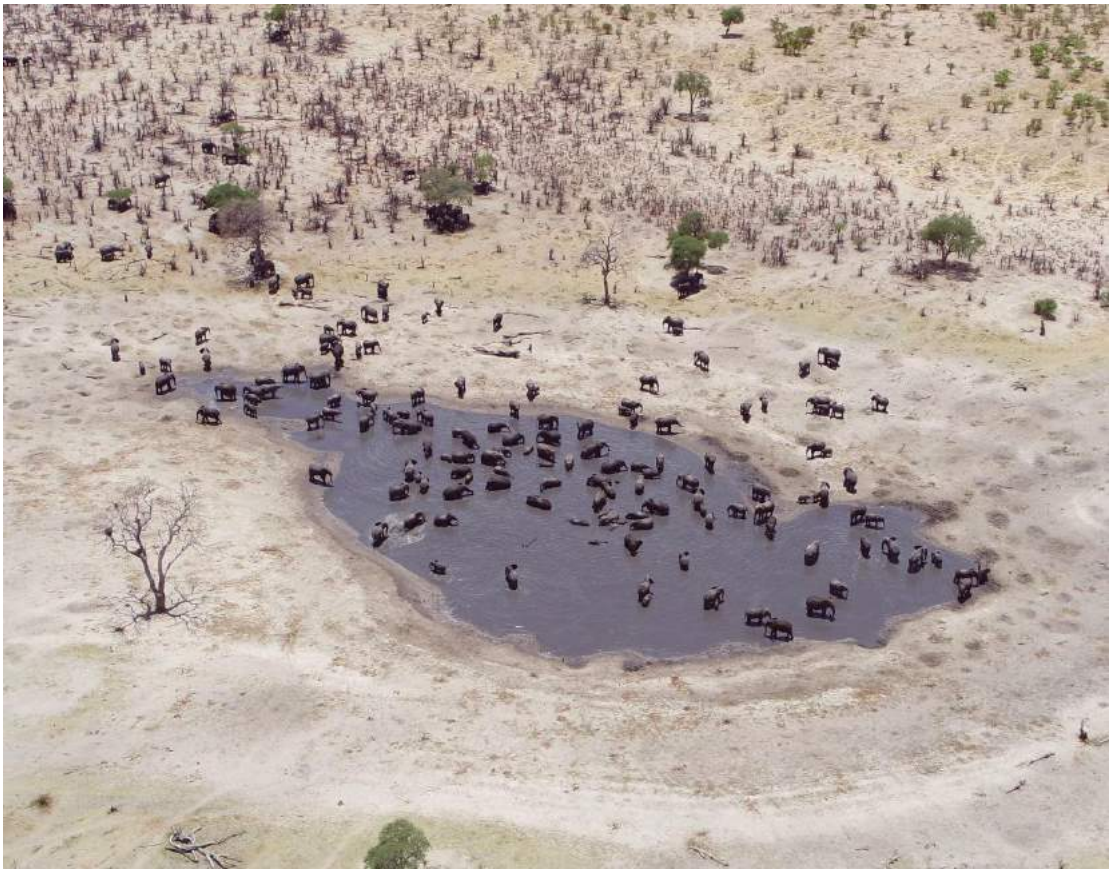
DRY SEASON AERIAL SURVEY OF ELEPHANTS AND WILDLIFE IN NORTHERN BOTSWANA

JULY – OCTOBER 2018

M. Chase, S. Schlossberg, R. Sutcliffe, & E. Seonyatseng



FINAL DRAFT

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DRY SEASON AERIAL SURVEY OF ELEPHANTS AND WILDLIFE IN NORTHERN BOTSWANA, JULY – OCTOBER 2018

Michael Chase[1*], Scott Schlossberg[1], Robert Sutcliffe[1], Elford Seonyatseng[2].

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[1] Elephants Without Borders, P.O. Box 682, Kasane, Botswana
[2] Department of Wildlife and National Parks, Box 131, Gaborone, Botswana

This survey was conducted jointly by Elephants Without Borders and the Department of Wildlife and National Parks (Botswana).

The opinions expressed in this report are those of Chase and Schlossberg and do not necessarily represent those of the Department of Wildlife and National Parks, or the donors who funded this aerial survey.

*Corresponding author: er@info.bw

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The 2018 aerial survey of wildlife over northern Botswana was a collaborative effort. It was jointly commissioned by the Department of Wildlife and National Parks (DWNP) and Elephants Without Borders (EWB) as a partnership, following the success of the 2010 and 2014 aerial surveys. As on previous surveys, on this aerial count, members of the DWNP actively took part in the exercise as observers counting wildlife.

The aerial survey was funded by both DWNP and EWB. Funding from the DWNP was received through a grant from the Conservation Trust Fund, an endowment administered by an independent board. No tax payers' money was used to fund any part of this survey.

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Prior to submitting this report to the GoB on 08 January 2019, EWB had the report extensively peer reviewed by the following professionals: Dr. Iain Douglas-Hamilton CBE, Dr. Paul Elkan, Dr. Richard Fynn, Dr. Falk Grossman, Dr. Keith Leggett, Dr. Keith Lindsay, and Prof. Rudi van Aarde. We acknowledge the reviewers for their assistance. Any remaining errors are the responsibility of authors Chase and Schlossberg.

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Finally, we acknowledge the thousands of public supporters - both Batswana and International - for their unwavering belief and support of our work, most especially the anticipated results of this survey. Thank you.

EXECUTIVE SUMMARY

During the 2018 dry season, a fixed-wing aerial survey of elephants and wildlife was flown over the core conservation areas of northern Botswana as well as surrounding pastoral lands. This aerial survey was commissioned by the Department of Wildlife and National Parks (DWNP) and Elephants Without Borders (EWB).

A small fixed-wing plane was used to survey an area of 103,662 km^2. Surveyed areas included Moremi Game Reserve (GR), Chobe National Park (NP), Makgadikgadi and Nxai Pan NPs and surrounding Wildlife Management Areas (WMAs) and pastoral areas in Ngamiland, Chobe and Central districts. The 2018 survey expanded upon EWB's 2014 and 2010 dry-season aerial surveys of northern Botswana through the addition of new strata south of the Okavango Delta near Maun, west of Makgadikgadi NP, and southeast of Ngwasha/Sepako near the Zimbabwe border.

The primary objective of this survey was to provide precise and accurate estimates of wildlife populations in the survey area, using repeatable, standardized methods. Secondary objectives included mapping the spatial distribution of elephants and other wildlife; determining the distribution of elephant carcasses, baobab trees, large birds, and livestock; and measuring trends in wildlife populations.

This report provides the results of this survey, including information on the spatial distribution, abundance, and recent trends of elephant and other wildlife populations. Maps and tables illustrating the distribution, numbers, density and trends of wildlife species in northern Botswana are provided.

The survey area was divided into 69 strata that largely conformed to the boundaries of WMAs and protected areas. For 62 strata, we used the sample count methodology, in which a subset of the stratum was surveyed via parallel transects spaced regularly 2-10 km apart. Sampling intensity in these strata ranged from 4 to 20%. In two strata, we conducted total counts in which the entire stratum was surveyed at high intensity so that the numbers of animals observed are assumed to be complete counts of the animals present. The remaining five strata utilized recce surveys in which non-systematic sampling was used to count animals in likely habitats. Recce surveys provide minimum population estimates. On all strata, high-resolution, wide-angle digital cameras were used to facilitate accurate estimation of herd sizes.

The estimated population numbers for the principal large herbivores, elephant carcasses and birds in northern Botswana were:

Species	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density
Elephants								
Elephant	126,114	22,565	5,054	9,923	8	116,191	136,036	1.22
Breeding herd	105,469	18,015	4,837	9,502	9	95,967	114,970	1.02
Bull	20,645	4,550	1,097	2,171	11	18,474	22,816	0.20

Species	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density
Elephant carcasses								
Fresh carcass (cat. 1)	226	40	41	81	36	145	307	0.002
Recent carcass (cat. 2)	611	88	78	154	25	457	765	0.01
Fresh/recent carcasses	837	128	90	177	21	661	1,014	0.01
Old carcass (cat. 3)	4,966	744	242	476	10	4,490	5,442	0.05
Very old carcass (cat. 4)	5,241	805	202	395	8	4,845	5,636	0.05
All carcasses	11,044	1,677	341	670	6	10,374	11,713	0.11
Other herbivores								
Buffalo	28,534	28,534	0	0				0.28
Duiker	303	34	66	132	44	170	435	0.003
Eland	2,098	275	544	1,077	51	1,021	3,175	0.02
Gemsbok	3,302	370	720	1,537	47	1,766	4,839	0.03
Giraffe	8,343	1,307	587	1,154	14	7,190	9,497	0.08
Hippo	13,232	2,307	1,015	2,001	15	11,231	15,233	0.13
Impala	77,694	13,371	3,884	7,679	10	70,015	85,374	0.75
Kudu	7,473	1,168	521	1,024	14	6,449	8,497	0.07
Lechwe	88,584	15,799	4,845	9,633	11	78,951	98,217	0.85
Reedbuck	2,620	452	227	452	17	2,168	3,072	0.03
Roan	833	132	138	272	33	561	1,106	0.01
Sable	2,872	484	799	1,631	57	1,242	4,503	0.03
Sitatunga	875	159	85	169	19	706	1,045	0.01
Springbok	120	69	52	655	547	69	774	0.001
Steenbuck	1,561	168	217	427	27	1,134	1,988	0.02
Tsessebe	3,650	628	384	760	21	2,891	4,410	0.04
Warthog	5,723	970	403	794	14	4,930	6,517	0.06
Waterbuck	993	186	182	365	37	628	1,358	0.01
Wildebeest	17,017	4,260	3,788	7,778	46	9,240	24,795	0.16
Zebra	60,170	11,182	9,247	18,399	31	41,771	78,569	0.58
Predators								
Hyena	91	17	36	80	88	17	171	0.001
Birds								
Bateleur	1,079	137	117	231	21	848	1,309	0.01
Fish eagle	2,242	392	131	258	12	1,983	2,500	0.02
Ground hornbill	438	77	86	169	39	269	607	0.004
Ostrich	3,429	463	427	841	25	2,588	4,271	0.03
Pelicans	6,423	1,206	2,731	5,794	90	1,206	12,217	0.06
Saddle-billed stork	552	96	62	123	22	429	676	0.01
Vulture	6,474	1,101	954	1,879	29	4,595	8,353	0.06
Wattled crane	1,373	251	211	425	31	948	1,797	0.01
Livestock								
Cow	128,936	18,493	8,292	16,543	13	112,393	145,479	1.24
Goat	51,035	5,451	6,132	12,586	25	38,449	63,621	0.49

When we restricted the 2018 data to only areas surveyed in on the 2014 aerial survey of northern Botswana, we found that estimated numbers of elephants had increased slightly and non-significantly since 2014, from 122,634 ± SE of 5,101 in 2014 to 122,831 ± 4,769 on this survey (Z = 0.03, P = 0.98). By stratum, changes in elephant population sizes between 2014 and 2018 were highly variable, with substantial movements of elephants likely occurring between strata.

The estimated number of elephant carcasses of all age categories was 11,044 for the entire survey area and gives an estimated carcass ratio of 8.0% for the entire survey. For sample counts (used on 62 of 69 strata), the carcass ratio was 8.1%. Carcass ratios greater than 8% on sample counts indicate a population that is potentially declining. The carcass ratio on strata surveyed via total and recce counts was 2.9%.

Estimated numbers of elephant carcasses and carcass ratios both increased significantly between 2014 and 2018. For all carcasses, estimated numbers of carcasses increased by 21%, and ratios increased from 6.8% to 8.1% between 2014 and 2018. For fresh/recent carcasses, numbers increased by 593%, and fresh/recent carcass ratios increased from 0.1% to 0.7%. These results indicate that mortality rates of elephants have likely increased recently in northern Botswana.

During the aerial survey, we identified four regions where large numbers of fresh/recent elephant carcasses were observed, many of which showed clear signs of being poached, i.e. skulls were chopped to remove tusks, or carcasses were covered with brush. We used a helicopter to conduct ground verification of the cause of death of 33 fresh/recent carcasses observed during the survey that were suspected of being poached. All 33 of the carcasses were confirmed to have been poached based on suspicious human activity, axe marks and damage to the skull, and other signs. Additionally, we conducted ground-based status checks for 79 carcasses of category 3 ("old") in NG 15, NG 18/19, and Chobe NP and found that 80% were poached. These results suggest that there is a significant elephant-poaching problem in northern Botswana that has likely been going on for over a year. The four poaching "hotspots" in northern Botswana are: NG 11/12/13, NG 15/18/19 & the Savuti section of Chobe NP, the vicinity of Maun, and NG 42.

Besides elephants, we observed substantial numbers of other wildlife species including: lechwe (population estimate = 88,584, the highest population estimate ever recorded for this species in northern Botswana), impala (77,694), zebra (60,170), and buffalo (28,534). Compared to 2014, populations increased significantly for hippopotamus, lechwe, reedbuck, sitatunga, fish eagle, and wattled crane. Populations of sable and saddle-billed stork decreased significantly since 2014.

We observed a total of 569 baobab trees during the survey, of which 14% were classified as small-sized trees. Dead trees (i.e. 100% damage, n = 20) accounted for 3.5% of the total number seen within the survey area. Estimated damage to trees increased significantly with both tree size class and elephant density in a stratum, though the effect of elephants on baobabs was weak.

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INTRODUCTION

This fixed-wing aerial survey of wildlife in northern Botswana was conducted during the dry season between July and October, 2018. Although the Department of Wildlife and National Parks (DWNP) has flown several aerial surveys of northern Botswana over the last three decades, this is only the third region-wide survey to provide concession-level estimates for wildlife populations via high-intensity surveys. This is also the first large-scale aerial survey of any kind in Botswana since 2014. Elephants Without Borders (EWB) previously provided concession-level estimates in their 2010 (Chase 2011) and 2014 (Chase et al. 2015) surveys of northern Botswana.

This survey comes at a critical time for the conservation of African savannah elephants (*Loxodonta africana*). Results of the 2014-2015 Great Elephant Census (GEC) showed that Botswana has the largest elephant population of any country, holding approximately 35% of remaining savannah elephants (Chase et al. 2016). Many African elephant populations have declined in recent years due to severe poaching. As of the 2014 survey, however, Botswana had been considered a safe harbor for elephants with relatively low poaching rates. With such a large proportion of Africa's elephants, ongoing monitoring of the status of Botswana's elephants is critical for conservation of this species.

The principal objective of this survey was to provide relatively accurate and precise estimates of the numbers of elephants as well as to estimate populations of other large herbivores in the survey area. This was accomplished using methods that could be executed within a reasonable time and at a reasonable cost. Secondary objectives include determining the spatial distributions of elephants and other large herbivores and birds, as well as estimating the number and distribution of elephant carcasses, livestock, and baobab trees. The methods used were suitable for meeting the survey objectives, repeatable and technically robust. Thus, this survey continues EWB's long-term efforts to monitor and understand the numbers and spatial distribution of wildlife in northern Botswana.

STUDY AREA

The elephant range within northern Botswana varies by season due to availability of water. During the wet season, elephants range over an area of ~115,800 km^2, extending from roughly Maun and the Boteti River in the south, north to the border with Namibia, and eastwards to the Zimbabwe border (Chase 2007). Small numbers of elephants are found south of this area in the Selebi-Phikwe and Tuli areas as well as in Central Kalahari Game Reserve. Those areas were not surveyed for this study.

During the dry season, the elephant range is smaller and is mainly concentrated around perennial rivers and artificial waterholes (~85,000 km^2). The 2018 survey area covered well over 90% of the dry-season elephant range. This area also includes areas where most other wildlife populations in northern Botswana occur.

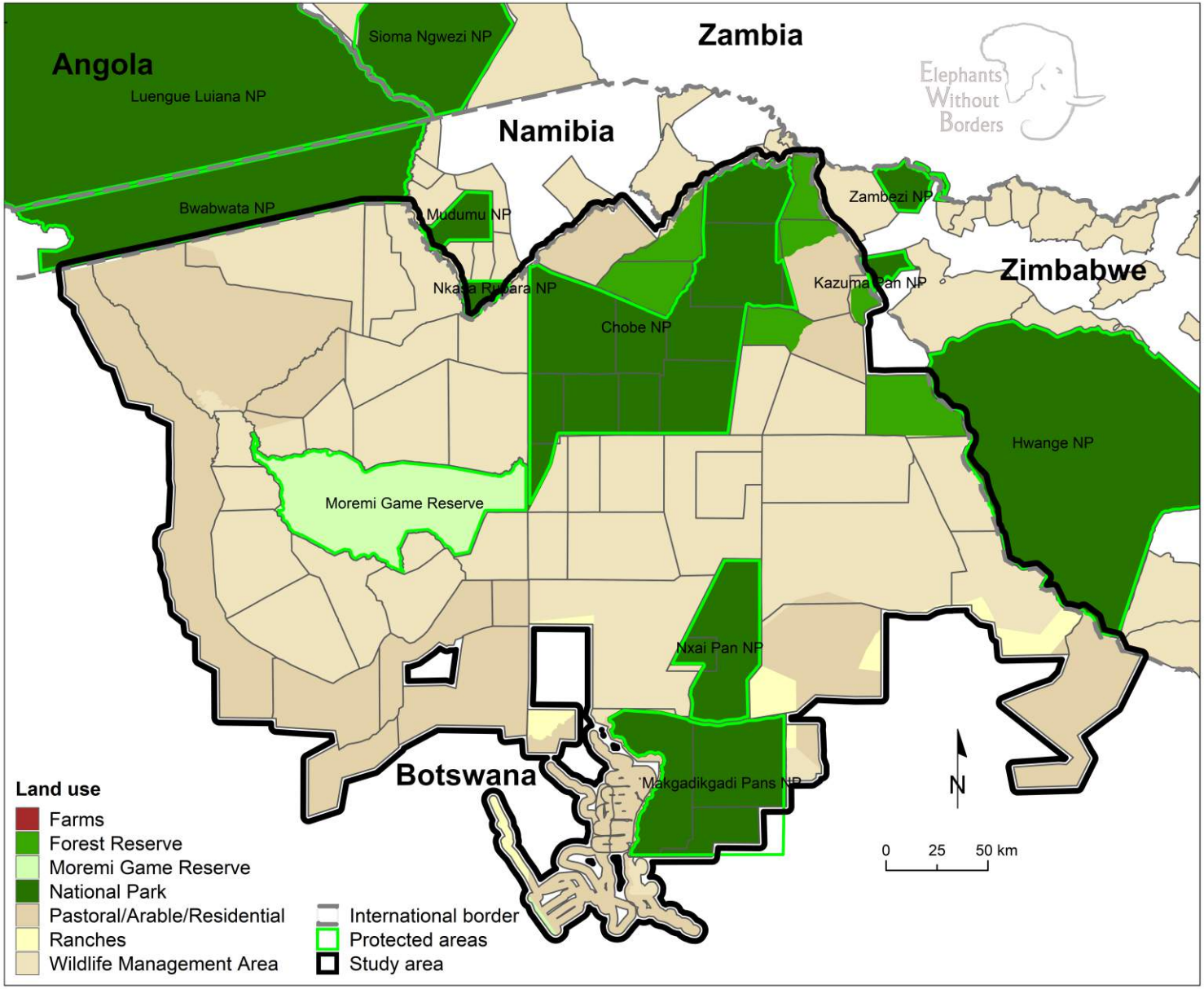
Within northern Botswana's elephant range, ~23,000 km^2 is strictly protected, including Chobe National Park (NP; 10,740 km^2), Makgadikgadi NP (4,900 km^2), Nxai Pan NP (2,590 km^2) and Moremi Game Reserve (GR; 4,911 km^2). An additional 65% (~75,000 km^2) of the elephants' range in northern Botswana is set aside for wildlife conservation in the form of Wildlife Management Areas (WMAs), which, as of 2018, are used for photographic ecotourism (Figure 1; Timberlake & Childes 2004). Some WMAs were previously used for hunting before a moratorium on hunting was enacted in 2014.

Rainfall in northern Botswana is strongly seasonal, occurring primarily during the October to April wet season. Rain occurs occasionally in May and September but is rare between June and August. Average annual rainfall for northern Botswana is ~660 mm. There are six perennial rivers in the study area (Figure 13, after the text). The Chobe, Zambezi and Okavango rivers are the largest rivers and provide abundant water throughout the year. The Khwai, Linyanti and Kwando rivers are smaller perennial rivers flanked by seasonally flooded wetlands. These rivers are highly dependent on rainfall in Angola and typically flood during the dry season in northern Botswana. Only in wet years may the Savuti, Boteti and Selinda rivers flow. The Okavango Delta is a large, inland wetland that floods annually over a 12,000 km^2 area (McCarthy & Ellery 1998). Throughout much of the study area, seasonal pans contain water during the wet season. Typically, water persists in these pans into August; the larger pans can retain water until November when the next wet season begins. Still, little water is available over large portions of the elephant range during the latter part of the dry season except at artificial waterholes.

The vegetation in our study area is diverse and consists predominately of deciduous dry woodland, upland grasslands, savannas, floodplain grasslands, wetlands, and shrublands (Thomas & Shaw 1991). Vegetation varies throughout the region due to soil type, wetness, and precipitation (Sianga & Fynn 2017).

To the north of the survey area, the Caprivi Border Fence extends for 135 km along the border with Namibia's Caprivi Strip (now officially known as the Zambezi Region), beginning on the east bank of the Okavango River and ending 35 km west of the Kwando River where it joins the Northern Buffalo Fence (Figure 13). This latter fence extends 130 km south to the Okavango Delta. The Namibian Border Fence begins on the west bank of the Okavango River and extends westward for 85 km and then south along the border for 300 km. This fence joins the Khuke Fence that extends for another 300 km eastward and joins the Makalamabedi Fence that turns north and connects with the Makgadikgadi/Nxai Pan and Southern Buffalo fences. The Ngwasha Fence connects with the Odiakwe Fence along the Maun – Nata road and extends eastward to the Zimbabwe border. Veterinary fences in Botswana are in variable condition, and some are easily crossed by elephants.

Figure 1. The survey area and land use in northern Botswana and neighbouring countries.



METHODS

Fixed-Wing Aerial Survey

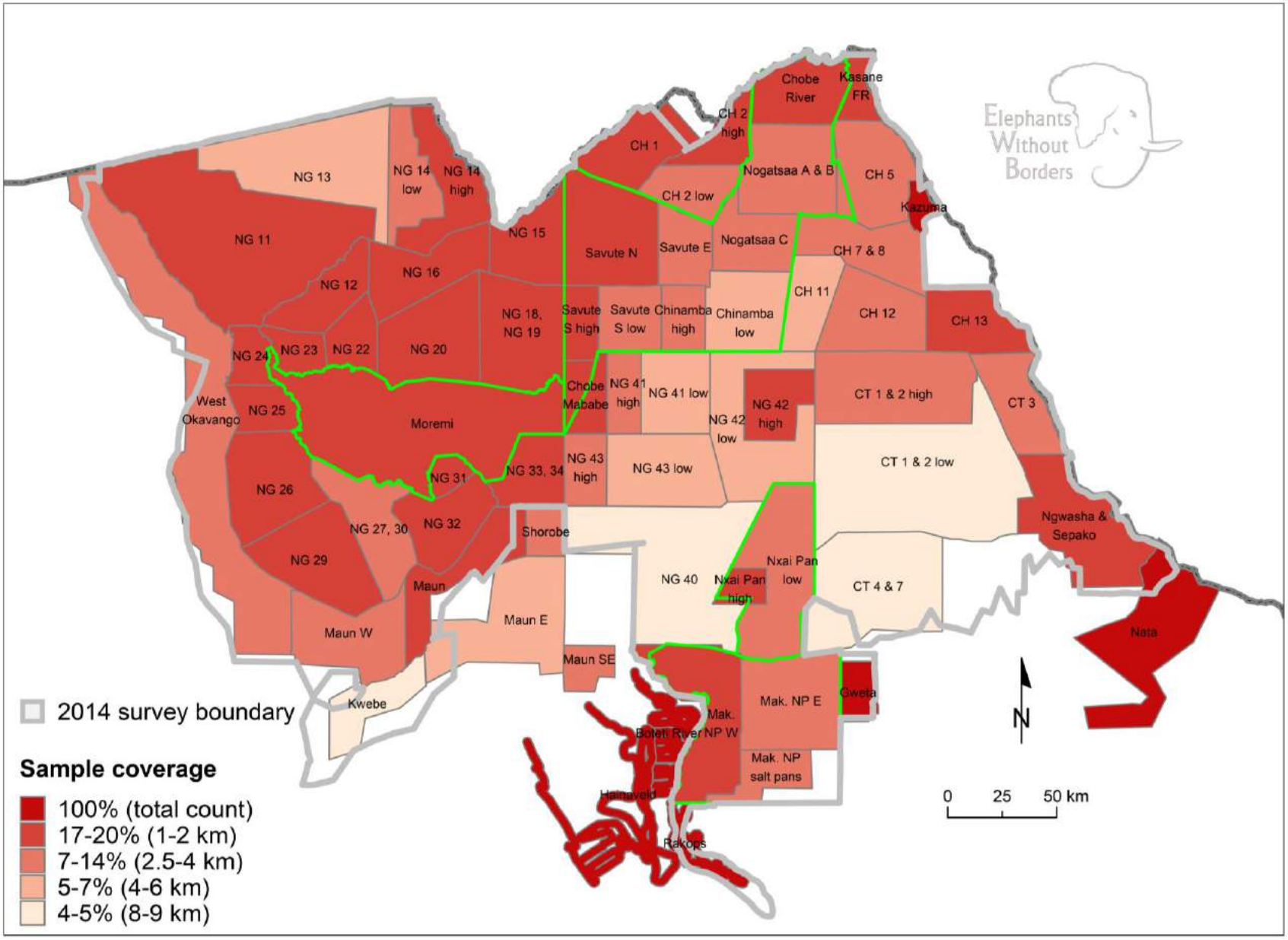
Survey Design

This report follows the procedures developed by Dunham et al. (2009) and Gasaway et al. (1986) for analyzing and presenting wildlife aerial survey data. Prior to the survey, the study area was divided into 69 strata (Figure 2). Strata were delineated according to WMA number, protected status, land use, expected distribution and abundance of wildlife from prior surveys, elephant satellite telemetry data, methods used on previous surveys, and land cover. We made a number of changes to the sampling design used in the 2014 survey. To increase the coverage of the elephant's range in northern Botswana, the 2018 study area was 5% larger than the area surveyed by EWB in 2014 (Chase et al. 2015). The 2018 survey added coverage in the southern and eastern portions of the study area, notably southeast of Ngwasha & Sepako along the Zimbabwe border, south and east of Maun, and west of the Boteti River and Makgadikgadi NP (Figure 2). Much of the added area was in pastoral lands, where relatively low wildlife populations were expected. To improve the precision of population estimates, sampling intensity was increased on several strata in Chobe district, and some strata used in 2014 were split to reduce spatial variation in expected wildlife densities. Excess variation within strata in animal densities can reduce the precision of population estimates. In the interests of efficiency, a few peripheral areas surveyed in 2014 that had little or no wildlife were not included in the 2018 survey.

On 62 of the 69 strata surveyed in 2018, we used standard strip-transect sampling (Norton-Griffiths 1978), a well-established method for aerial surveys of large African herbivores (Chase & Griffin 2009, Craig & Gibson 2002). To reduce the variance in population estimates, we oriented systematic, parallel transects perpendicular to major rivers, drainage valleys, environmental features, watercourses and fence lines. The position of the first transect in each stratum was determined randomly using GIS software.

The goal of our sampling design was to maximize the precision of elephant population estimates under constraints of time and funding. Hence, the sampling intensity, determined by the distance between adjacent transects, varied between strata and was proportional to expected elephant density. For a fixed overall sampling effort, spacing transects more closely in denser populations reduces the variance in population estimates (Norton-Griffiths 1978). Transect separation for sample surveys in 2018 ranged from 2 to 10 km (Figure 2). In areas expected to have dense elephant populations, transects were 2 km apart, providing ~20% sampling coverage for a strip width of ~360 m (i.e. combined width of the search strips on either side of the aircraft). Transects were spaced ~5 km apart in areas designated for moderate sampling intensity, providing a sampling coverage of ~7%. In strata with few elephants expected, we used a transect spacing of 10 km, providing ~4% sampling coverage. Transect lengths were typically < 30 km and could be flown in < 10 min, thereby minimizing observer fatigue.

Figure 2. Survey strata and sample coverage during 2018 dry-season aerial survey of northern Botswana.



On the Kazuma Forest Reserve (FR) and Gweta strata, we used total counts, in which all animals were counted on transects spaced 1 km apart (Norton-Griffiths 1978). This results in an effective counting strip ~500 m wide on either side of the aircraft.

On the Boteti, Rakops, Hainaveld, CT 4 & 7, and Nata strata, we utilized recce counts. These are similar to total counts in that all wildlife within view are counted, but regular transects were generally not followed. Rather, the surveys in these strata targeted river valleys, water holes, and other areas likely to have wildlife. Recce surveys were primarily used in pastoral areas where we expected wildlife to be clustered in uncommon patches of suitable habitat, making high-intensity surveys inefficient.

In strata designated for both agriculture and wildlife conservation (NG 10, 11, 12, 13, 35, 37, West Okavango, CH 1, 2, 5, CT 4, 7, Ngwasha & Sepako, Nata, various Maun strata, Kwebe, and Shorobe), the survey results provide information on the numbers and spatial distribution of cattle and goats.

The survey was designed using DNR Garmin software and ArcMap (ESRI 2012). Stratum boundaries were mapped in ArcMap, and the transect orientation and spacing were generated using the DNR Garmin Sampling Extension in ArcMap. This software generates flight lines (transects), with the first flight line offset from the end of the stratum by a random distance. The start and end points for each transect were transferred as waypoints to Mapsource (GARMIN 2007). Prior to flying, all transects were incorporated into a digital map of the survey area with their beginning and end point coordinates (Decimal Degrees, WGS 84). This digital map was created using ArcView software and showed observable landmarks and boundaries. All transects were then mapped as routes (GARMIN 2007) prior to flying and then uploaded on a digital map within each GPS receiver with their beginning and end point coordinates.

Flight Procedures

The survey was conducted during the height of the hot-dry season when good visibility of wildlife was expected due to lack of clouds or rain and deciduous trees' being leafless. Transects were flown at a target speed of 180 km per hour and a target altitude of 300 feet (91.4 m) above ground level (agl), as recommended by Norton-Griffiths (1978). Height above ground level was maintained using a laser altimeter (AgLasers, Rancho Cucamonga, California, USA), linked to a tablet display mounted on the dash of the plane. The plane was equipped with three GPS receivers. The pilot used one GPS to navigate along transect lines, a second GPS was used by the front seat data recorder to ensure the pilot did not deviate off the transect line, and the third GPS was used to record the locations of animal observations. The track log of the aircraft was recorded using a custom data logger (Vulcan Inc., Seattle, Washington, USA) that recorded speed and height above ground level once per second on transects, regardless of whether or not animals were seen. Later, the mean height for each transect was calculated by averaging the recorded values. The times at which the flight along each transect was started and ended were also recorded to provide a guide to the average speed and search effort (Craig & Gibson 2002, Dunham et al. 2009).

The aircraft crew included a pilot (Tammi McAllister), a data recorder (Michael Chase), who sat next to the pilot, and two observers who sat behind the pilot and recorder on either side of the plane. Three highly experienced observers were used during the surveys.

Robert Sutcliffe (EWB, > 400 hrs previous experience) was the left observer, and Elford Seonyatseng (DWNP, > 700 hrs previous experience) was the right observer for all but two days of surveys. During his absence, Tempe Adams (EWB, > 200 hrs previous experience) was the right observer.

All four crew members were able to communicate through headsets connected to a four-way intercom. For all strata we used the standard methodology for transect sampling developed by Norton-Griffiths (1978). For each observation within the transect strip (see section Strip Width and Calibration below), the observer called out the species and number observed when the object(s) were as nearly perpendicular to the plane as possible. The recorder marked each observation as a waypoint in the GPS receiver and also kept a written data log entered on a datasheet for each observation within the strip, including the waypoint number and time, altitude from the laser altimeter, number of individuals observed, and which observer made the sighting. A digital audio recorder was used to record the observers' call outs. At the end of each day, recordings were played back on a computer to verify the recorder's written observations.

A mark was placed on the plane window to help observers keep their eyes at a consistent height and maintain a consistent viewing angle throughout sampling. Any animals outside of the area delineated by the wands were not counted

Transects were typically flown during morning hours (~06h30 - ~11h30); however, some were flown between ~16h00 - ~17h30 due to logistical constraints (Table 13). Afternoon samples totaled 2.8% of all on-transect survey time.

Observations

During the survey observers were instructed to search for the species listed in Table 1. These included large and medium-sized mammals and large birds. In the tribal grazing areas, cattle and goats were counted.

Elephants were recorded as being in breeding herds (sometimes referred to as "family groups" elsewhere) or bull groups. Breeding herds were herds in which females and young were present; the herd may have included elephant bulls. Bull groups contained no females or juveniles; some bull groups consisted of a single individual bull. The observers also recorded any elephant carcasses seen. All elephant carcasses noted were classified using four age categories specified by the Monitoring the Illegal Killing of Elephants (MIKE) program as in Table 2 (Craig 2012). To help determine if carcasses were possibly illegally hunted, observers attempted to determine if tusks had been chopped or removed, if the carcass was covered in bushes, or if they were marked by a unique Government of Botswana marker.

Table 1. Animal species for which observers were instructed to search on the 2018 survey.

Common name	**Scientific name**
elephant	*Loxodonta africana*
buffalo	*Syncerus caffer*
duiker	*Sylvicapra grimmia*
eland	*Taurotragus oryx*
gemsbok	*Oryx gazelle*
giraffe	*Giraffa camelopardalis*
hippo	*Hippopotamus amphibius*
impala	*Aepyceros melampus*
kudu	*Tragelaphus strepsiceros*
roan	*Hippotragus equinus*
sable	*Hippotragus niger*
springbok	*Antidorcas marsupialis*
steenbuck	*Raphicerus campestris*
lechwe	*Kobus leche*
reedbuck	*Redunca arundinum*
sitatunga	*Tragelaphus spekii*
waterbuck	*Kobus ellipsiprymnus*
tsessebe	*Damaliscus lunatus*
warthog	*Phacochoerus africanus*
wildebeest	*Connochaetes taurinus*
zebra	*Equus quagga*
cattle	*Bos taurus*
goat	*Capra aegagrus hircus*
bateleur	*Terathopius ecaudatus*
ostrich	*Struthio camelus*
fish eagle	*Haliaeetus vocifer*
pelican	*Pelecanus onocrotalus*
ground hornbill	*Bucorvus leadbeateri*
saddle-billed stork	*Ephippiorhynchus senegalensis*
wattled crane	*Bugeranus carunculatus*

Table 2. Elephant carcass categories from the MIKE Program used to classify carcasses seen during the aerial survey.

Carcass category	**Definition**
1	**Fresh** Still has flesh, giving the body a rounded appearance. Vultures probably present and ground still moist from body fluids. (Likely to have died <1 month ago).
2	**Recent** Rot patch and skin still present. Skeleton not scattered. (Likely to have died <1 year ago).
3	**Old** Clean bones, skin usually absent, vegetation regrown in rot patch. (Likely to have died >1 year ago).
4	**Very old** Bones scattered and turning grey. (Likely to have died up to 10 years ago).

In northern Botswana there has been increasing concern about the impact elephants and fires are having on large trees (e.g. baobab) and the regeneration of other vulnerable tree species (Chase 2010). To provide current information on the status of baobab trees in the survey area, observers counted baobabs during the survey and assessed the level of damage (assumed to have been caused by elephants) to trees seen. This 'damage/impact' was expressed as a percentage of the tree which had been impacted. During the aerial survey, when baobabs were sighted, observers visually estimated the proportion of damage to the tree to the nearest 10%. Baobab trees were classified into three approximate size categories:

Baobab size	Definition
Small	< 1.5 m in diameter
Medium	1.5 – 3 m in diameter
Large	> 3 m in diameter

All wildlife species seen during the survey were recorded, but estimates (and assessments) are provided only for those in Table 1. Estimates of small or cryptic species and those whose behaviour (diving or hiding as the plane approaches) or habitat makes them difficult to see from the air can be inaccurate. Rare species, such as sitatunga, or species that have clumped distributions, such as zebra, tend to have less precise estimates (Craig & Gibson 2002). We tried to address these concerns by stratification of survey effort and aerial photography, which should improve the precision and accuracy of the survey, respectively.

In the study area, buffalo can occur in large herds of 1,000 or more animals and have a highly clumped distribution between transects. Thus, during surveys, the front seat observer attempted to count buffalo herds completely (a "partial total count"), with all visible individuals counted rather than only those within the strips. This should lead to a more accurate estimate of buffalo populations than would have been possible if only the subset of animals within strips were counted.

Strip Width and Calibration

Precise survey strips were defined by attaching two parallel aluminum wands to custom-made brackets to each wing strut of the aircraft. The wands could be moved in any direction during the setup phase to delineate a planned 200-m field of view on each side of the plane at an altitude of 91.4 m agl. Interval widths on each side of the plane were calibrated and confirmed prior to initiating survey flights. This was done by marking an airstrip at 10-m intervals and conducting flyover tests. On each test, observers recorded the number of 10-m intervals in their strip as the plane passed perpendicularly over the markers. After repeated flyovers at ~91.4 m agl and photo verification, wands were adjusted to provide a designated field of view for each strip interval of ~200 m at the planned flight altitude. The aluminum wands were attached to the struts for the duration of the survey.

To ensure that the wands remained in place and determine the exact strip width of each observer, at least one calibration flight was conducted on each day of aerial surveys. Deviations of observer strip widths from the nominal 200 m will affect density estimates, so we used the calibration data to determine the exact strip width for each observer. We did this by regressing measured strip widths from calibration flights on the height above ground level during the flyover. The resulting regression equation was used to predict the expected strip width at 91.4 m agl. This calculation was made separately for each observer. Estimated strip widths were 181.5 m for R. Sutcliffe and 180.6 m for E. Seonyatseng.

Aerial photography is frequently used to improve the accuracy of wildlife surveys (Chase & Griffin 2009). Two Canon EOS 7D digital cameras (18-megapixel resolution) were fixed to specially adapted mounts on the front-most windows on each side of the plane. The components of the camera system consisted of two cameras with 28-mm wide-angle lenses, remote switches and the two window camera mounts. The centers of the lenses were aligned horizontally with the marks on the plane window used by observers to keep their eyes at a consistent height. The focal length of the lens was adjusted to incorporate the full counting strip, providing a consistent viewing angle. Observers were instructed to take photos of any animal group too large for all individuals within it to be counted easily. These photos were used to verify the size of the herd within the interval defined by the wands. A GPS time code and date were recorded within the cameras to the second for every frame exposed.

Ground-based carcass assessments

During the survey, observers recorded an unexpectedly large number of fresh/recent carcasses (category 1 and 2), some of which showed probable signs of poaching such as a carcass covered by brush, obvious removal of tusks with axe or saw, trunk cut and removed from face, and carcasses of similar size (age and sex) in close proximity to each other. These carcasses were primarily located in four "hotspots": 1) eastern portions of NG 11, NG12, and NG13; 2) NG18/19, NG 15, and the Savuti section of Chobe NP; 3) the Maun stratum; and 4) the high-intensity NG 42 stratum. The large number of fresh/recent carcasses observed raised the possibility that poaching has increased recently in these areas.

Observations made during aerial surveys are not always sufficient to determine if a carcass originated from poaching, human-elephant conflict (HEC), or natural elephant mortality. Thus, we used helicopters to conduct two primarily ground-based assessments of elephant carcasses, with the goals of determining likely causes of mortality and how long poaching may have been going on. Detailed methods used in these assessments, along with results and photographs, can be found in Appendices 1 and 2 of this report.

The first helicopter-based assessment was made opportunistically and concurrently with the aerial survey. This assessment focused on fresh and recent carcasses. We assessed 33 of the 104 fresh/recent carcasses that were identified as potentially poached during the aerial survey. Selection of locations for the assessment was constrained by logistical requirements of the survey and the availability of helicopters. Each carcass was assessed for several potential indicators of poaching per MIKE program standards (MIKE Programme 2015), as described in Appendices 1 and 2.

The second helicopter-based assessment focused on "old" carcasses (category 3) in the NG 15/18/19 and Savuti hotspot. Fresh/recent carcasses are generally considered to come from elephants that died within roughly one year prior to the survey. We chose to examine category 3 carcasses to determine if potential poaching had been going on for longer than one year. When poachers use axes or saws to remove tusks from poached elephants, the damage to the skull remains and is still evident >1 year after the elephant's death. We also examined each site for suspicious human activity, such as if carcasses were covered in bushes. Thus, we were able to assess whether or not poaching was the likely cause of death for the assessed carcasses. We also aged and sexed carcasses by measuring skulls and teeth, again via MIKE program standards. We assessed all category-3 carcasses located on the aerial surveys in a ~1,400-km^2 region that we had identified as a potential poaching hotspot (see Appendix 2).

Data Analysis

Strip Transect Sampling / Fixed-Wing Aerial Survey

Survey strata were largely delineated according to the boundaries of WMAs and protected areas to provide wildlife estimates specific to these areas. The entire survey area, in this report is termed ‘northern Botswana.’ While the survey area did not cover all of northern Botswana the term is used in reference to the 103,662-km^{2}area sampled within the region.

For strata surveyed with sample transects, we followed the guidelines developed by Norton-Griffiths (1978) to estimate population sizes for each stratum from observations made within the survey strips. We photo-corrected herd sizes before analysis. We also adjusted for altitude when calculating the area surveyed on each transect. Because effective strip width increases linearly with height above ground level, we adjusted strip width for each transect by multiplying the strip area by the ratio of mean altitude on the transect to 91.4 m. We used the traditional Jolly’s Method II for unequal-sized sampling units (Jolly 1969) to calculate the population estimate and variance for each species in each stratum. Jolly’s Method II is a ratio estimator that estimates the density of animals in a stratum as the total number of animals counted divided by the total area searched.

The population estimate is simply the density estimate times the stratum area, and the variance in the estimate depends upon the variation between transects in animal density.

As discussed above, buffalo herds were counted completely, so the population estimate for each stratum was simply the total number of animals counted during the surveys. The CI and SE of these estimates was assumed to be 0.

Likewise, for the seven strata sampled by recce surveys or total counts, the population estimate was simply the sum of the observed counts of animals. Again, the SE and CI of these estimates were assumed to be 0.

Population estimates for larger areas. To estimate population sizes for aggregations of strata or the entire survey area, we summed stratum population estimates to obtain estimates for the larger area. The upper and lower 95% confidence limits for combined population estimates were calculated following Dunham et al. (2009) as population estimate ± $t_v \sqrt{\sum S_i}$, where

t_v = critical value from the *t* distribution with *v* degrees of freedom and α = 0.025, and
S_i = the estimated variance of the population estimate in stratum *i*.

The degrees of freedom, *v*, were estimated by Satterthwaite's rule (Gasaway et al. 1986) and were calculated using this formula, where *n* is the number of strata with $S_i > 0$ being combined:

$$v = (n-1)(\sum S_i)^2 / \sum S_i^2$$

Comparison of observers. To determine if the two primary observers differed in their ability to detect animals, we made two sets of comparisons. First, we compared total numbers of herds observed between observers for the more common species. This comparison is based on the assumption that, over a large sample of transects, the observed number of herds on each side of the plane should be roughly equal if both observers have similar detection probabilities. For each species, we calculated the total number of groups counted by each observer. To determine how many groups were expected on each side, we had to correct for differences in strip width between observers. For each observer and each species, the expected number of groups was:

$$E_s = \frac{2w_s \mathrm{Os}}{W}$$

where E_s is the expected number for side *s*, w_s is the strip width for side *s*, *W* is the summed strip width for both sides, and O_s is the observed number of groups for side *s*. For each species, observed and expected numbers of groups seen were compared using χ^2 goodness-of-fit tests with 1 degree of freedom (Dunham et al. 2009). Differences between observers were considered significant at $P < 0.05$. Because χ^2 tests are unreliable for small sample sizes, we did not test differences between observers for species with expected herd counts ≤ 5 for either observer.

As a second method of comparing observers, we calculated population estimates for each observer alone while excluding the other observer's data. As above, if both observers are equally competent, separate population estimates from each observer for the same

species should be similar. For each animal species and observer, we summed population estimates across all strata. We compared population estimates between observers with two-sample *Z*-tests.

Elephant carcasses. Following the method developed by Douglas-Hamilton & Burrill (1991), and adapted by Dunham et al. (2009), the elephant carcass 'ratio' was calculated for each stratum as the number of dead elephants observed divided by the number of dead plus live elephants observed. We report this ratio as a percentage. We calculated separate carcass ratios for category 1 and 2 carcasses combined (the 'fresh/recent carcass ratio') as well as for all carcasses combined (the 'all-carcass ratio'). It is reasonable to assume that category 1 and 2 carcasses represent elephants that may have died within the year leading up to the survey (Dunham et al. 2009). Hence, the fresh-carcass ratio should provide an index of elephant mortality, both natural and anthropogenic, during the year prior to the survey date. Research suggests that the all-carcass ratio is proportional to elephant population change over the preceding 4 years (Douglas-Hamilton & Burrill 1991). All-carcass ratios >8% generally indicate a declining population.

For larger areas, such as the entire study area, we calculated carcass ratios by summing the stratum population estimates for carcasses and elephants and calculating the ratio as above. The variance of a combined carcass ratio was calculated via the delta method.

Photo-interpretation. High-resolution digital photographs taken with cameras mounted on each side of the plane were used to verify or correct the numbers of animals seen by observers. Photographs were viewed in Adobe Photoshop, colour-corrected if necessary, and marked with dots on each counted animal within each herd to facilitate counting. Photo interpretation was especially helpful in accurately counting large herds that are difficult for observers to enumerate during surveys. In addition, photos helped to verify whether animals occurred within the counting strip (Norton-Griffiths 1978).

Other analyses. Linear regression with a random effect of stratum was used to test the relationship of elephant density with damage to baobabs. Program R (R Core Team 2018) was used for all statistical analyses.

Trend Analyses

To understand how wildlife populations have changed in Botswana in recent years, we compared populations of elephants and other wildlife species between the 2014 and 2018 surveys. Valid comparisons between surveys require ensuring that the study areas were identical in each year. Thus, we used Program R to trim the strata, transects, and observations from 2018 to the area coincident with 2014 study area. Then, we used the methods described above to estimate population sizes for the trimmed study areas.

We first compared overall populations between 2014 and 2018 for the entire study area. We computed the exponential population growth rate as:

$$r = [\log(population\ est.2018) - \log(population\ est.2014)]/4$$

We used the delta method to calculate the variance of *r* estimates. We used two-group Z-tests to determine the significance of changes in estimated populations. This test takes into account the error in population estimates for both 2018 and 2014.

For elephants, we conducted detailed analyses of how populations have changed by stratum. We used the 2014 strata as the basis for comparison, as these were larger on average than the 2018 strata and required less breaking up of strata to compare results across years. For each 2018 stratum, we calculated the proportional area of that stratum in each 2014 stratum which it intersected. We assumed that elephant populations within strata were distributed uniformly, and we assigned 2018 elephant populations to 2014 strata in proportion to their overlapping areas. Thus, if a 2018 stratum had 50% of its area in each of two 2014 strata, the estimated 2018 elephant population allocated to each 2014 stratum was 50% of the 2018 stratum estimate. Standard errors for population estimates were also divided proportionally to area. We summed the 2018 estimates and variances for each 2014 stratum and then compared each pair of the 2014 and 2018 estimates with two-group Z-tests. We also calculated *r* for each stratum as above.

For carcass ratios, we calculated separate ratios for 2014 and 2018 as described above, and we compared carcass ratios by year with two-group Z tests.

Search Effort

Greater the time spent searching each square kilometer of a transect leads to a greater probability that an observer will see animals that occur within the counting strip (Caughley et al. 1976). Search effort (in km^2 per minute) for a stratum was defined as the total area of all transects within the stratum divided by the total time spent flying those transects (Gasaway et al. 1986). Aerial survey standards call for a search effort of 1-1.5 km^2 per minute (Craig 2012). Faster search effort would potentially result in missing animals in the survey strip.

Aerial surveys inherently underestimate wildlife numbers, with the degree of underestimation greater for small or cryptic species than for larger species (Norton-Griffiths 1978; Schlossberg et al. 2016, 2018a). However, population estimates are given for all species listed in Table 1 because the estimates provide useful indices of abundance (with measures of precision) that can be used to determine spatial distribution as well as temporal trends in population numbers (Dunham et al. 2009). Other than observations that were corrected by reference to photographs, no other corrections have been applied to any estimates to compensate for any undercounting or missed animals.

RESULTS

Fixed-wing Aerial Survey

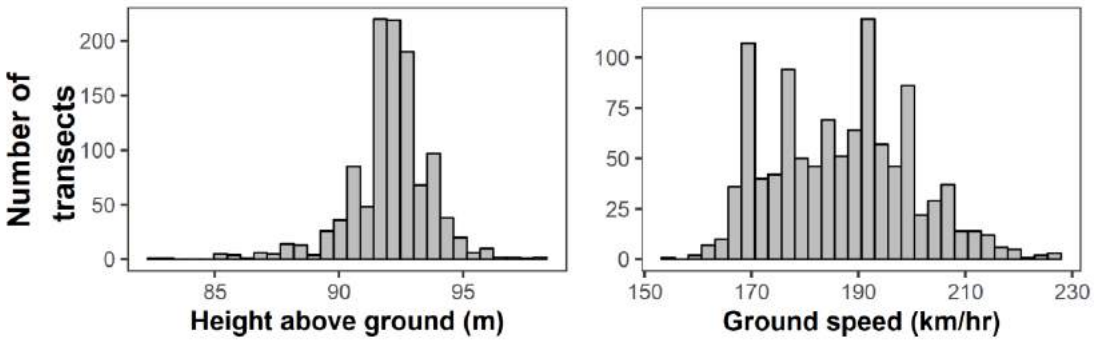
Sampling Effort

The study area totaled 103,662 km^2 in area. On the 62 strata surveyed with sample counts, we flew 1,074 transects, totaling 32,283 km in length (mean length = 30 ± SD of 14 km) in 151 hours over 62 survey days (Tables 13 & 14, Figure 14 following the text). An additional

487 km were flown on 40 transects in the two total-count strata. Finally, we flew ~2,128 km of recce surveys. Overall sample coverage on strata surveyed by sample transects and total counts was 12.6%.

By transect, flight altitude averaged 92 m ± SD of 2 m (range 82 - 98 m; Figure 3). These values are well within suggested guidelines for aerial surveys. Flight speed averaged 187 ± 13 km/hr (range: 156 – 228 km/hr; Figure 3) which is slightly higher than the target of 180 km/hr.

Figure 3. Height above ground and ground speed by transect on the 2018 aerial survey of northern Botswana.



The search rate was calculated for total and sample counts as the total area sampled divided by the total time on transects and averaged 1.27 km^2/min for sample counts (Table 13). This value is also well within standard guidelines. We did not calculate search rate for recce counts because the strip width was not defined.

Strip-width calibration

Estimated strip widths at 91.4 m agl were 181.5 m for the left observer and 180.6 m for the right observer. Estimated strip widths during calibration flights showed a good correspondence to altitudes, with r^2 values for this relationship equal to 0.83 and 0.81 for the left and right observers, respectively.

Population estimates

Population estimates for the entire survey area are shown in Table 3. Estimated numbers by stratum of animal species or other items in Table 3 are given in Table 5 (below, for elephants) and Tables 15 through 54, following the report text. Estimates are given for each stratum, by district and for the entire survey area. Any apparent arithmetic errors in the tables are due to rounding.

The columns in Table 5 as well as Tables 15 through 54, following the text, provide:

- the name of the **stratum**,
- the **estimate** of the number of animals of that species in that stratum, in other words the population estimate,

- the number of individuals of that species seen (**No. seen**) inside the search strips during the survey of that stratum,
- the **standard error** of the estimated number of animals in that stratum,
- the 95% confidence interval (**CI**) of the population estimate for that species in the stratum, also expressed as a percentage of the population estimate for that stratum (**% CI**),
- the lower 95% confidence limit of the population estimate (**Lower CL**),
- the upper 95% confidence limit of the population estimate (**Upper CL**), and
- the **density** (estimate in animals per km^2) calculated using the stratum area.

If the calculated lower confidence limit (Lower CL), was less than the actual number of animals counted within the strip (No. seen), we replaced the calculated confidence limit with the number seen. Total counts were assumed to have standard error and confidence interval equal to 0.

Table 3. Population estimates and statistics for major wildlife species, elephant carcasses, baobabs, and livestock during the 2018 dry season aerial survey in northern Botswana.

Species	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density
Elephants								
Elephant	126,114	22,565	5,054	9,923	8	116,191	136,036	1.22
Breeding herd	105,469	18,015	4,837	9,502	9	95,967	114,970	1.02
Bull	20,645	4,550	1,097	2,171	11	18,474	22,816	0.20
Elephant carcasses								
Fresh carcass (cat. 1)	226	40	41	81	36	145	307	0.002
Recent carcass (cat. 2)	611	88	78	154	25	457	765	0.01
Fresh/recent carcasses	837	128	90	177	21	661	1,014	0.01
Old carcass (cat. 3)	4,966	744	242	476	10	4,490	5,442	0.05
Very old carcass (cat. 4)	5,241	805	202	395	8	4,845	5,636	0.05
Old/very old carcasses	10,206	1,549	326	641	6	9,566	10,847	0.10
All carcasses	11,044	1,677	341	670	6	10,374	11,713	0.11
Other herbivores								
Buffalo	28,534	28,534	0					0.28
Duiker	303	34	66	132	44	170	435	0.003
Eland	2,098	275	544	1,077	51	1,021	3,175	0.02
Gemsbok	3,302	370	720	1,537	47	1,766	4,839	0.03
Giraffe	8,343	1,307	587	1,154	14	7,190	9,497	0.08
Hippo	13,232	2,307	1,015	2,001	15	11,231	15,233	0.13
Impala	77,694	13,371	3,884	7,679	10	70,015	85,374	0.75
Kudu	7,473	1,168	521	1,024	14	6,449	8,497	0.07
Lechwe	88,584	15,799	4,845	9,633	11	78,951	98,217	0.85
Reedbuck	2,620	452	227	452	17	2,168	3,072	0.03
Roan	833	132	138	272	33	561	1,106	0.01
Sable	2,872	484	799	1,631	57	1,242	4,503	0.03
Sitatunga	875	159	85	169	19	706	1,045	0.01

Species	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density
Springbok	120	69	52	655	547	69	774	0.001
Steenbuck	1,561	168	217	427	27	1,134	1,988	0.02
Tsessebe	3,650	628	384	760	21	2,891	4,410	0.04
Warthog	5,723	970	403	794	14	4,930	6,517	0.06
Waterbuck	993	186	182	365	37	628	1,358	0.01
Wildebeest	17,017	4,260	3,788	7,778	46	9,240	24,795	0.16
Zebra	60,170	11,182	9,247	18,399	31	41,771	78,569	0.58
Predators								
Hyena	91	17	36	80	88	17	171	0.001
Birds								
Bateleur	1,079	137	117	231	21	848	1,309	0.01
Fish eagle	2,242	392	131	258	12	1,983	2,500	0.02
Ground hornbill	438	77	86	169	39	269	607	0.004
Ostrich	3,429	463	427	841	25	2,588	4,271	0.03
Pelicans	6,423	1,206	2,731	5,794	90	1,206	12,217	0.06
Saddle-billed stork	552	96	62	123	22	429	676	0.01
Vulture	6,474	1,101	954	1,879	29	4,595	8,353	0.06
Wattled crane	1,373	251	211	425	31	948	1,797	0.01
Livestock								
Cow	128,936	18,493	8,292	16,543	13	112,393	145,479	1.24
Goat	51,035	5,451	6,132	12,586	25	38,449	63,621	0.49
Baobabs								
Baobab	4,015	569	416	823	20	3,192	4,837	0.04

Elephants were the most abundant mammal observed on the survey, as discussed below. Other notable mammal estimates include 88,584 lechwe, 60,170 zebra, 77,694 impala, 28,534 buffalo, and 8,343 giraffe.

Group sizes for elephants and wildlife

During the survey we observed a total of 18,822 groups of the animals and other observation types in Table 3 (Table 4). Elephants were the most commonly observed mammal (3,883 herds). Using a sex ratio of 2:3 bulls to cows within breeding herds (Craig & Gibson 2002), we estimated totals of 62,833 bulls vs 63,281 cows on the survey. This gives an overall sex ratio of 1.01:1 females to males. The value is little changed from the estimated sex ratio of 0.99:1 on the 2014 survey of northern Botswana.

Within-strip herd size for the elephant breeding herds averaged 9.9 ± SD of 10.2 animals. For bulls, the mean herd size was 2.2 ± 2.6 animals; 57% of the bulls were solitary, while 20% were observed in pairs.

Table 4. Numbers seen, groups counted, and average group size of animals, baobabs, birds and carcasses seen during the 2018 dry-season aerial survey in northern Botswana.

Species	Number of individuals seen	Number of groups seen	Average group size	Min. group size	Max. group size	Std. dev. of group size
Elephants						
Elephant	22,565	3,883	5.8	1	179	8.2
Breeding herd	18,015	1,818	9.9	1	179	10.2
Bull	4,550	2,065	2.2	1	49	2.6
Elephant carcasses						
Fresh carcass (cat. 1)	40	38	1.1	1	2	0.2
Recent carcass (cat. 2)	88	86	1.0	1	2	0.2
Fresh/recent carcasses	128	124	1.0	1	2	0.2
Old carcass (cat. 3)	744	731	1.0	1	2	0.1
Very old carcass (cat. 4)	805	799	1.0	1	2	0.1
Old/very old carcasses	1,549	1,530	1.0	1	2	0.1
All carcasses	1,677	1,654	1.0	1	2	0.1
Other herbivores						
Buffalo	28,534	472	60.5	1	3,498	221.3
Duiker	34	30	1.1	1	2	0.3
Eland	275	54	5.1	1	48	7.7
Gemsbok	370	116	3.2	1	13	2.9
Giraffe	1,307	518	2.5	1	14	2.1
Hippo	2,307	594	3.9	1	33	4.4
Impala	13,371	1,032	13.0	1	175	13.2
Kudu	1,168	351	3.3	1	13	2.3
Lechwe	15,799	1,618	9.8	1	146	10.5
Reedbuck	452	253	1.8	1	6	1.0
Roan	132	58	2.3	1	9	2.0
Sable	484	101	4.8	1	56	8.3
Sitatunga	159	141	1.1	1	3	0.4
Springbok	69	6	11.5	1	26	9.0
Steenbuck	168	129	1.3	1	17	1.4
Tsessebe	628	142	4.4	1	18	3.2
Warthog	970	347	2.8	1	11	1.7
Waterbuck	186	42	4.4	1	22	3.9
Wildebeest	4,260	183	23.3	1	642	58.0
Zebra	11,182	784	14.3	1	286	26.6
Predators						
Hyena	17	7	2.4	1	6	1.7
Birds						
Bateleur	137	132	1.0	1	2	0.2
Fish eagle	392	341	1.1	1	3	0.4
Ground hornbill	77	24	3.2	1	5	1.1
Ostrich	463	227	2.0	1	35	2.8

Species	Number of individuals seen	Number of groups seen	Average group size	Min. group size	Max. group size	Std. dev. of group size
Pelicans	1,206	12	100.5	6	402	134.7
Saddle-billed stork	96	79	1.2	1	2	0.4
Vulture	1,101	152	7.2	1	78	11.5
Wattled crane	251	107	2.3	1	30	3.5
Livestock						
Cow	18,493	1,273	14.5	1	220	15.7
Goat	5,451	208	26.2	3	201	19.7
Baobabs						
Baobab	569	432	1.3	1	13	1.0

Elephant populations

The total estimated elephant population on the survey was 126,114 with 95% confidence interval of 116,191 to 136,036. Elephants were found in 66 of the 69 strata; exceptions were the low-intensity NG 41 & NG 43 strata and the salt pans of Makgadikgadi NP, which are generally too dry to support elephants in the dry season (Table 5, Figure 4). Density of elephants was greatest in Ngwasha & Sepako and along the Chobe and Kwando Rivers (Table 5, Figure 4). Relatively high densities of elephants were found throughout the Okavango Delta and in Chobe NP. Locations of individual elephant herds are not shown in Figure 4 or elsewhere in this report because of potential poaching issues.

Overall, 20% of estimated elephant populations were in NPs and Moremi GR, 57% were in WMAs and Forest Reserves, and 22% were in pastoral or other unprotected areas (Figure 5). The estimated elephant population in Chobe NP was 15,404 animals (95% confidence interval: 10,789 to 20,020).

Table 5. Population estimates for elephants on the 2018 aerial survey of northern Botswana.

Stratum	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density (animals km^{-2})
Chobe (CH) district								
CH 1 Chobe Enclave	3,747	646	1,091	2,256	0.60	1,491	6,003	2.97
CH 2 Chobe FR (high density)	3,658	615	729	1,546	0.42	2,113	5,204	5.47
CH 2 Chobe FR (low density)	335	29	226	581	1.73	0	915	0.40
CH 4 Kasane FR	607	101	230	492	0.81	114	1,099	1.40
CH 5 N Plains	95	8	67	150	1.58	0	246	0.06
CH 7 & 8	67	5	63	139	2.08	0	206	0.05
CH 11	958	54	725	1,773	1.85	0	2,731	1.07
CH 12	2,486	208	871	1,897	0.76	589	4,383	1.68
Nogatsaa C	2,860	280	1,788	3,983	1.39	0	6,844	2.69
Chinamba (low density)	590	34	391	1,005	1.70	0	1,596	0.44
Chinamba (high density)	760	68	453	1,259	1.66	0	2,018	1.24
Chobe Mababe	2,813	525	540	1,222	0.43	1,591	4,034	4.18
Chobe River	2,556	480	459	953	0.37	1,603	3,509	2.13

Stratum	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density (animals km^{-2})
Kazuma FR (total count)	322	322	0	0	0.00	322	322	1.28
Nogatsaa A and B	1,417	134	461	958	0.68	459	2,375	0.81
Savute East	2,221	261	762	1,802	0.81	419	4,024	2.73
Savute North	3,547	657	535	1,112	0.31	2,435	4,659	1.74
Savute South (high density)	464	86	171	404	0.87	60	868	0.86
Savute South (low density)	356	36	205	486	1.37	0	841	0.41
Sibuyu FR	2,853	539	650	1,338	0.47	1,515	4,190	2.37
Chobe National Park Subtotal	**15,404**	**2,141**	**2,230**	**4,615**	**0.30**	**10,789**	**20,020**	**1.46**
CH District Subtotal	**32,712**	**5,088**	**2,957**	**5,866**	**0.18**	**26,845**	**38,578**	**1.57**
Central (CT) district								
CT 1 & 2 (high density)	124	11	52	123	0.99	2	247	0.05
CT 1 & 2 (low density)	1,275	56	883	2,036	1.60	0	3,311	0.26
CT 3	147	12	67	149	1.01	0	296	0.12
Ngwasha & Sepako	12,728	2,242	2,348	4,809	0.38	7,919	17,537	5.72
Mak. NP East	37	3	35	80	2.15	0	117	0.02
Mak. NP East (salt pans)	0	0	0	0	0.00	0	0	0.00
Mak. NP West	1,426	253	210	426	0.30	1,000	1,852	0.68
CT 4 & 7 (recce count)	55	55	0	0	0.00	55	55	0.02
Boteti River (recce count)	403	403	0	0	0.00	403	403	0.41
Gweta (total count)	162	162	0	0	0.00	162	162	0.37
Hainaveld (recce count)	81	81	0	0	0.00	81	81	0.05
Nata (recce count)	1,065	1,065	0	0	0.00	1,065	1,065	0.45
Rakops (recce count)	184	184	0	0	0.00	184	184	0.39
CT District Subtotal	**17,688**	**4,527**	**2,519**	**6,051**	**0.34**	**11,636**	**23,739**	**0.72**
Ngamiland (NG) district								
Moremi GR NG 28	8,402	1,514	647	1,291	0.15	7,111	9,694	1.71
NG 7 & 8 West Okavango	2,229	194	825	1,654	0.74	575	3,883	0.43
NG 10 & 11	12,010	2,367	1,536	3,067	0.26	8,943	15,077	2.15
NG 12	3,153	588	665	1,375	0.44	1,778	4,528	3.21
NG 13	79	6	56	118	1.49	0	196	0.03
NG 14 Kwando (high density)	5,915	999	1,037	2,112	0.36	3,803	8,026	4.17
NG 14 Kwando (low density)	2,996	271	891	2,290	0.76	706	5,287	2.98
NG 15 Linyanti	1,549	291	349	736	0.48	813	2,285	1.31
NG 16 Selinda	3,911	764	766	1,567	0.40	2,344	5,479	2.81
NG 18 & 19 Khwai	3,895	767	454	946	0.24	2,949	4,842	2.04
NG 20 & 21 Splash	4,165	807	640	1,322	0.32	2,843	5,487	2.28
NG 22 Vumbra	1,754	347	243	529	0.30	1,225	2,283	2.77
NG 23 Duba Plains	560	107	89	190	0.34	370	749	1.17
NG 24 Jedibe	153	29	59	127	0.83	26	280	0.33
NG 25 Jao	615	105	169	382	0.62	232	997	1.02
NG 26 Abu / EBS	4,943	876	866	1,784	0.36	3,159	6,728	2.84
NG 27 A & B & NG 30	2,095	293	387	799	0.38	1,296	2,894	1.54
NG 29	4,001	709	612	1,261	0.32	2,740	5,262	2.16
NG 31 & 17 Chitabe	788	157	180	401	0.51	387	1,189	2.79
NG 32 Stanleys	2,572	451	532	1,101	0.43	1,471	3,673	2.12
NG 33 & 34	2,218	393	519	1,106	0.50	1,112	3,324	2.43
NG 41 Mababe (high density)	2,167	301	510	1,310	0.60	857	3,477	3.67
NG 41 Mababe (low density)	0	0	0	0	0.00	0	0	0.00
NG 42 (high density)	1,043	179	209	446	0.43	597	1,490	1.14
NG 42 (low density)	18	1	17	38	2.06	0	56	0.01
NG 43 (high density)	53	4	51	163	3.05	0	216	0.08
NG 43 (low density)	0	0	0	0	0.00	0	0	0.00

Stratum	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density (animals km^{-2})
NG 47 & 49	1,454	67	803	1,898	1.31	0	3,353	0.39
Nxai Pan NP (high density)	348	62	121	286	0.82	62	634	1.03
Nxai Pan NP (low density)	162	14	81	169	1.04	0	332	0.07
Maun East	878	52	566	1,207	1.37	0	2,086	0.38
Kwebe	25	1	26	71	2.85	0	96	0.03
Maun	862	166	243	496	0.58	366	1,358	0.68
Shorobe	149	15	94	262	1.75	0	411	0.37
Maun Southeast	76	7	39	101	1.33	0	176	0.17
Maun West	474	46	176	380	0.80	93	854	0.29
NG District Subtotal	**75,714**	**12,950**	**3,233**	**6,358**	**0.08**	**69,356**	**82,072**	**1.30**
TOTAL	**126,114**	**22,565**	**5,054**	**9,923**	**0.08**	**116,191**	**136,036**	**1.22**

Figure 4. Estimated density of elephants on the 2018 aerial survey of northern Botswana.

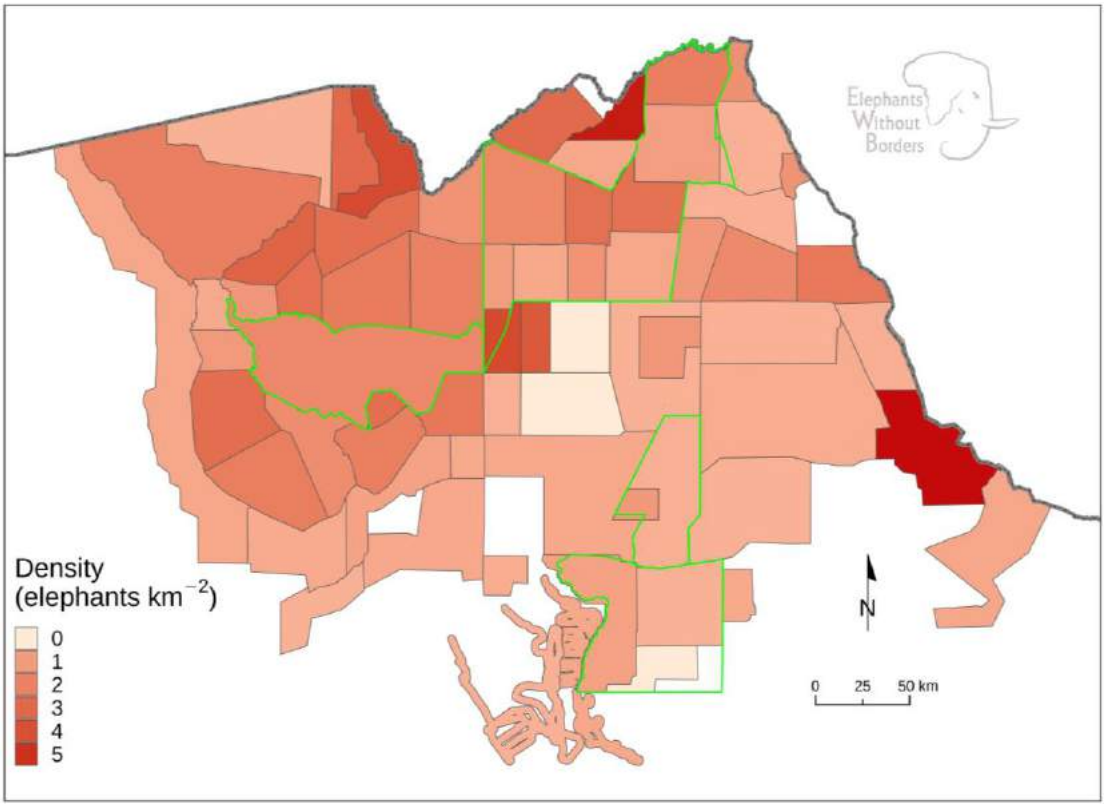
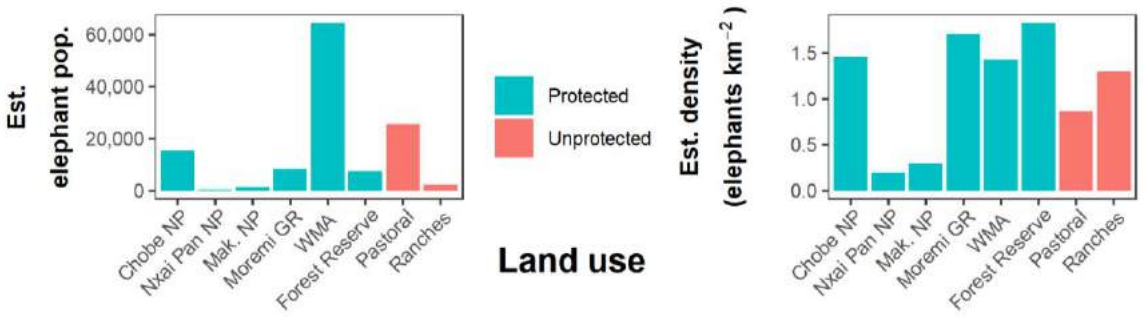


Figure 5. Estimated numbers and densities of elephants by land use and protection.



Carcass ratios

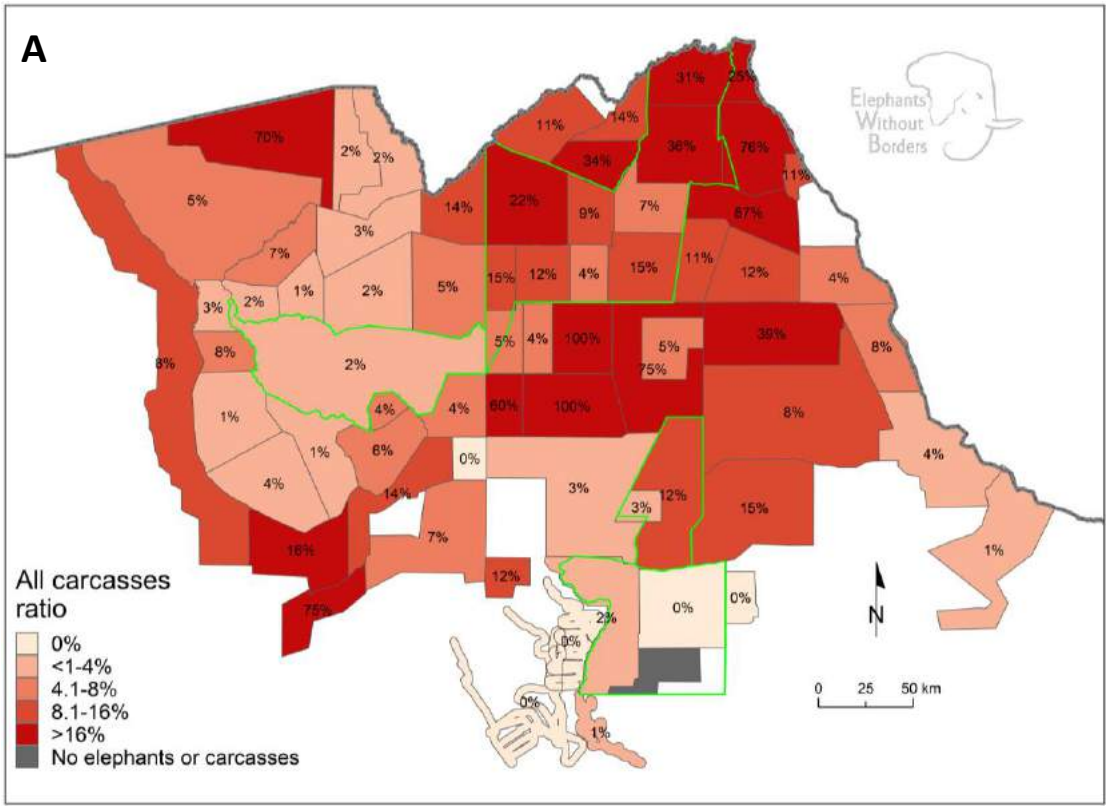
Douglas-Hamilton and Burrill (1991) found that for sample counts, an all-carcass ratio of 2 – 8% should be expected in a stable or increasing elephant population, and ratios >8% indicate a declining population. The estimated all-carcass ratio observed on sample counts in 2018 was 8.1%, suggesting that the population could be declining (Table 6). When examined by stratum, all-carcass ratios were consistently well over 8% in most of Chobe district, in Central district outside of the National Parks and away from the Zimbabwe border, and in Ngamiland in pastoral areas (Figure 6A). Carcass ratios were lowest in the Okavango Delta WMAs and along the Zimbabwe border.

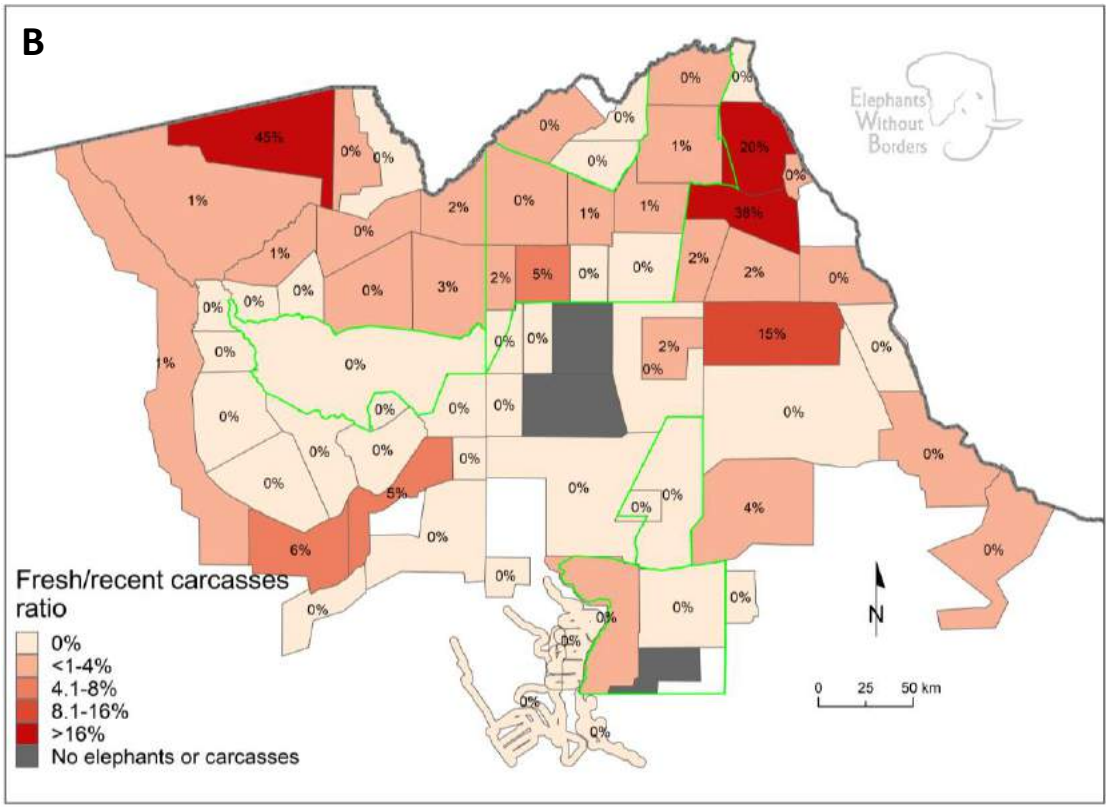
Table 6. Estimated carcass ratios by count type and carcass age on the 2018 aerial survey of northern Botswana.

Count type	All-carcass ratio (%)	SE (%)	Fresh/recent carcass ratio (%)	SE	Total carcasses + elephants
Sample count	8.1	0.4	0.7	0.08	134,817
Total/recce count	2.9	0.0	0.4	0.0	2,340

Fresh and recent carcass ratios were anomalously high in NG 13, CH 5, and CT 1 & 2 (Figure 6B). All of these strata, however, had ≤11 observed live elephants in survey strips, so observations of a few fresh/recent carcasses would lead to a very high carcass ratio. Thus, these high fresh/recent ratio estimates may not indicate serious mortality, though they bear further monitoring. Elsewhere, fresh carcass ratios tended to be highest in the northern part of the study area and low towards the south, with the exception of the strata near Maun that had the highest fresh/recent carcass ratios of any strata with >40 elephants observed (Figure 6B).

Figure 6. Carcass ratios observed for (A) all carcasses and (B) fresh/recent carcasses on the 2018 survey of northern Botswana.





Comparison of observers

As a first method of comparing observers, we compared population estimates calculated separately for each observer (Table 7). Estimates for all elephants, bulls, and breeding herds were not significantly different between observers, with estimates differing by a mean of 5%. The left observer had a higher estimate for category 3 carcasses while the right observer had a higher estimate for category 4 carcasses, suggesting that the two observers may have been classifying older carcasses differently. Combined estimates for carcass 3 and 4, however, did not differ significantly between observers, nor did any other carcass category. Because we did not calculate separate carcass ratios for carcass 3 and carcass 4, differences in classifying old and very old carcasses should not affect conclusions about elephant populations.

Estimates from the two observers were significantly different for a few other species. The left observer had higher estimates for fish eagles and storks. The right observer had higher estimates for giraffe, kudu, steenbok, warthog, goats, vultures and baobabs.

Comparison of the numbers of herds or groups detected showed similar results (Table 8). The right observer saw significantly more groups of giraffe, kudu, steenbuck, warthog, zebra, and vultures. The left observer saw significantly more groups of fish eagles and saddle-billed storks.

Wildlife Distributions

The spatial distributions of wildlife species and other observations are illustrated in Figures 15 to 54, following the text. On each map, the distribution is shown in two ways. First, each stratum is shaded to represent the estimated density of the given species in that stratum. Secondly, locations where herds were sighted, together with an indication of the size of the group/herd, are depicted by points of varying sizes. For elephants, herd locations are not shown on the maps. When viewing the maps, it should be noted that the actual number of groups recorded is a function of both group density and sampling intensity which, by design, varied between strata (Table 13, Figure 2). Thus, sparse observation points do not necessarily indicate a low-density population once sampling intensity is taken into account.

Wildlife was widely distributed throughout the survey area; this can be attributed to both the diverse number of species found in the area and the heterogeneous habitats found in northern Botswana. Highest numbers of animals were recorded in the Okavango Delta and within 30 km of the major perennial rivers. Wildlife densities were lowest in the dry interiors of the survey area including the CT strata, the Chinamba region of Chobe NP, and the easternmost strata in Ngamiland District.

Table 7. Population estimates by observer and their differences for the 2018 aerial survey.

	Left observer		Right observer		Difference				
Species	**Estimate**	**SE**	**Estimate**	**SE**	**Difference**	**% diff.**	**SE**	**Z**	**P**
Elephant	121,593	5,694	128,379	6,904	6,787	5	8,949	0.76	0.45
Breeding herd	102,201	5,525	107,965	6,556	5,764	5	8,574	0.67	0.50
Bull	19,391	874	20,414	1,906	1,023	5	2,097	0.49	0.63
Fresh carcass (cat. 1)	178	62	316	76	138	56	98	1.41	0.16
Recent carcass (cat. 2)	694	109	527	106	-167	-27	152	-1.10	0.27
Fresh/recent carcasses	871	126	843	135	-29	-3	185	-0.16	0.88
Old carcass (cat. 3)	**6,026**	**375**	**3,860**	**293**	**-2,166**	**-44**	**476**	**-4.55**	**< 0.001**
Very old carcass (cat. 4)	**3,949**	**253**	**6,518**	**336**	**2,568**	**49**	**420**	**6.11**	**< 0.001**
Old/very old carcasses	9,975	478	10,378	471	403	4	671	0.60	0.55
All carcasses	10,847	505	11,221	499	374	3	710	0.53	0.60
Buffalo	16,452	0	12,082	0	-4,370				
Duiker	305	83	300	83	-6	-2	118	-0.05	0.96
Eland	1,710	677	2,477	828	768	37	1,069	0.72	0.47
Gemsbok	3,456	988	3,144	873	-312	-9	1,318	-0.24	0.81
Giraffe	**7,154**	**818**	**9,523**	**815**	**2,369**	**28**	**1,155**	**2.05**	**0.04**
Hippo	12,536	1,271	13,931	1,543	1,395	11	1,999	0.70	0.49
Impala	80,413	6,413	74,952	5,474	-5,461	-7	8,431	-0.65	0.52
Kudu	**5,275**	**588**	**9,642**	**935**	**4,367**	**59**	**1,104**	**3.95**	**< 0.001**
Lechwe	92,502	5,777	84,646	5,899	-7,856	-9	8,256	-0.95	0.34
Reedbuck	2,369	293	2,872	338	503	19	448	1.12	0.26
Roan	960	238	706	164	-254	-30	289	-0.88	0.38
Sable	2,883	1,489	2,785	640	-98	-3	1,621	-0.06	0.95
Sitatunga	887	119	863	116	-24	-3	167	-0.15	0.88
Springbok	123	108	58	0	-65	-72	108	-0.60	0.55
Steenbuck	**891**	**264**	**2,234**	**309**	**1,343**	**86**	**406**	**3.31**	**< 0.001**
Tsessebe	3,239	522	4,063	601	824	23	796	1.04	0.30
Warthog	**4,625**	**551**	**6,826**	**561**	**2,201**	**38**	**787**	**2.80**	**0.01**
Waterbuck	1,091	325	893	212	-198	-20	388	-0.51	0.61
Wildebeest	19,742	7,546	11,751	1,897	-7,991	-51	7,781	-1.03	0.30
Zebra	49,553	8,284	68,468	11,798	18,915	32	14,416	1.31	0.19
Hyena	88	44	94	62	7	7	76	0.09	0.93
Bateleur	1,113	165	1,044	157	-69	-6	228	-0.30	0.76
Fish eagle	**2,801**	**204**	**1,680**	**172**	**-1,121**	**-50**	**267**	**-4.21**	**< 0.001**
Ground hornbill	507	141	366	113	-140	-32	181	-0.78	0.44
Ostrich	3,324	545	3,475	689	151	4	879	0.17	0.86
Pelicans	6,383	4,568	6,417	3,528	34	1	5,772	0.01	1.00
Saddle-billed stork	**781**	**106**	**323**	**72**	**-458**	**-83**	**128**	**-3.56**	**< 0.001**
Vulture	**4,247**	**1,178**	**8,619**	**1,621**	**4,372**	**68**	**2,004**	**2.18**	**0.03**
Wattled crane	1,175	220	1,571	385	395	29	443	0.89	0.37
Cow	125,378	9,876	129,986	9,496	4,607	4	13,701	0.34	0.74
Goat	**38,731**	**6,411**	**63,052**	**8,331**	**24,321**	**48**	**10,513**	**2.31**	**0.02**
Baobab	**3,306**	**373**	**4,684**	**605**	**1,378**	**34**	**711**	**1.94**	**0.05**

Table 8. Comparison of numbers of herds/groups seen by the left and right observers, with results separated by pair of observers. Only species with ≥5 expected herds for each observer are shown.

	Observed number of individuals		Observed number of herds		Expected number of herds			
Species	**Left**	**Right**	**Left**	**Right**	**Left**	**Right**	**χ^2**	**P value**
Elephant	10,209	10,084	1,807	1,698	1,757	1,748	2.87	0.09
Breeding herd	8,627	8,603	922	856	891	887	2.13	0.14
Bull	1,582	1,481	885	842	866	861	0.87	0.35
Buffalo	16,452	12,082	248	224	237	235	1.1	0.29
Duiker	17	17	16	14	15	15	0.12	0.73
Eland	89	175	23	29	26	26	0.72	0.40
Gemsbok	181	186	55	60	58	57	0.24	0.62
Giraffe	**533**	**759**	**218**	**295**	**257**	**256**	**11.94**	**< 0.001**
Hippo	1,122	1,185	303	291	298	296	0.19	0.67
Impala	6,951	6,411	518	512	516	514	0.01	0.91
Kudu	**409**	**719**	**134**	**205**	**170**	**169**	**15.23**	**< 0.001**
Lechwe	8,251	7,548	835	783	811	807	1.42	0.23
Reedbuck	201	251	113	140	127	126	3.02	0.08
Roan	78	54	28	30	29	29	0.08	0.78
Sable	179	229	37	55	46	46	3.61	0.06
Sitatunga	80	79	70	71	71	70	0.01	0.91
Steenbuck	**50**	**118**	**29**	**100**	**65**	**64**	**39.43**	**< 0.001**
Tsessebe	281	346	68	73	71	70	0.2	0.65
Warthog	**397**	**572**	**134**	**212**	**173**	**173**	**17.97**	**< 0.001**
Waterbuck	101	85	18	24	21	21	0.89	0.35
Wildebeest	1,015	724	70	75	73	72	0.2	0.66
Zebra	**3,745**	**5,071**	**338**	**396**	**368**	**366**	**4.88**	**0.03**
Bateleur	71	66	67	65	66	66	0.02	0.88
Fish eagle	**248**	**144**	**221**	**120**	**171**	**170**	**29.42**	**< 0.001**
Ground hornbill	46	28	12	11	12	11	0.04	0.84
Ostrich	212	191	112	93	103	102	1.67	0.20
Saddle-billed stork	**69**	**27**	**57**	**22**	**40**	**39**	**15.33**	**< 0.001**
Vulture	**294**	**714**	**54**	**82**	**68**	**68**	**5.9**	**0.02**
Wattled crane	107	144	54	53	54	53	0.01	0.94
Cow	7,596	8,379	588	621	606	603	1.07	0.30
Baobab	**233**	**294**	**174**	**235**	**205**	**204**	**9.4**	**0.002**

Trends in elephant populations in northern Botswana

To determine how elephant populations have changed recently in northern Botswana, we compared population estimates and carcass ratios between the 2014 (Chase et al. 2015) and 2018 surveys of the region. To ensure that the comparisons are valid, we restricted the samples for the 2014 and 2018 datasets to the area in common for both surveys. Because the 2014 strata were generally larger than the 2018 strata, we used the 2014 strata as the baseline for our stratum-level comparisons.

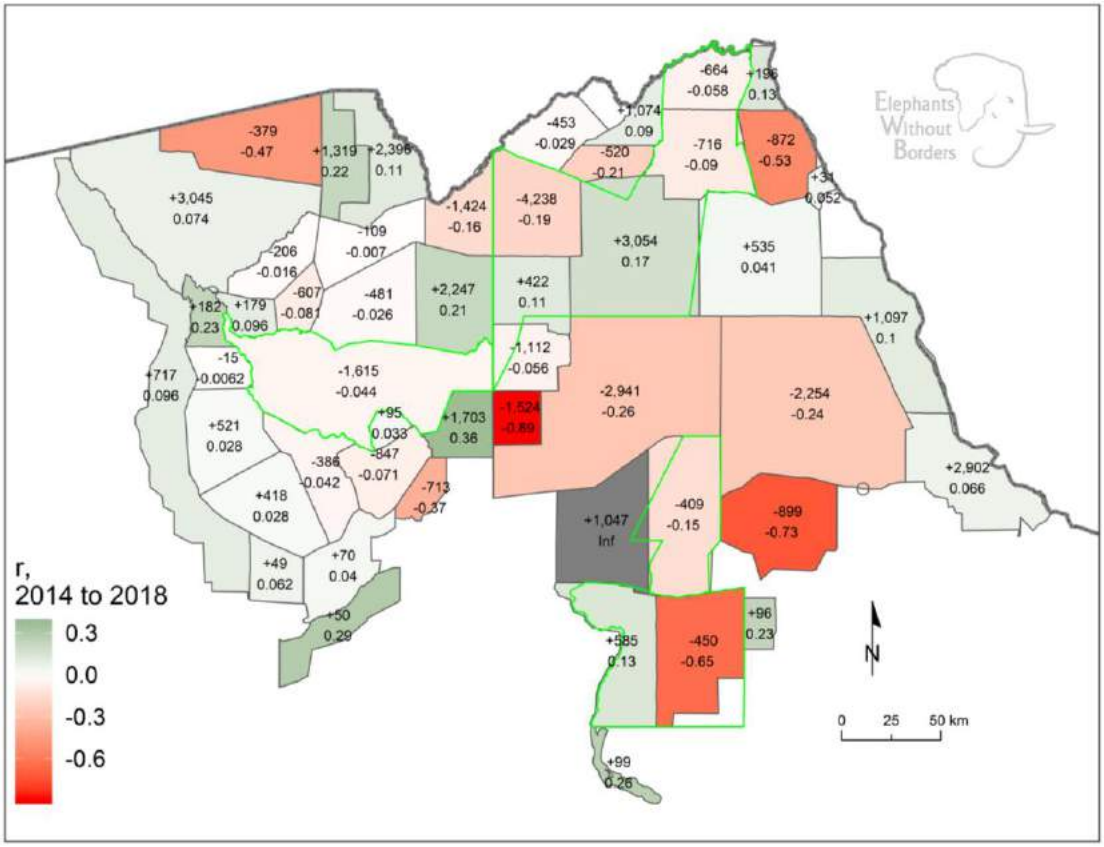
Overall, for identical study areas, estimated elephant populations increased by just 297 elephants (r = 0.0004 ± SE of 0.01) between 2014 and 2018 (Table 9) which was not significant (P = 0.98). Bull populations decreased non-significantly at a rate of r = -0.03 ± 0.02 from 2014 to 2018. Numbers of breeding herds increased non-significantly at r = 0.06 ± 0.02. Estimated numbers of both fresh (+593%) and all carcasses (+21%) increased significantly between surveys (Table 9).

Table 9. Change in elephant populations and elephant carcasses from 2014 to 2018.

	2018 survey		2014 survey		2014 to 2018 change			
Species	**Population estimate**	**SE**	**Population estimate**	**SE**	**Change in estimate**	**SE of change**	**Z**	**P**
Elephant	122,831	4,769	122,634	5,101	197	6,983	0.03	0.98
Breeding herd	103,416	4,555	101,042	4,700	2,374	6,545	0.36	0.72
Bull	19,415	1,058	21,592	1,107	-2,177	1,532	-1.42	0.16
Fresh/recent carcasses	832	85	120	29	712	90	7.94	< 0.001
All carcasses	10,831	329	8,955	355	1,877	484	3.88	< 0.001

Trends in elephant population varied regionally (Figure 7). The largest decreases, in terms of numbers or r values, occurred in Central District and eastern Ngamiland strata. Populations were generally stable or increasing in the Okavango Delta. Notably large increases were observed in CT 3 and Ngwasha/Sepako, along the Zimbabwe border. Though there was little net change in overall elephant populations, we observed substantial reshuffling of local populations. Thus, much of the change in elephant populations was likely due to movements by elephants across stratum boundaries or the borders with Namibia and Zimbabwe. The maximum rate of increase for African elephant populations is estimated to be 5.5 – 7% per year, equivalent to r = 0.05-0.07 (Calef 1988). Several strata showed increases of $r \geq 0.10$, suggesting that immigration, rather than births, bolstered populations.

Figure 7. Change in elephant population estimates, 2014 to 2018. Top number in each stratum is the change in number of elephants. Bottom number is the exponential growth rate *r*.



When considered separately, breeding herds and bulls showed distinct patterns of population change between 2014 and 2018 (Figure 8). Bull herds declined notably along the Namibia border and in Chobe NP. Breeding herd decline was greatest in Central District and south of the Okavango Delta. There was no significant correlation between population changes for bulls and breeding herds by stratum (r_{42} = 0.19, P = 0.21).

For the entire study area, carcass ratios for both fresh/recent carcasses and for all carcasses increased significantly between 2014 and 2018 (Table 10). For all carcasses, ratios increased from 2014 to 2018 in 32 of 49 strata (Figure 9A). Notable increases in ratios occurred in pastoral areas south of the Okavango Delta and in a tier of strata near the Namibia border, from NG 15 through CH 5. For fresh/recent carcasses, ratios increased in 40 of 49 strata (Figure 9B). One stratum had insufficient data for calculating change in carcass ratios.

Table 10. Carcass ratio change from 2014 to 2018 in northern Botswana.

	2014 ratios		2018 ratios		2014 to 2018 change			
Ratio type	**Ratio (%)**	**SE (%)**	**Ratio (%)**	**SE (%)**	**Diff. (%)**	**SE (%)**	**Z**	**P**
Fresh/recent carcasses	0.1	0.02	0.7	0.07	0.6	0.1	7.49	< 0.001
All carcasses	6.8	0.4	8.1	0.4	1.3	0.5	2.51	0.01

Figure 8. Population change for (A) bulls and (B) breeding herds from 2014 to 2018.

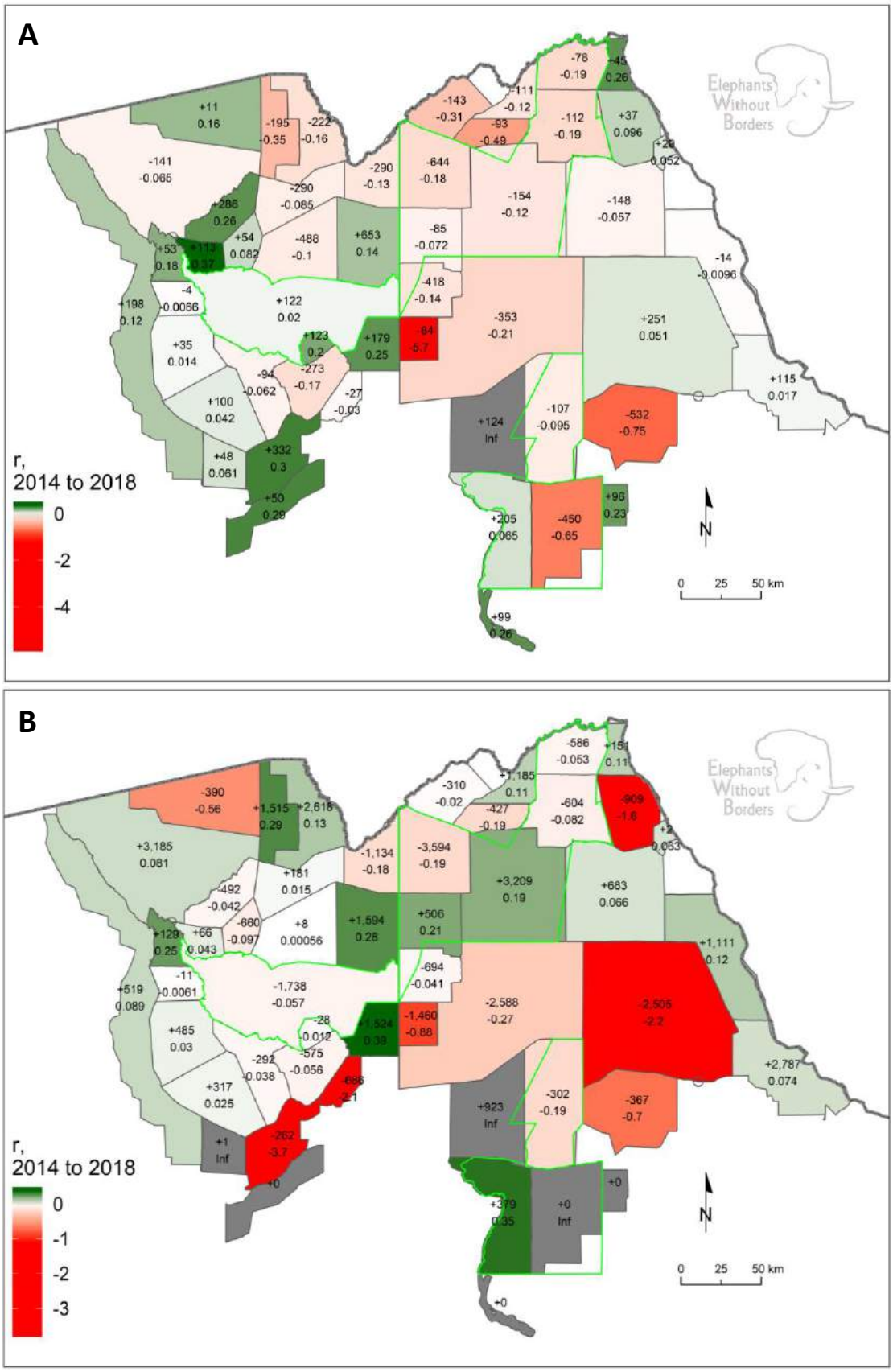
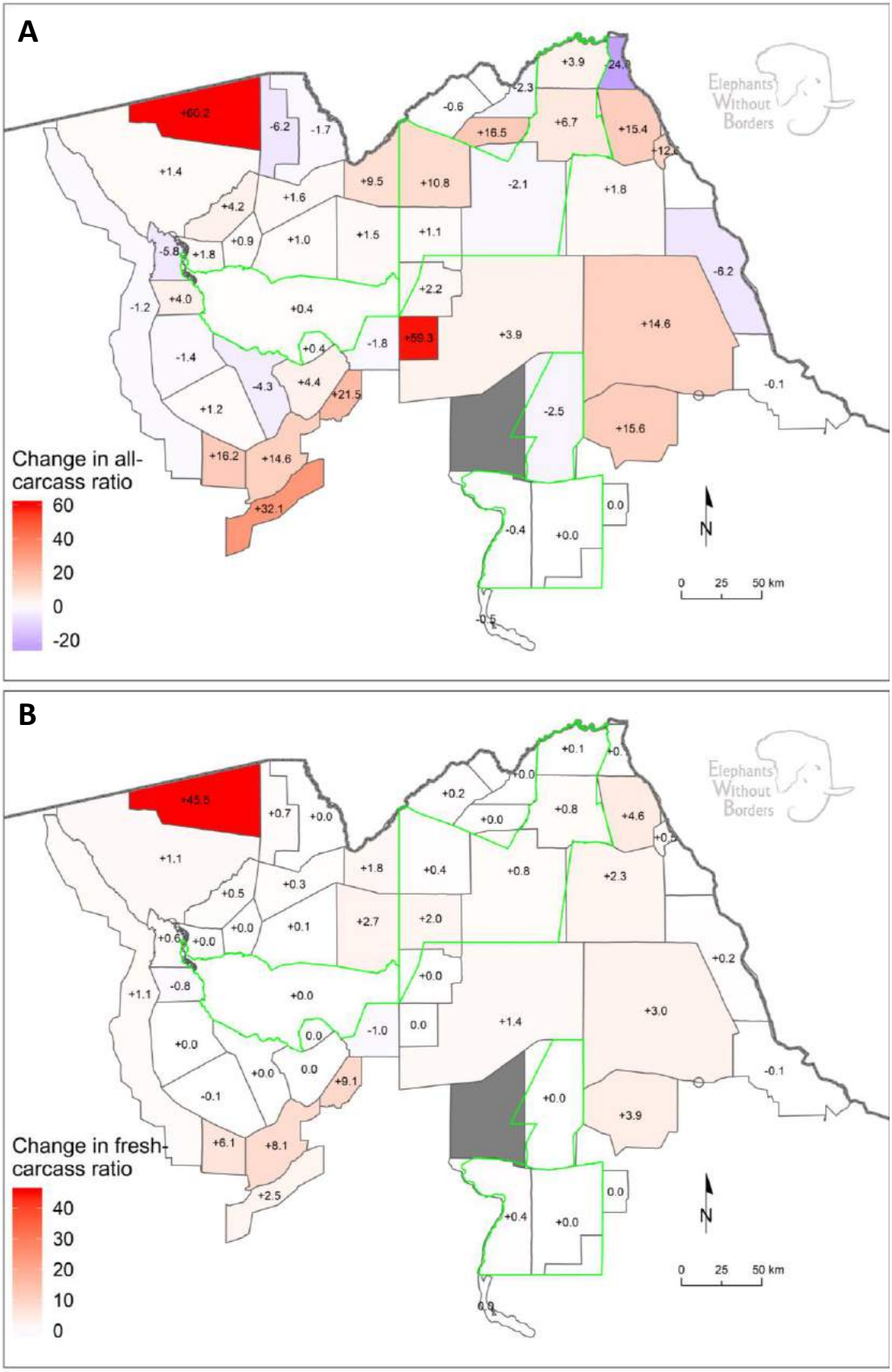


Figure 9. Change (in percentage points) in (A) all-carcass ratios and (B) fresh-carcass ratios (right) between 2014 and 2018.



Trends in Chobe NP. In Chobe NP, estimated elephant populations decreased at an exponential rate of -0.04 ± SE of 0.04 from 2014 to 2018, which was not significantly different from $r = 0$ (Table 11). Bull populations, however, decreased at a rate of -0.14 ± 0.04 from 2014 to 2018, a significant change. The estimated number of fresh/recent carcasses increased significantly, from 16 in 2014 to 104 in 2018. For all carcass categories combined, however, estimated numbers of carcasses did not change significantly.

Table 11. Changes in elephant populations and elephant carcasses from 2014 to 2018 in Chobe National Park.

	2018 survey		2014 survey		2014 to 2018 change			
Species	**Population estimate**	**SE**	**Population estimate**	**SE**	**Change in estimate**	**SE of change**	**Z**	**P**
Elephant	15,404	2,230	17,774	1,593	-2,370	2,741	-0.86	0.39
Breeding herd	13,906	2,207	15,183	1,582	-1,276	2,716	-0.47	0.64
Bull	1,498	185	2,591	292	-1,093	345	-3.16	0.002
Fresh/recent carcasses	104	25	16	8	89	27	3.34	<0.001
All carcasses	3,653	189	3,305	213	337	285	1.19	0.24

Trends in Wildlife Numbers

Comparison of wildlife populations between 2014 and 2018 showed significant changes for several species (Table 12). We observed significant increases in population estimates for hippo, lechwe, reedbuck, sitatunga, fish eagle, and wattled crane. We observed significant decreases in sable, saddle-billed stork, and cattle. For the increasing species, increases were generally greatest in and around the Okavango Delta.

Livestock Distribution

Most of the study area is protected as national parks or wildlife conservation areas, but livestock grazing is permitted under mixed-use systems in some of the WMAs and Forest Reserves. We observed substantial numbers of livestock (estimate >500) in protected strata CH 1, CH 2, and Makgadikgadi NP West (Tables 53, 54). Additionally, elephants and other wildlife co-occurred in areas designated for pastoral and agricultural usage (Figure 1). In fact, densities of elephants were only modestly lower on ranches and pastoral areas than in protected areas (Figure 5). Small numbers of cattle were observed on the peripheries of several WMAs, primarily in Ngamiland (Figure 52).

Baobabs

We observed a total of 569 baobab trees during the survey, of which 34% were classified as large, 52% as medium and 14% as small. Most trees showed relatively little damage, though 3.5% of trees observed were completely dead (Figure 10). The mean proportion of damage to trees in 2018 was 0.16, which is little changed from the 2014 estimate of

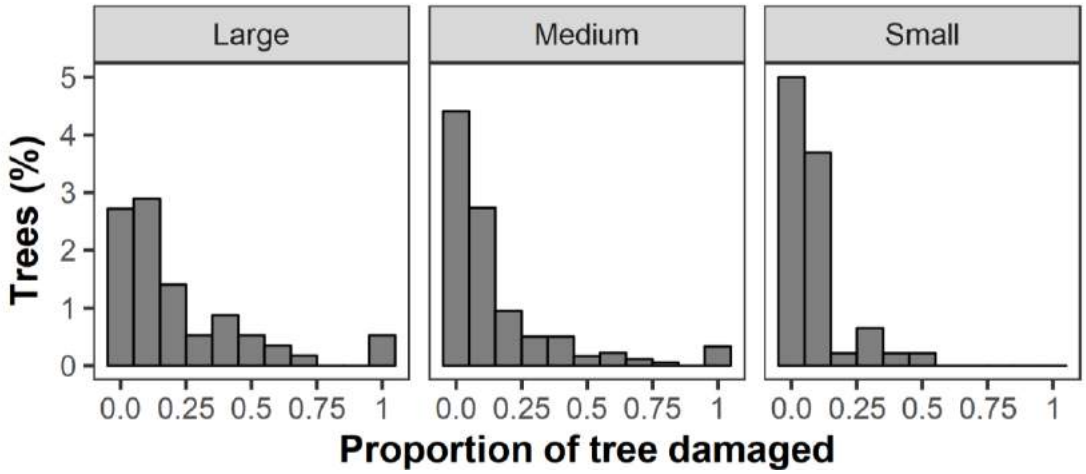
0.17. Damage to baobabs increased with baobab size (small: $\bar{x}$ = 0.08; medium: $\bar{x}$ = 0.15; large: $\bar{x}$ = 0.22).

Table 12. Change in wildlife population estimates from 2014 to 2018 in northern Botswana.

	2018 survey		2014 survey		2014 to 2018 change			
Species	**Population estimate**	**SE**	**Population estimate**	**SE**	**Change in estimate**	**SE of change**	**Z**	**P**
Buffalo	28,534	0	26,467	0	2,067	0		
Eland	2,100	522	3,043	758	-943	920	-1.02	0.31
Gemsbok	3,294	681	3,190	605	105	911	0.11	0.91
Giraffe	8,340	550	9,268	608	-928	819	-1.13	0.26
Hippo	**12,660**	**881**	**8,680**	**608**	**3,981**	**1,071**	**3.72**	**<0.001**
Impala	77,697	3,869	72,337	5,231	5,359	6,506	0.82	0.41
Kudu	7,116	471	6,645	514	471	697	0.68	0.50
Lechwe	**88,585**	**4,835**	**57,691**	**3,220**	**30,894**	**5,809**	**5.32**	**<0.001**
Reedbuck	**2,620**	**227**	**1,498**	**132**	**1,122**	**263**	**4.27**	**<0.001**
Roan	834	129	1,379	277	-545	306	-1.78	0.07
Sable	**2,871**	**792**	**5,164**	**821**	**-2,293**	**1,140**	**-2.01**	**0.04**
Sitatunga	**875**	**84**	**637**	**70**	**238**	**109**	**2.18**	**0.03**
Springbok	120	39	328	177	-208	181	-1.15	0.25
Tsessebe	3,650	382	3,220	333	430	506	0.85	0.40
Warthog	5,723	399	5,087	315	636	508	1.25	0.21
Waterbuck	994	181	602	188	393	262	1.50	0.13
Wildebeest	16,485	3,674	8,945	1,909	7,540	4,140	1.82	0.07
Zebra	59,592	7,756	47,075	5,136	12,517	9,303	1.35	0.18
Fish eagle	**2,242**	**129**	**1,221**	**93**	**1,021**	**159**	**6.41**	**<0.001**
Ground hornbill	411	82	439	97	-28	127	-0.22	0.83
Ostrich	3,043	354	2,587	287	456	456	1.00	0.32
Saddle-billed stork	**552**	**62**	**953**	**92**	**-401**	**111**	**-3.61**	**<0.001**
Wattled crane	**1,372**	**201**	**775**	**137**	**597**	**243**	**2.46**	**0.01**
Cow	**105,805**	**6,605**	**148,191**	**12,062**	**-42,386**	**13,752**	**-3.08**	**0.002**

We tested the hypothesis that elephants are damaging baobabs by examining the relationship between elephant density and baobab damage. This was done via linear regression with a random effect of stratum to account for lack of independence of observations within strata. Baobab damage increased significantly with elephant density (coefficient = 3.1 ± SD of 1.4, t_{35} = 2.2, P = 0.03), though the effect was relatively weak, with only ~5% of the variance in damage explained by elephant density.

Figure 10. Percentage of baobab trees by size and damage level on 2018 aerial survey.

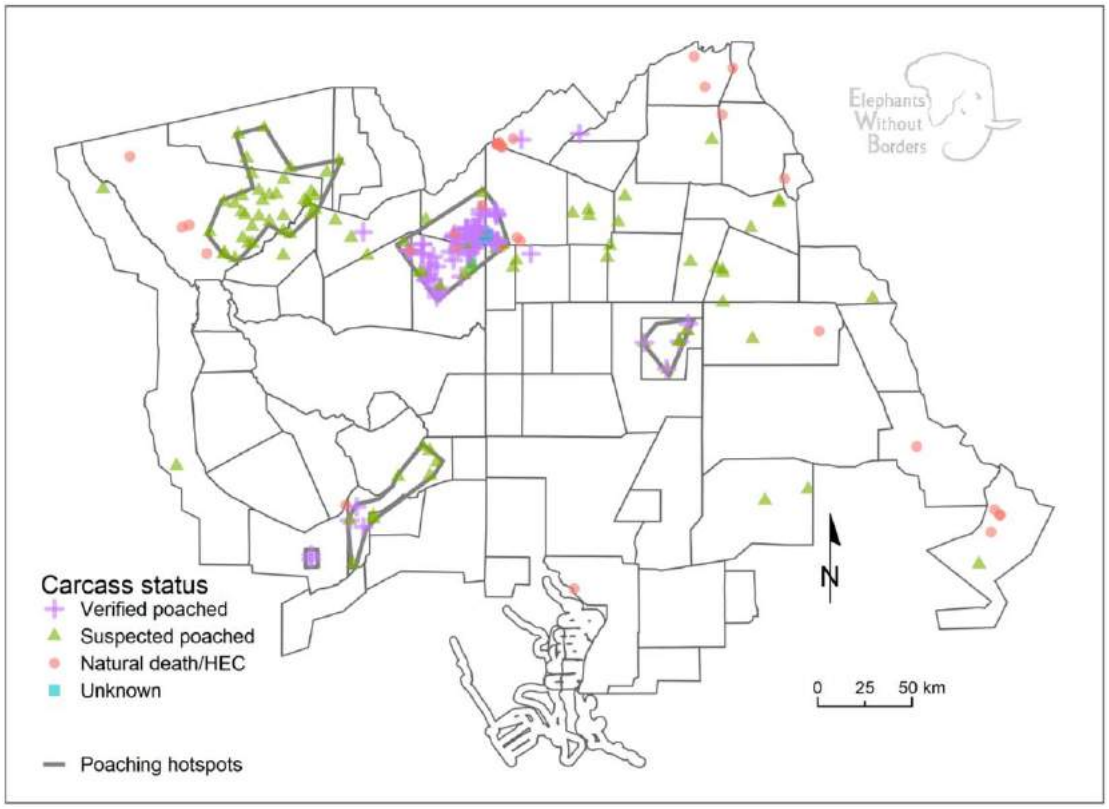


Carcass assessments

During the assessment of category 1 & 2 carcasses conducted concurrently with the aerial survey, we assessed 33 carcasses on the ground. These were primarily located in NG 15, NG 18/19, and Savuti with several others located in NG 42 (high intensity). We found evidence of poaching for all 33 of the carcasses assessed (Appendix 1). An additional 39 carcasses photographed from the air showed evidence of poaching (Appendix 1). Finally, 22 carcasses were suspected (but not confirmed) poached based on photographs taken during the survey. Observers suspected poaching for 10 additional carcasses seen during the survey that were not photographed. Thus, of the 128 fresh/recent carcasses seen on the survey, a total of 72 carcasses were confirmed to be poached and 32 more are suspected poached. Carcasses suspected to originate from HEC or natural mortality were generally found outside of the poaching hotspots (Figure 11, Appendix 1).

The assessment of category-3 carcasses was conducted on 26-28 October 2018 in NG 15, NG 18/19, and the Savuti section of Chobe NP (Appendix 2). We visited 66 carcasses on the ground; an additional 13 carcasses were assessed by air from low elevation because ground conditions did not permit landing. Of these 79 carcasses, 63 (80%) were determined to be poached. All 63 of the poached carcasses were bulls. During the assessment, we determined that 8 of the carcasses should have been classified as category 2 due to the presence of flesh and skin. Many of the poached elephants were near seasonal water pans (Appendix 2).

Figure 11. Carcass verification results and poaching hotspots in northern Botswana.



DISCUSSION

Elephant populations and trends

We estimated a population of 126,114 elephants in northern Botswana in 2018. The overall estimate on the 2014 survey was 129,500, though the area surveyed in 2018 was 5% larger than in 2014 (103,662 km^2 in 2018 vs. 98,425 km^2 in 2014). A more meaningful comparison comes from restricting the two surveys to identical areas. In that case, we observed an increase of 197 ± SE of 6,983 elephants from 2014 to 2018. This change was not statistically significant which suggests that northern Botswana's elephant population is generally stable overall (exponential population growth rate, *r*, = 0.0004 for 2014-2018). The 2010 survey had a population estimate of 128,340 elephants for an area of 73,478 km^2 (Chase 2011), substantially smaller than areas surveyed in 2014 or 2018.

Compared to 2014, nearly all strata in the study area showed substantial change in elephant populations (Figure 7; mean absolute value of *r* = 0.18). These changes are almost certainly too large to have been driven by deaths or births. Rather, elephants have likely moved within the study area. For instance, elephant populations in the dry Ngamiland and Central District strata (CT 1 & 2, CT 4 & 7, NG 41-43) decreased substantially, but elephant numbers in surrounding strata (CT 3, Ngwasha/Sepako, NG 33/34, southern portions of Chobe NP) all increased. To confirm the hypothesis that changes in local elephant populations were driven by movement, we would need far more satellite tracking data than is currently available. Factors driving movements of elephants

could include food availability, water availability, fires, human activity, and density-dependent migration (Chamaillé-Jammes et al. 2008, Loarie et al. 2009a,b).

Elephant populations in Chobe NP decreased non-significantly between 2014 and 2018, but the longer-term trend is downward, with estimates decreasing from 26,609 on the 2010 survey to 17,774 in 2014 to 15,404 in 2018. Factors that may have caused elephant populations to decline in Chobe NP include frequent fires which have damaged woody vegetation, closure/failure of artificial water holes, and density-dependent dispersal caused by reduced food availability or social spacing mechanisms (M. Chase, pers. obs.). Persecution of elephants by poachers along the Chobe and Linyanti Rivers may also be a factor.

We believe that the 2018 survey was the most comprehensive and effective survey of elephants to date in northern Botswana. The % CI for the elephant population estimate was 8% vs 10% in 2014. Compared to the 2014 survey, the 2018 survey was expanded to include new areas south of the primary elephant habitats, including Nata, the Maun strata, and the Hainaveld and Boteti recce counts (Figure 2). Substantial numbers of elephants counted in these areas suggest a population that is still spreading south from historical strongholds in the Okavango Delta and Chobe NP. Satellite tracking data shows that small numbers of elephants now extend as far south as the Central Kalahari Game Reserve (Chase et al., unpublished data).

Elephant carcasses and carcass ratios

For the entire study area, the all-carcass ratio was 8.1% on sample counts and 2.9% on total and recce counts. The recce and total counts represent only 1.8% of the overall elephant population, so the total carcass ratio for all strata combined was 8.0%. For sample counts, ratios >8% are thought to indicate declining populations (Douglas-Hamilton & Burrill 1991). Thus, the observed ratio is consistent with an elephant population that is stable or potentially declining slowly. For identical study areas, the overall carcass ratio increased from 6.8% to 8.1% between 2014 and 2018 (Table 10). When compared by stratum, 32 of 49 strata showed increases in all-carcass ratios in the past four years (Figure 9A).

By stratum, all-carcass ratios in 2018 were consistently lowest in the Okavango Delta and the Kwando River area (Figure 6A). Compared to other regions of northern Botswana, the Okavango Delta remains one of the safest and most stable areas for elephants, with relatively low carcass ratios and less change in elephant populations over time than other regions (Figure 7). All-carcass ratios were highest in the strata south and east of Chobe NP as well as northern sections of Chobe NP.

The fresh/recent carcass ratio for the entire study area was 0.7% for sample counts and 0.4% for total and recce counts (Table 9). As with all-carcass ratios, fresh/recent carcass ratios were lowest (0% in several strata) in the Okavango Delta and generally higher in northern parts of the study area as well as the strata near Maun (Figure 6B).

Though there is no accepted pivotal value for a fresh/recent carcass ratio that indicates declining populations or excessive mortality, the 0.7% fresh/recent ratio observed in 2018 was significantly greater than the estimated 0.1% ratio for fresh/recent carcasses on the

2014 survey. Likewise, the estimated number of fresh/recent carcasses in 2018 (832) was much greater than the estimate in 2014 (120) for identical study areas. Fresh/recent carcass ratios increased in 40 of 49 strata between 2014 and 2018. Only 4 strata had lower fresh/recent carcass ratios in 2018. These results suggest increasing rates of recent elephant mortality in much of our study area (see below).

As discussed above, with elephant populations moving freely in most of our study area, carcass ratios for individual strata may not be good predictors of population change or health. Large influxes of elephants, as may be occurring in the Ngwasha/Sepako area and other strata along the Zimbabwe border, can reduce carcass ratios. Likewise, seasonal migration of elephants can influence carcass ratios by decoupling numbers of live and dead elephants. Thus, for individual strata, high carcass ratios alone may not be a sign of an unhealthy population. Rather, carcass ratios are just one piece of evidence in assessing elephant population status, along with change in elephant numbers, poaching records, and changes in habitats.

Evidence for elephant poaching

We found at least nine lines of evidence that poaching is currently affecting elephant populations in portions of our study area.

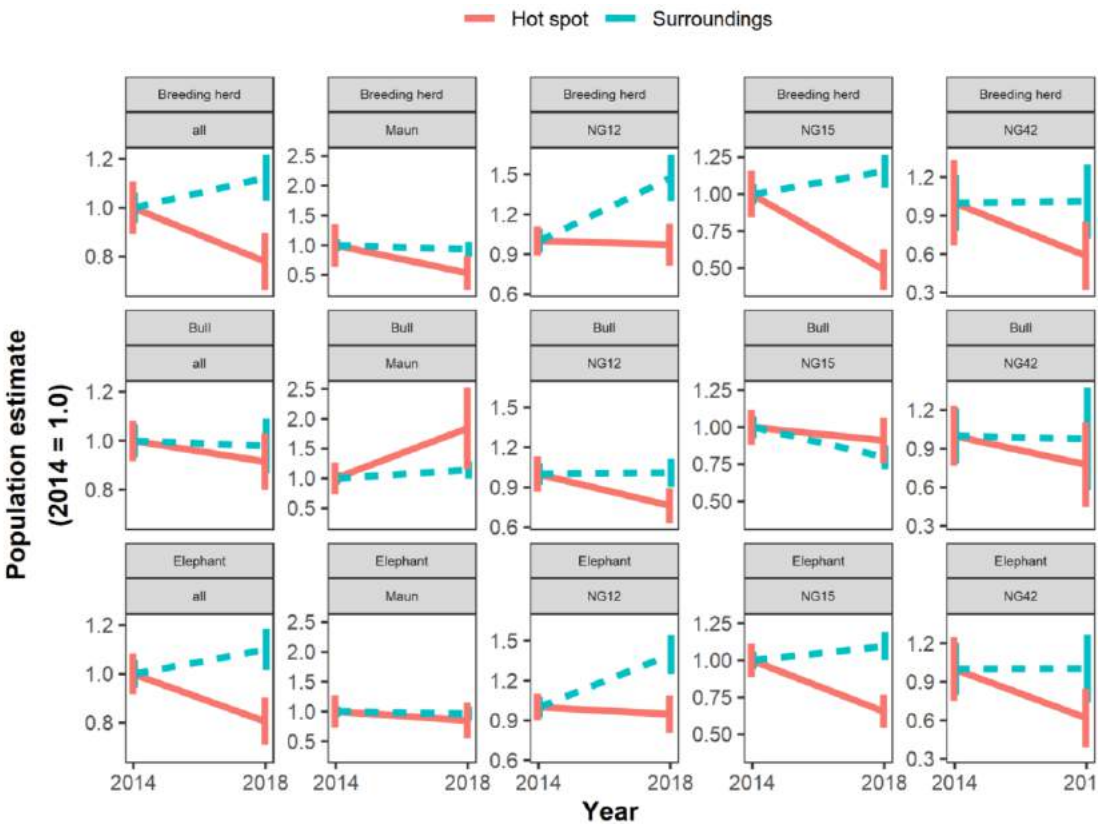
1) *Increased numbers of fresh/recent carcasses*. Between 2014 and 2018, we observed a 593% increase in estimated numbers of fresh and recent carcasses and a 0.6 percentage point increase in fresh carcass ratios, both of which suggest recent increases in mortality rates (Tables 9, 10).
2) *Clustered fresh/recent carcasses*. Beyond the increase in numbers, most of the fresh and recent elephant carcasses observed were clustered in a few hotspots (Figure 11). This is exactly the pattern one would expect if poachers are targeting elephants in relatively small areas where the poachers operate.
3) *Poached fresh/recent carcasses*. During the aerial survey, observers identified 104 fresh/recent carcasses that were suspected to be poached. Ground assessment of 33 of these carcasses verified that all 33 were likely poached based on chopped skulls and other indicators (Appendix 1). We consider an additional 39 fresh/recent carcasses confirmed as poached based on indicators such as damaged skulls photographed during the survey (Appendix 1).
4) *Poached old carcasses on ground assessments in NG 15, NG 18/19 and Savuti*. The second ground assessment revealed that an estimated 80% of "old" carcasses in this poaching hotspot were likely poached, suggesting that the poaching problem has been ongoing for some time (Appendix 2).
5) *Nearly all carcasses suspected of being poached were bulls*. All of the assessed carcasses that were suspected to have been poached and were sexed were bulls. Bulls are generally the first elephants in a region targeted for their ivory because of their large tusks.
6) *Declines in elephant populations in areas experiencing poaching relative to adjacent areas*. For the four poaching hotspots in Figure 11, we calculated elephant population change between 2014 and 2018 in the hotspots themselves and in surrounding areas, defined as a 50-km ring buffer around the hotspots. For 6 of 8 hotspot and herd-type combinations (not including all elephants, which are the sum of bulls and breeding herds), trends in elephant populations were worse

in hotspots than outside them (Figure 12). Overall differences between hotspots and surroundings were significant for all elephants combined (P = 0.02) and for breeding herds (P = 0.02).

7) *Increased elephant poaching in Chobe NP*. Data from CITES' MIKE program collected in Chobe NP showed an uptick in illegally killed elephant carcasses in 2017 versus previous years. In 2017, 21.8% of all carcasses encountered were killed illegally versus a mean of 4.0% of carcasses encountered for 2013-2016 (CITES 2018).
8) *Other elephant poaching reports*. Local media in Botswana have also reported poached elephants that were not observed on the aerial survey (Appendix 1).
9) *Rhinoceros poaching*. From January through November 2018, nine rhinoceros were reported poached in Botswana. These poaching incidents have not been directly linked to elephant poaching, but three rhinos were taken in the Okavango Delta, suggesting that poachers are operating well within Botswana.

Taken together, these lines of evidence suggest that a significant poaching outbreak is ongoing in at least four distinct hotspots: NG 15/18/19 and Savuti, NG 11/12/13, the Maun area, and east-central NG 42 (Figure 11).

Figure 12. Change in elephant populations between 2014 and 2018 in poaching hotspots and surrounding areas in northern Botswana. Error bars indicate ±1 SE. Leftmost column ("all") shows the sum of all four hotspots for bull herds, breeding herds, and all elephants.



Trends in Wildlife Numbers

Between 2014 and 2018, we observed increases in population estimates for most wildlife species (Table 12). Increases were significant for hippo, lechwe, reedbuck, sitatunga, fish eagle, and wattled crane. The only significantly decreasing wildlife species were sable and saddle-billed storks. Cattle numbers decreased significantly as well.

A number of other wildlife species showed non-significant increases, including buffalo (no statistical comparison made because counts were total), impala, wildebeest, and zebra. Ostrich, which are declining in many areas, increased non-significantly. Giraffes, which are experiencing declines elsewhere in Africa, decreased non-significantly.

Many of the species that increased, particularly lechwe, had their largest increases in the Okavango Delta region. Lack of large floods in recent years may have allowed grasslands to expand in area, providing additional habitat for species that utilize grasslands.

Comparison of observers

Both of our aerial observers had extensive experience in counting animals from the air. Counts and population estimates for elephants were similar for both observers, with differences of no more than 5% between observers. Likewise, elephant carcass counts were similar overall for both observers. The two observes did appear to differ in how they classified category 3 and category 4 carcasses, with the left observer counting more category 3 carcasses and the right observer counting more category 4 carcasses. For carcasses 3 and 4 combined, however, the observers' counts did not differ. Because we did not analyze carcass ratios for category 3 and 4 carcasses separately, this difference in classification should not affect any conclusions about elephant population status.

Elephants, because they are large and relatively easy to count, tend to have similar detectabilities regardless of observer experience (Schlossberg et al. 2016). Smaller species, on the other hand, are more likely to be missed (Schlossberg et al. 2018a), and differences between observers may be more likely as a result. Consequently, for several wildlife species, we noted difference between the observers in counts and population estimates.

One important caveat when considering results of aerial surveys is that all counts are underestimates because some herds go undetected (Caughley 1974, Schlossberg et al. 2016, 2018a). Differences between observers do not make a survey's results invalid. Rather, such differences indicate that one observer likely had a higher detection probability than the other for the given species. Both observers' detection probabilities, however, are surely <1 for all species. Likewise, lack of difference between observers in herds counted does not imply that all herds were counted. Rather, this indicates that both observers likely had similar detection probabilities for a given species.

Baobab trees

The proportion of baobabs completely dead in 2018 was 3.5%, a small decrease from the 5.8% mortality recorded in 2014. We found a small but significant tendency for baobab damage to be greater in strata with higher elephant densities. Baobab damage tended to

increase with baobab size, a worrisome trend given recent reports of mortality of large baobabs (Patrut et al. 2018).

CONCLUSION

As of 2018, Botswana continues to have the largest elephant population of any country, with roughly 30% of all remaining savannah elephants. Since 2010, however, aerial surveys by EWB indicate that the population overall has apparently plateaued and may be slowly decreasing. Locally, such as along the Zimbabwe border, populations may be increasing, but the population as a whole is not.

At the same time, elephants are facing a growing poaching problem in northern Botswana. Just north of Botswana, poachers have decimated elephant herds in southeast Angola and southwest Zambia's Sioma Ngwezi NP (Schlossberg et al. 2018b, Chase et al. 2016). Poaching in Botswana does not appear to have reached similar levels of severity at this time, but evidence suggests that this problem has now reached Botswana.

REFERENCES

Calef, G.W. (1988) Maximum rate of increase in the African elephant. African Journal of Ecology 26:323-328.

Caughley, G. (1974) Bias in aerial survey. Journal of Wildlife Management 38:921–933.

Caughley, G., R. Sinclair, and D. Scott-Kemmis. (1976) Experiments in aerial survey. Journal of Wildlife Management 40:290-300.

Chamaillé-Jammes S., H. Fritz, M. Valeix., F. Murindagomo, and J. Clobert. (2008) Resource variability, aggregation and direct density dependence: the local regulation of an African elephant population. Journal of Animal Ecology 77:135-144.

Chase, M.J. (2007) Home ranges, transboundary movements and harvest of elephants in northern Botswana and factors affecting elephant distribution and abundance in the Lower Kwando River Basin. PhD Dissertation. University of Massachusetts.

Chase, M.J. (2011) Dry season fixed-wing aerial survey of elephants and wildlife in northern Botswana. Elephants Without Borders, Kasane, Botswana.

Chase, M.J. (2010) Ecology of elephants in the Okavango Delta. Elephants Without Borders, Kasane, Botswana.

Chase, M.J. and C. Griffin. (2008) Seasonal abundance and distribution of Elephants in Sioma Ngwezi National Park, southwest Zambia. Pachyderm 45:88-97.

Chase, M.J. and C. Griffin. (2009) Elephants caught in the middle: Impacts of war, fences, and people on elephant distribution and abundance in the Caprivi Strip, Namibia. African Journal of Ecology 47:223-233.

Chase, M.J., S. Schlossberg, C.R. Griffin, P.J.C. Bouché, S.W. Djene, P.W. Elkan, S. Ferreira, F. Grossman, E.M. Kohi, K. Landen, P. Omondi, A. Peltier, S.A.J. Selier, and R. Sutcliffe. (2016) Continent-wide survey reveals massive decline in African savannah elephants. PeerJ 4:e2354.

Chase, M.J., Schlossberg, S., Landen, K., Sutcliffe, R., Seonyatseng, E., Keitsile, A., and Flyman, M. (2015) Dry season aerial survey of elephants and wildlife in northern Botswana, July - October 2014. Elephants Without Borders, Kasane, Botswana.

Craig, G.C. (2012) Aerial survey standards for the MIKE programme. Version 2.0. CITES MIKE Programme, Nairobi, Kenya. Available at https:// cites.org/common/prog/ mike/ survey/MIKE_aerial_standards.v2.pdf

Craig, C. and D.St.C. Gibson. (2002) Aerial survey of wildlife in the Niassa Reserve and hunting concessions, Moçambique, October/November 2002.

Douglas-Hamilton, I., and A. Burrill. 1991. Using elephant carcass ratios to determine population trends. Pages 98–105 African Wildlife: Research and Management. International Council of Scientific Unions, Paris, France.

Dunham, K.M., E. van der Westhuizen, H.F. van der Westhuizen and E. Gandiwa. (2009) Aerial Survey of Elephants and other Large Herbivores in Gonarezhou National Park (Zimbabwe), Zinave National Park (Mozambique) and surrounds. Frankfurt Zoological Society.

DNR Garmin Extension. (2002) Minnesota Department of Natural Resources, GIS Section. Available from: http://www.dnr.state.mn.us/mis/gis/tools/arcview/ extensions/DNRGarmin/DNRGarmin.html.

ESRI. (2012) ArcMap 10.1. Environmental Systems Research Institute. Redlands, California.

Ferguson, K. and J. Hanks., Eds. (2010) Fencing Impacts: A review of the environmental, social and economic impacts of game and veterinary fencing in Africa with particular reference to the Great Limpopo and Kavango-Zambezi Transfrontier Conservation Areas. Pretoria: Mammal Research Institute.

Garmin Corporation. (2007) MapSource: User's manual and reference guide. GARMIN International, Olathe, Kansas, USA.

Gasaway W.C., S.D. duBois, D.J. Reed and S.J. Harbo. (1986) Estimating moose population parameters from aerial surveys. Biological Papers of the University of Alaska No. 22. 108pp.

Jolly, G.M. (1969) Sampling methods for aerial census of wildlife populations. East African Agriculture and Forestry Journal 34:46-49.

Loarie, S.R., R.J. Van Aarde, and S.L. Pimm. (2009a) Fences and artificial water affect african savannah elephant movement patterns. Biological Conservation 142:3086–3098.

Loarie, S.R., R.J. van Aarde, and S.L. Pimm. (2009b) Elephant seasonal vegetation preferences across dry and wet savannas. Biological Conservation 142:3099–3107.

McCarthy, T. S. and W.N. Ellery. (1998) The Okavango Delta. Transactions of the Royal Society of South Africa 53:157-182.

MIKE Programme (2015). MIKE site monitoring guidelines and procedures. Version 15.3. CITES MIKE Programme, Nairobi, Kenya.

Norton-Griffiths, M. (1978) Counting animals. African Wildlife Leadership Foundation. Nairobi, Kenya. pp. 139.

Patrut, A., S. Woodborne, R. T. Patrut, L. Rakosy, D. A. Lowy, G. Hall, and K. F. von Reden. 2018. The demise of the largest and oldest african baobabs. Nature Plants 4:423-426.

R Core Team. (2018). R: A language and environment for statistical computing. R Foundation for Statistical Computing. Vienna, Austria. URL http://www.R-project.org/.

Schlossberg, S., M.J. Chase, and C.R. Griffin. (2016) Testing the accuracy of aerial surveys for large mammals: an experiment with African savanna elephants (*Loxodonta africana*). PLoS ONE 11:e0164904.

Schlossberg, S., M.J. Chase, and C.R. Griffin. (2018a) Using species traits to predict detectability of animals on aerial surveys. Ecological Applications 28, 106-118.

Schlossberg, S., M. J. Chase, and C. R. Griffin. (2018b) Poaching and human encroachment reverse recovery of African savannah elephants in south-east Angola despite 14 years of peace. PLOS ONE 13:e0193469.

Sianga, K., and R. Fynn. (2017) The vegetation and wildlife habitats of the Savuti-Mababe-Linyanti ecosystem, northern Botswana. Koedoe 59, 1–16.

Thomas, D. and P.A. Shaw. (1991) The Kalahari Environment. Cambridge University Press, Cambridge, UK.

Timberlake, J.R. and S.L. Childes. (2004) Biodiversity of the Four Corners Area. Technical Reviews Volume Two (Chapters 5-15). Occasional Publications in Biodiversity No. 15. Biodiversity Foundation for Africa/ Zambezi Society, Harare, Zimbabwe.

Table 13. Stratum number, name, area and survey coverage during the 2018 dry-season aerial survey in northern Botswana. Subtotals and totals for sample coverage are for strata surveyed by sample counts or total counts (recce counts not included because of uncertain area sampled).

Stratum	Stratum area (km^2)	Total transect length	Number of transects	Area sampled (km^2)	Sample coverage	Transect spacing (km)
Chobe (CH) district						
CH 1 Chobe Enclave	1,262	601	24	218	0.17	2
CH 2 Chobe FR (high density)	668	308	17	112	0.17	2
CH 2 Chobe FR (low density)	835	197	6	72	0.09	4
CH 4 Kasane FR	432	196	15	72	0.17	2
CH 5 N Plains	1,602	370	11	134	0.08	4
CH 7 & 8	1,327	269	12	99	0.07	4
CH 11	899	138	7	51	0.06	6
CH 12	1,481	340	13	124	0.08	4
Nogatsaa C	1,062	284	11	104	0.10	4
Chinamba (low density)	1,336	214	6	77	0.06	6
Chinamba (high density)	612	151	5	55	0.09	4
Chobe Mababe	673	343	10	126	0.19	2
Chobe River	1,201	616	23	225	0.19	2
Kazuma FR (total count)	251	211	23	77	0.31	1
Nogatsaa A and B	1,746	454	22	165	0.09	4
Savute East	814	263	8	96	0.12	3
Savute North	2,039	1,034	22	378	0.19	2
Savute South (high density)	542	274	8	101	0.19	2
Savute South (low density)	872	242	8	88	0.10	4
Sibuyu FR	1,206	622	26	228	0.19	2
CH District Subtotal	**20,860**	**7,128**	**277**	**2,601**	**0.12**	
Central (CT) district						
CT 1 & 2 (high density)	2,409	577	8	213	0.09	4
CT 1 & 2 (low density)	4,993	595	9	219	0.04	8
CT 3	1,215	269	11	99	0.08	4
Ngwasha & Sepako	2,226	1,063	29	392	0.18	2
Mak. NP East	1,959	431	10	158	0.08	4
Mak. NP East (salt pans)	718	162	6	60	0.08	4
Mak. NP West	2,088	1,013	36	370	0.18	2
CT 4 & 7 (recce count)	2,914	482		2,914	1.00	
Boteti River (recce count)	980	337		980	1.00	
Gweta (total count)	442	275	17	102	0.23	
Hainaveld (recce count)	1,736	531		1,736	1.00	
Nata (recce count)	2,383	600		2,383	1.00	
Rakops (recce count)	473	178		473	1.00	
CT District Subtotal	**24,535**	**6,515**	**126**	**10,099**	**0.10**	
Ngamiland (NG) district						
Moremi GR NG 28	4,908	2,460	68	884	0.18	2
NG 7 & 8 West Okavango	5,202	1,236	54	453	0.09	4
NG 10 & 11	5,593	3,000	68	1,102	0.20	2

Stratum	Stratum area (km^2)	Total transect length	Number of transects	Area sampled (km^2)	Sample coverage	Transect spacing (km)
NG 12	982	514	24	183	0.19	2
NG 13	2,879	592	18	219	0.08	5
NG 14 Kwando (high density)	1,420	654	33	240	0.17	2
NG 14 Kwando (low density)	1,004	248	6	91	0.09	4
NG 15 Linyanti	1,179	607	18	222	0.19	2
NG 16 Selinda	1,394	753	30	272	0.20	2
NG 18 & 19 Khwai	1,912	1,029	21	377	0.20	2
NG 20 & 21 Splash	1,828	972	25	354	0.19	2
NG 22 Vumbra	633	341	13	125	0.20	2
NG 23 Duba Plains	478	253	16	91	0.19	2
NG 24 Jedibe	466	242	14	88	0.19	2
NG 25 Jao	601	281	10	103	0.17	2
NG 26 Abu / EBS	1,739	853	26	308	0.18	2
NG 27 A & B & NG 30	1,362	527	25	191	0.14	2
NG 29	1,855	912	26	329	0.18	2
NG 31 & 17 Chitabe	282	154	11	56	0.20	2
NG 32 Stanleys	1,215	595	24	213	0.18	2
NG 33 & 34	914	442	16	162	0.18	2
NG 41 Mababe (high density)	591	224	6	82	0.14	3
NG 41 Mababe (low density)	1,190	227	6	83	0.07	6
NG 42 (high density)	915	430	16	157	0.17	2
NG 42 (low density)	2,100	314	11	115	0.05	6
NG 43 (high density)	643	132	4	48	0.07	4
NG 43 (low density)	1,717	297	9	109	0.06	6
NG 47 & 49	3,773	478	8	174	0.05	8
Nxai Pan NP (high density)	338	165	8	60	0.18	2
Nxai Pan NP (low density)	2,187	516	21	188	0.09	4
Maun East	2,315	375	16	137	0.06	6
Kwebe	897	99	5	36	0.04	9
Maun	1,269	673	30	244	0.19	2
Shorobe	408	113	5	41	0.10	4
Maun Southeast	442	112	6	41	0.09	4
Maun West	1,634	436	14	159	0.10	4
NG District Subtotal	**58,268**	**21,255**	**711**	**7,738**	**0.13**	
TOTAL	**103,662**	**34,898**	**1,114**	**20,438**	**0.13**	

Table 14. Sampling statistics for the 2014 dry season aerial survey of wildlife in northern Botswana. Data for CT 1 & 2 were lost due to equipment failure.

Stratum	Time & date sampled	Transect time (hrs)	Stratum time (hrs)	Area sampled (km^2)	Sampling effort (km^2 min^{-1})
Chobe (CH) District					
CH 1 Chobe Enclave	am 16 Sep.	2.9	3.6	218	1.27
CH 2 Chobe FR (high density)	am 22 Sep.	1.6	1.8	112	1.20
CH 2 Chobe FR (low density)	am 22 Sep.	0.9	1.0	72	1.33
CH 4 Kasane FR	am 26 Sep.	1.0	1.2	72	1.25
CH 5 N Plains	am 26 Sep.	1.7	2.2	134	1.28
CH 7 & 8	am 24 Sep.	1.1	1.4	99	1.47
CH 11	am 27 Sep.	0.6	0.7	51	1.46
CH 12	am 27 Sep.	1.6	2.0	124	1.29
Nogatsaa C	am 24 Sep.	1.3	1.6	104	1.32
Chinamba (low density)	am 1 Sep.	1.0	1.2	77	1.24
Chinamba (high density)	am 1 Sep.	0.7	0.7	55	1.32
Chobe Mababe	am 29 & 31 Sep.	1.6	1.7	126	1.30
Chobe River	am 23 Sep.	2.9	3.4	225	1.28
Kazuma FR (total count)	am 27 Sep.	1.0	1.4	77	1.33
Nogatsaa A and B	am 17 Sep.	2.0	2.7	165	1.36
Savute East	am 15 & 24 Sep.	1.2	1.4	96	1.34
Savute North	am 14-15 Sep.	4.7	4.8	378	1.33
Savute South (high density)	am 30-31 Aug.	1.3	1.1	101	1.25
Savute South (low density)	am 30 Aug.	1.1	1.1	77	1.17
Sibuyu FR	am 28 Sep.	2.3	2.6	228	1.63
CH District Subtotal		**32.6**	**37.7**	**2,589**	**1.33**
Central (CT) District					
CT 1 & 2 (high density)	am 1 Oct.				
CT 1 & 2 (low density)	am 1 Oct.				
CT 3	am 28 Sep. & 1 Oct.	1.2	1.2	99	1.41
Ngwasha & Sepako	am 29 Sep. – 1 Oct.	5.1	5.2	392	1.28
Mak. NP East	am 9 Sep.	2.1	2.2	158	1.25
Mak. NP East (salt pans)	am 9-10 Sep.	0.8	0.9	60	1.27
Mak. NP West	am & pm 8 Sep., am 9 Sep.	4.7	5.7	370	1.31
CT 4 & 7 (recce count)	am 2 Oct.				
Boteti River (recce count)	am 10 Sep.				
Gweta (total count)	am 2 Oct.	1.7	1.8	102	1.00
Hainaveld (recce count)	am 12 Sep.				
Nata (recce count)	pm 1 Oct., am 3 Oct.				
Rakops (recce count)	am 9 Sep.				
CT District Subtotal		**15.6**	**17.0**	**1,181**	**1.26**
Ngamidland (NG) District					
Moremi GR NG 28	am 22-23 Jul., 15-18 Aug.	12.4	13.9	884	1.19
NG 7 & 8 West Okavango	am 3 Jul., am & pm 17 Jul., am 19 Jul.	5.9	7.3	453	1.28
NG 10 & 11	pm 6 Jul., 7-10 Jul.	13.8	14.4	1,102	1.33
NG 12	am 5 Jul.	2.5	3.3	183	1.25
NG 13	am 4 Jul.	2.8	3.4	219	1.32

Stratum	Time & date sampled	Transect time (hrs)	Stratum time (hrs)	Area sampled (km^2)	Sampling effort ($km^2\ min^{-1}$)
NG 14 Kwando (high density)	am 24-25 Jul.	3.3	4.0	240	1.22
NG 14 Kwando (low density)	am 24-25 Jul.	1.1	0.9	91	1.35
NG 15 Linyanti	am 2-3 Aug.	3.0	3.3	222	1.24
NG 16 Selinda	am 1-2 Aug.	3.5	4.4	272	1.31
NG 18 & 19 Khwai	am 26 & 28 Aug.	5.1	5.3	377	1.24
NG 20 & 21 Splash	am 4-5 & 26 Aug.	4.9	4.9	354	1.22
NG 22 Vumbra	am 22 Jul.	1.8	2.1	125	1.18
NG 23 Duba Plains	am & pm 22 Jul.	1.3	1.8	91	1.18
NG 24 Jedibe	am 18 Jul.	1.3	1.5	88	1.13
NG 25 Jao	am & pm 18 Jul.	1.5	1.6	103	1.12
NG 26 Abu / EBS	am & pm 21 Jul., am 23 Jul.	4.6	9.4	308	1.11
NG 27 A & B & NG 30	am 21 Aug.	2.6	3.3	191	1.22
NG 29	am & pm 23 Aug., am 23 Aug.	4.6	5.1	329	1.20
NG 31 & 17 Chitabe	am & pm 25 Aug.	0.8	0.9	56	1.23
NG 32 Stanleys	am 20 Aug.	2.9	3.6	213	1.21
NG 33 & 34	am 25 Aug.	2.3	2.6	162	1.17
NG 41 Mababe (high density)	am 29 Aug. & 1 Sep.	1.1	0.9	82	1.30
NG 41 Mababe (low density)	am 29 Aug.	0.9	1.0	83	1.46
NG 42 (high density)	am 1-3 Sep.	2.3	2.2	157	1.14
NG 42 (low density)	am 1-2 Sep.	1.5	3.2	115	1.26
NG 43 (high density)	am 31 Aug.	0.7	0.6	48	1.23
NG 43 (low density)	am 31 Aug. & 1 Sep.	1.1	1.0	109	1.62
NG 47 & 49	am 16 Jul.	2.5	2.8	174	1.18
Nxai Pan NP (high density)	am 11 Sep.	0.9	1.3	60	1.17
Nxai Pan NP (low density)	am 16 Jul. & 2 Sep., am & pm 11 Sep.	2.2	4.0	188	1.40
Maun East	am 14 Jul.	1.6	2.1	137	1.41
Kwebe	am 14 Jul.	0.3	0.4	26	1.30
Maun	am 12-13 Jul.	3.2	3.5	244	1.28
Shorobe	am 12 Jul.	0.5	0.5	41	1.33
Maun Southeast	am 8 Sep.	0.5	0.6	41	1.35
Maun West	am 13 Jul.	2.0	2.3	159	1.31
NG District Subtotal		**103.0**	**123.3**	**7,728**	**1.25**
TOTAL		**151.1**	**178.0**	**11,498**	**1.27**

Figure 13. District boundaries, rivers, and veterinary fences in northern Botswana.

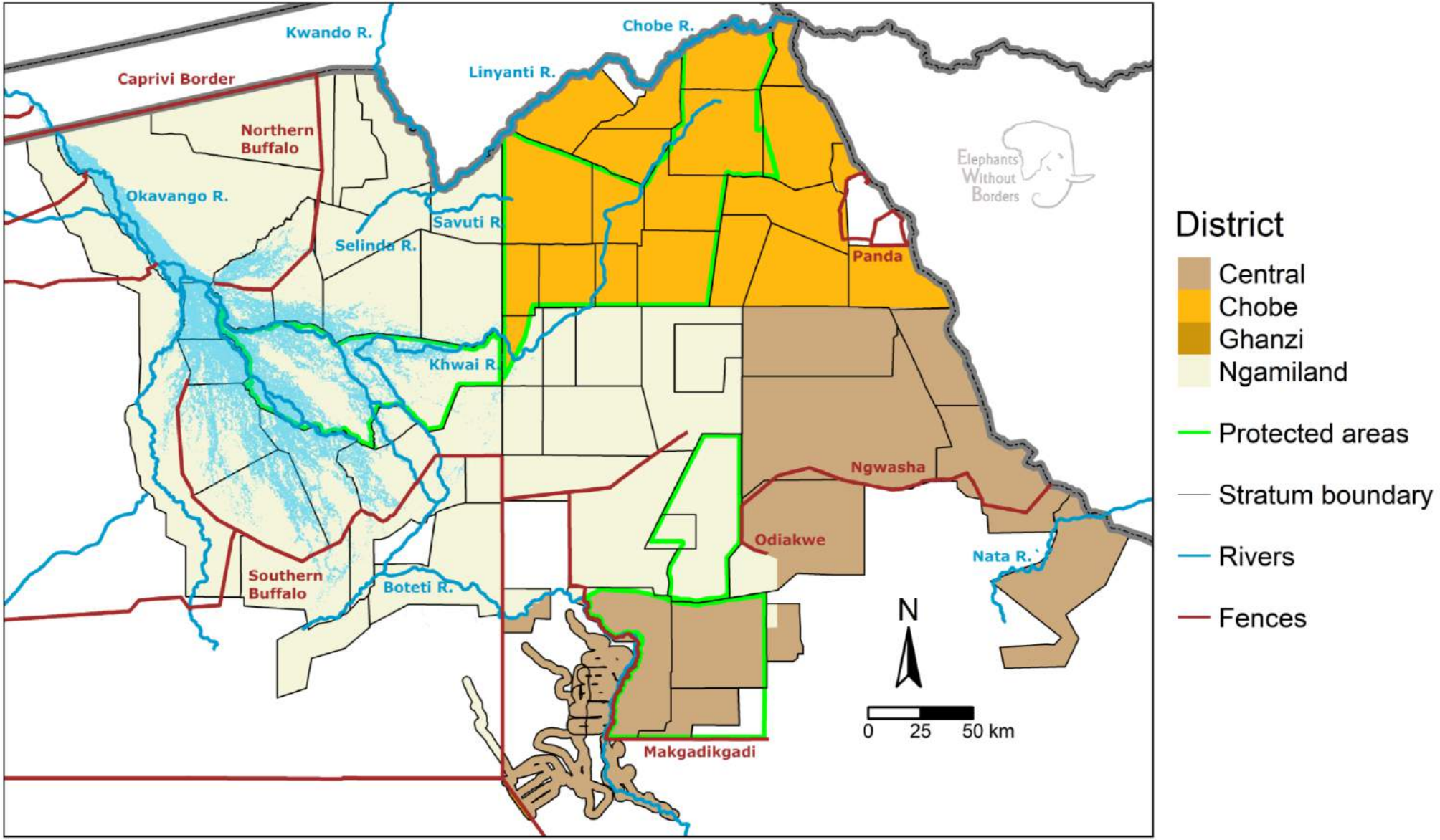


Figure 14. Recorded track log of flight lines indicting transects flown during the 2018 dry season aerial survey, northern Botswana.

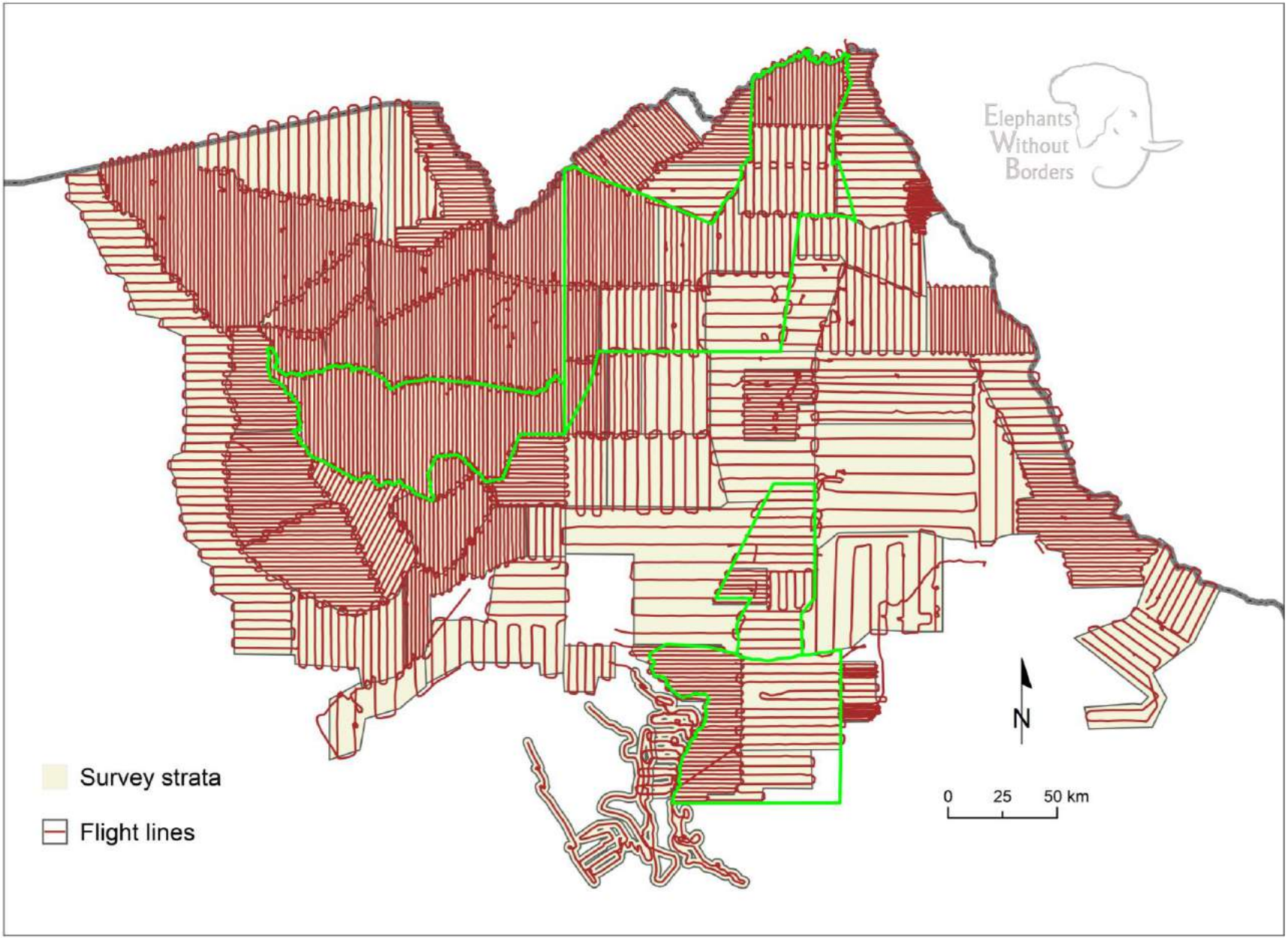


Table 15. Dry season population estimates for elephant breeding herd

Stratum	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density (animals km^{-2})
Chobe (CH) district								
CH 1 Chobe Enclave	3,619	624	1,100	2,275	63	1,345	5,894	2.87
CH 2 Chobe FR (high density)	3,480	585	720	1,526	44	1,954	5,006	5.21
CH 2 Chobe FR (low density)	323	28	222	571	177	0	894	0.39
CH 4 Kasane FR	541	90	205	440	81	101	981	1.25
CH 5 N Plains	0	0	0	0	0	0	0	0.00
CH 7 & 8	0	0	0	0	0	0	0	0.00
CH 11	869	49	713	1,746	201	0	2,615	0.97
CH 12	2,068	173	730	1,591	77	477	3,658	1.40
Nogatsaa C	2,646	259	1,772	3,947	149	0	6,593	2.49
Chinamba (low density)	590	34	391	1,005	170	0	1,596	0.44
Chinamba (high density)	749	67	453	1,258	168	0	2,007	1.22
Chobe Mababe	2,288	427	482	1,090	48	1,198	3,377	3.40
Chobe River	2,487	467	457	948	38	1,539	3,435	2.07
Kazuma FR (total count)	110	110	0	0	0	110	110	0.44
Nogatsaa A and B	1,343	127	461	959	71	384	2,302	0.77
Savute East	2,196	258	760	1,797	82	398	3,993	2.70
Savute North	2,937	544	524	1,089	37	1,848	4,026	1.44
Savute South (high density)	259	48	123	291	113	0	550	0.48
Savute South (low density)	326	33	202	478	147	0	804	0.37
Sibuyu FR	2,620	495	624	1,285	49	1,334	3,905	2.17
CH District Subtotal	**29,450**	**4,418**	**2,883**	**5,731**	**19**	**23,719**	**35,180**	**1.41**
Central (CT) district								
CT 1 & 2 (high density)	0	0	0	0	0	0	0	0.00
CT 1 & 2 (low density)	0	0	0	0	0	0	0	0.00
CT 3	49	4	47	105	214	0	154	0.04
Ngwasha & Sepako	10,997	1,937	2,278	4,667	42	6,330	15,663	4.94
Mak. NP East	0	0	0	0	0	0	0	0.00
Mak. NP East (salt pans)	0	0	0	0	0	0	0	0.00
Mak. NP West	513	91	177	360	70	153	873	0.25
CT 4 & 7 (recce count)	40	40	0	0	0	40	40	0.01
Boteti River (recce count)	36	36	0	0	0	36	36	0.04
Gweta (total count)	0	0	0	0	0	0	0	0.00
Hainaveld (recce count)	0	0	0	0	0	0	0	0.00
Nata (recce count)	599	599	0	0	0	599	599	0.25
Rakops (recce count)	0	0	0	0	0	0	0	0.00
CT District Subtotal	**12,234**	**2,707**	**2,286**	**9,715**	**79**	**2,707**	**21,948**	**0.50**
Ngamiland (NG) district								
Moremi GR NG 28	6,810	1,227	601	1,199	18	5,610	8,009	1.39
NG 7 & 8 West Okavango	1,735	151	796	1,596	92	139	3,331	0.33
NG 10 & 11	11,544	2,275	1,501	2,996	26	8,548	14,539	2.06
NG 12	2,702	504	649	1,342	50	1,360	4,044	2.75
NG 13	53	4	51	107	205	0	160	0.02
NG 14 Kwando (high density)	5,684	960	1,005	2,047	36	3,637	7,731	4.00
NG 14 Kwando (low density)	2,919	264	887	2,280	78	639	5,199	2.91
NG 15 Linyanti	1,107	208	327	690	62	417	1,797	0.94
NG 16 Selinda	3,184	622	731	1,495	47	1,689	4,680	2.28
NG 18 & 19 Khwai	2,357	464	427	891	38	1,465	3,248	1.23
NG 20 & 21 Splash	3,220	624	628	1,296	40	1,924	4,517	1.76
NG 22 Vumbra	1,541	305	230	501	33	1,040	2,043	2.43
NG 23 Duba Plains	413	79	88	187	45	226	600	0.86

Stratum	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density (animals km^{-2})
NG 24 Jedibe	58	11	43	93	160	0	151	0.12
NG 25 Jao	462	79	143	324	70	138	787	0.77
NG 26 Abu / EBS	4,294	761	860	1,770	41	2,524	6,065	2.47
NG 27 A & B & NG 30	1,759	246	381	786	45	973	2,545	1.29
NG 29	3,352	594	611	1,257	38	2,095	4,610	1.81
NG 31 & 17 Chitabe	562	112	150	334	59	228	896	1.99
NG 32 Stanleys	2,287	401	534	1,104	48	1,182	3,391	1.88
NG 33 & 34	1,936	343	513	1,094	57	842	3,030	2.12
NG 41 Mababe (high density)	2,088	290	487	1,253	60	835	3,341	3.53
NG 41 Mababe (low density)	0	0	0	0	0	0	0	0.00
NG 42 (high density)	822	141	182	389	47	433	1,211	0.90
NG 42 (low density)	0	0	0	0	0	0	0	0.00
NG 43 (high density)	53	4	51	163	305	0	216	0.08
NG 43 (low density)	0	0	0	0	0	0	0	0.00
NG 47 & 49	1,368	63	773	1,828	134	0	3,196	0.36
Nxai Pan NP (high density)	163	29	110	260	160	0	423	0.48
Nxai Pan NP (low density)	70	6	66	138	198	0	208	0.03
Maun East	811	48	567	1,208	149	0	2,019	0.35
Kwebe	0	0	0	0	0	0	0	0.00
Maun	343	66	227	465	136	0	808	0.27
Shorobe	89	9	85	235	263	0	325	0.22
Maun Southeast	0	0	0	0	0	0	0	0.00
Maun West	0	0	0	0	0	0	0	0.00
NG District Subtotal	**63,786**	**10,890**	**3,141**	**6,180**	**10**	**57,605**	**69,966**	**1.09**
TOTAL	**105,469**	**18,015**	**4,837**	**9,502**	**9**	**95,967**	**114,970**	**1.02**

Figure 15. Estimated density for breeding herd on the 2018 dry-season aerial survey of northern Botswana. Observation locations are withheld.

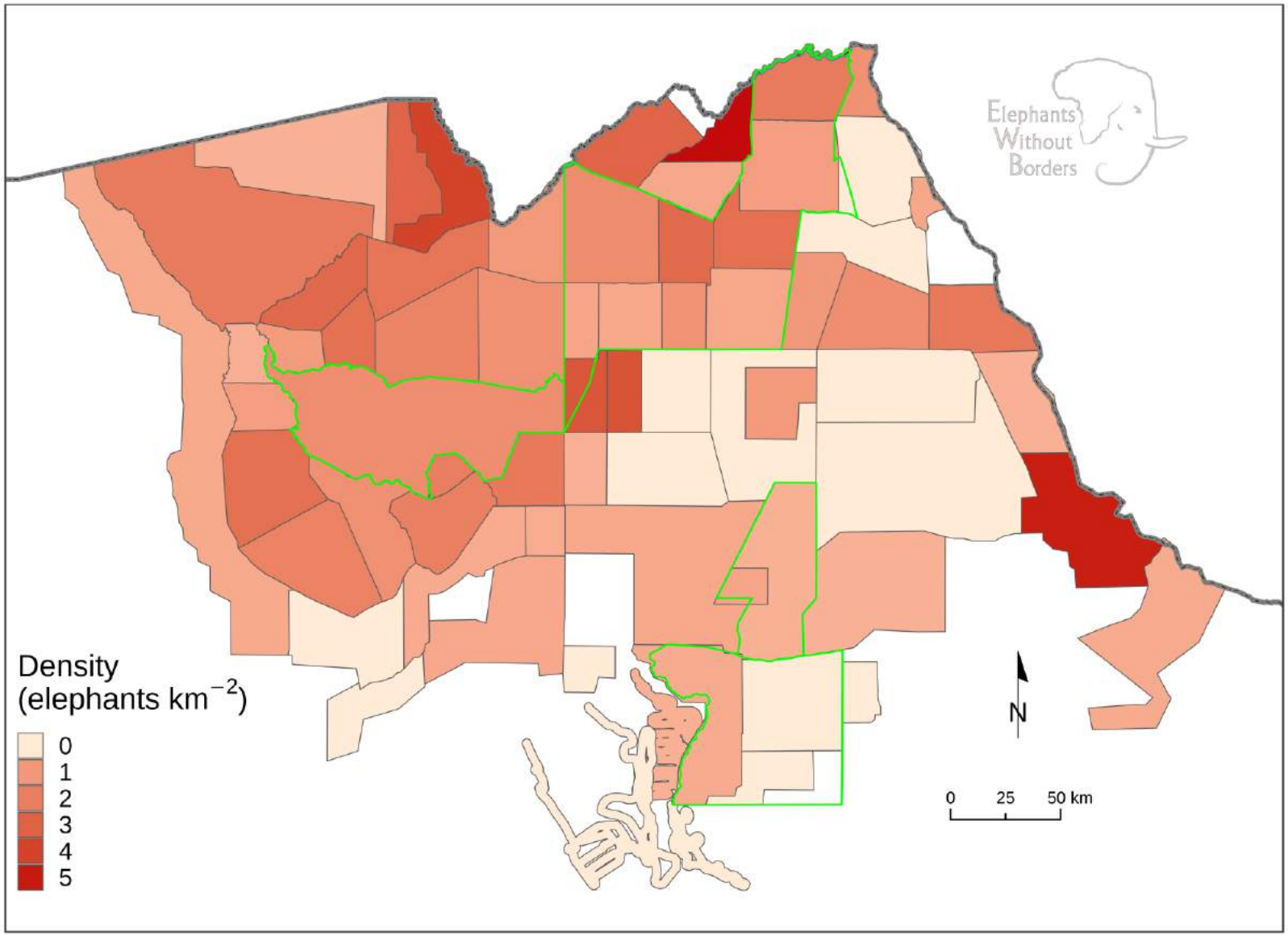


Table 16. Dry season population estimates for elephant bull

Stratum	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density (animals km^{-2})
Chobe (CH) district								
CH 1 Chobe Enclave	128	22	77	160	125	0	287	0.10
CH 2 Chobe FR (high density)	178	30	61	130	73	49	308	0.27
CH 2 Chobe FR (low density)	12	1	11	27	236	0	39	0.01
CH 4 Kasane FR	66	11	39	83	126	0	149	0.15
CH 5 N Plains	95	8	67	150	158	0	246	0.06
CH 7 & 8	67	5	63	139	208	0	206	0.05
CH 11	89	5	43	105	119	0	194	0.10
CH 12	418	35	274	598	143	0	1,016	0.28
Nogatsaa C	215	21	57	127	59	87	342	0.20
Chinamba (low density)	0	0	0	0	0	0	0	0.00
Chinamba (high density)	11	1	11	30	265	0	41	0.02
Chobe Mababe	525	98	143	322	61	203	847	0.78
Chobe River	69	13	19	39	57	30	109	0.06
Kazuma FR (total count)	212	212	0	0	0	212	212	0.84
Nogatsaa A and B	74	7	31	65	88	9	139	0.04
Savute East	26	3	24	57	225	0	83	0.03
Savute North	610	113	104	217	36	393	827	0.30
Savute South (high density)	205	38	93	220	107	0	425	0.38
Savute South (low density)	30	3	28	66	224	0	96	0.03
Sibuyu FR	233	44	64	132	57	101	365	0.19
CH District Subtotal	**3,262**	**670**	**384**	**768**	**24**	**2,494**	**4,030**	**0.16**
Central (CT) district								
CT 1 & 2 (high density)	124	11	52	123	99	2	247	0.05
CT 1 & 2 (low density)	1,275	56	883	2,036	160	0	3,311	0.26
CT 3	98	8	56	124	127	0	222	0.08
Ngwasha & Sepako	1,732	305	204	418	24	1,314	2,149	0.78
Mak. NP East	37	3	35	80	215	0	117	0.02
Mak. NP East (salt pans)	0	0	0	0	0	0	0	0.00
Mak. NP West	913	162	103	209	23	705	1,122	0.44
CT 4 & 7 (recce count)	15	15	0	0	0	15	15	0.01
Boteti River (recce count)	367	367	0	0	0	367	367	0.37
Gweta (total count)	162	162	0	0	0	162	162	0.37
Hainaveld (recce count)	81	81	0	0	0	81	81	0.05
Nata (recce count)	466	466	0	0	0	466	466	0.20
Rakops (recce count)	184	184	0	0	0	184	184	0.39
CT District Subtotal	**5,454**	**1,820**	**916**	**2,263**	**41**	**3,191**	**7,717**	**0.22**
Ngamiland (NG) district								
Moremi GR NG 28	1,593	287	132	263	17	1,330	1,856	0.32
NG 7 & 8 West Okavango	494	43	136	272	55	222	766	0.09
NG 10 & 11	467	92	102	203	43	264	670	0.08
NG 12	450	84	84	174	39	277	624	0.46
NG 13	26	2	25	53	203	0	80	0.01
NG 14 Kwando (high density)	231	39	58	119	51	112	349	0.16
NG 14 Kwando (low density)	77	7	38	98	127	0	176	0.08
NG 15 Linyanti	442	83	87	184	42	258	625	0.37
NG 16 Selinda	727	142	99	203	28	524	930	0.52
NG 18 & 19 Khwai	1,539	303	157	328	21	1,211	1,867	0.80
NG 20 & 21 Splash	944	183	120	247	26	698	1,191	0.52
NG 22 Vumbra	212	42	40	88	41	124	300	0.34
NG 23 Duba Plains	146	28	35	74	51	72	221	0.31

Stratum	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density (animals km^{-2})
NG 24 Jedibe	95	18	28	61	64	34	156	0.20
NG 25 Jao	152	26	50	113	75	39	266	0.25
NG 26 Abu / EBS	649	115	94	195	30	454	844	0.37
NG 27 A & B & NG 30	336	47	61	127	38	209	463	0.25
NG 29	649	115	94	194	30	455	843	0.35
NG 31 & 17 Chitabe	226	45	50	111	49	115	337	0.80
NG 32 Stanleys	285	50	50	104	37	181	389	0.23
NG 33 & 34	282	50	68	145	52	137	428	0.31
NG 41 Mababe (high density)	79	11	43	111	140	0	190	0.13
NG 41 Mababe (low density)	0	0	0	0	0	0	0	0.00
NG 42 (high density)	222	38	53	112	51	109	334	0.24
NG 42 (low density)	18	1	17	38	206	0	56	0.01
NG 43 (high density)	0	0	0	0	0	0	0	0.00
NG 43 (low density)	0	0	0	0	0	0	0	0.00
NG 47 & 49	87	4	35	84	96	3	171	0.02
Nxai Pan NP (high density)	185	33	64	151	81	34	336	0.55
Nxai Pan NP (low density)	93	8	55	115	124	0	208	0.04
Maun East	68	4	52	110	163	0	178	0.03
Kwebe	25	1	26	71	285	0	96	0.03
Maun	519	100	120	245	47	275	764	0.41
Shorobe	60	6	46	127	213	0	187	0.15
Maun Southeast	76	7	39	101	133	0	176	0.17
Maun West	474	46	176	380	80	93	854	0.29
NG District Subtotal	**11,929**	**2,060**	**467**	**918**	**8**	**11,011**	**12,846**	**0.20**
TOTAL	**20,645**	**4,550**	**1,097**	**2,171**	**11**	**18,474**	**22,816**	**0.20**

Figure 16. Estimated density for elephant bull on the 2018 dry-season aerial survey of northern Botswana. Observation locations are withheld.

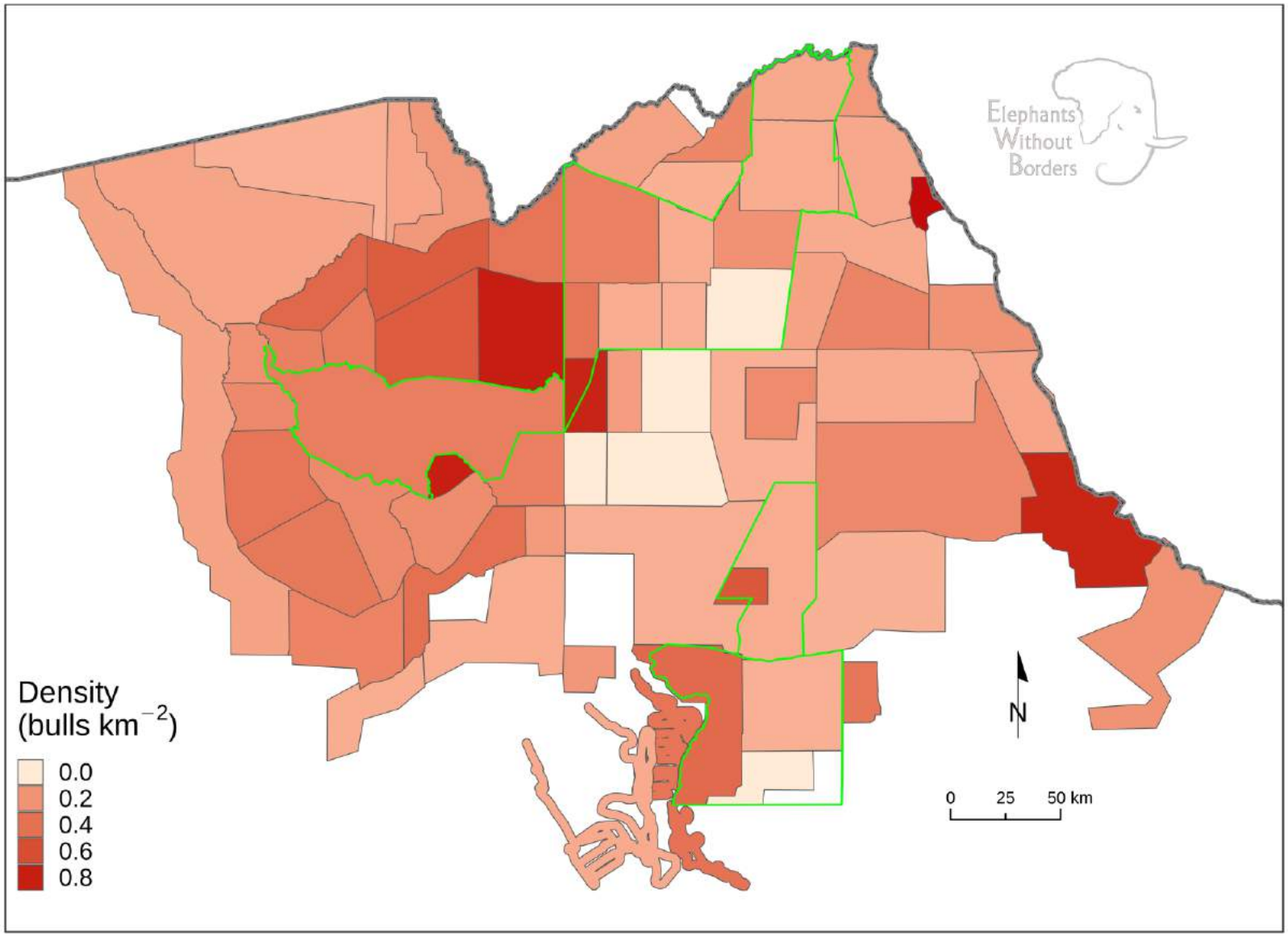


Table 17. Dry season population estimates for fresh elephant carcasses (category 1)

Stratum	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density (animals km^{-2})
Chobe (CH) district								
CH 1 Chobe Enclave	12	2	7	15	130	0	27	0.01
CH 2 Chobe FR (high density)	0	0	0	0	0	0	0	0.00
CH 2 Chobe FR (low density)	0	0	0	0	0	0	0	0.00
CH 4 Kasane FR	0	0	0	0	0	0	0	0.00
CH 5 N Plains	24	2	23	52	216	0	75	0.01
CH 7 & 8	0	0	0	0	0	0	0	0.00
CH 11	0	0	0	0	0	0	0	0.00
CH 12	0	0	0	0	0	0	0	0.00
Nogatsaa C	0	0	0	0	0	0	0	0.00
Chinamba (low density)	0	0	0	0	0	0	0	0.00
Chinamba (high density)	0	0	0	0	0	0	0	0.00
Chobe Mababe	0	0	0	0	0	0	0	0.00
Chobe River	0	0	0	0	0	0	0	0.00
Kazuma FR (total count)	1	1	0	0	0	1	1	0.00
Nogatsaa A and B	11	1	10	21	200	0	32	0.01
Savute East	0	0	0	0	0	0	0	0.00
Savute North	0	0	0	0	0	0	0	0.00
Savute South (high density)	0	0	0	0	0	0	0	0.00
Savute South (low density)	0	0	0	0	0	0	0	0.00
Sibuyu FR	0	0	0	0	0	0	0	0.00
CH District Subtotal	**47**	**6**	**26**	**81**	**172**	**6**	**128**	**0.00**
Central (CT) district								
CT 1 & 2 (high density)	11	1	11	25	226	0	37	0.00
CT 1 & 2 (low density)	0	0	0	0	0	0	0	0.00
CT 3	0	0	0	0	0	0	0	0.00
Ngwasha & Sepako	6	1	5	10	184	0	16	0.00
Mak. NP East	0	0	0	0	0	0	0	0.00
Mak. NP East (salt pans)	0	0	0	0	0	0	0	0.00
Mak. NP West	6	1	5	10	184	0	16	0.00
CT 4 & 7 (recce count)	1	1	0	0	0	1	1	0.00
Boteti River (recce count)	0	0	0	0	0	0	0	0.00
Gweta (total count)	0	0	0	0	0	0	0	0.00
Hainaveld (recce count)	0	0	0	0	0	0	0	0.00
Nata (recce count)	4	4	0	0	0	4	4	0.00
Rakops (recce count)	0	0	0	0	0	0	0	0.00
CT District Subtotal	**28**	**8**	**13**	**37**	**133**	**8**	**64**	**0.00**
Ngamiland (NG) district								
Moremi GR NG 28	0	0	0	0	0	0	0	0.00
NG 7 & 8 West Okavango	11	1	11	22	191	0	33	0.00
NG 10 & 11	41	8	14	28	69	13	69	0.01
NG 12	5	1	5	10	186	0	15	0.01
NG 13	0	0	0	0	0	0	0	0.00
NG 14 Kwando (high density)	0	0	0	0	0	0	0	0.00
NG 14 Kwando (low density)	0	0	0	0	0	0	0	0.00
NG 15 Linyanti	16	3	10	22	137	0	38	0.01
NG 16 Selinda	5	1	5	9	185	0	15	0.00
NG 18 & 19 Khwai	20	4	8	17	86	3	38	0.01
NG 20 & 21 Splash	0	0	0	0	0	0	0	0.00
NG 22 Vumbra	0	0	0	0	0	0	0	0.00
NG 23 Duba Plains	0	0	0	0	0	0	0	0.00

Stratum	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density (animals km^{-2})
NG 24 Jedibe	0	0	0	0	0	0	0	0.00
NG 25 Jao	0	0	0	0	0	0	0	0.00
NG 26 Abu / EBS	0	0	0	0	0	0	0	0.00
NG 27 A & B & NG 30	0	0	0	0	0	0	0	0.00
NG 29	0	0	0	0	0	0	0	0.00
NG 31 & 17 Chitabe	0	0	0	0	0	0	0	0.00
NG 32 Stanleys	0	0	0	0	0	0	0	0.00
NG 33 & 34	0	0	0	0	0	0	0	0.00
NG 41 Mababe (high density)	0	0	0	0	0	0	0	0.00
NG 41 Mababe (low density)	0	0	0	0	0	0	0	0.00
NG 42 (high density)	6	1	5	11	196	0	17	0.01
NG 42 (low density)	0	0	0	0	0	0	0	0.00
NG 43 (high density)	0	0	0	0	0	0	0	0.00
NG 43 (low density)	0	0	0	0	0	0	0	0.00
NG 47 & 49	0	0	0	0	0	0	0	0.00
Nxai Pan NP (high density)	0	0	0	0	0	0	0	0.00
Nxai Pan NP (low density)	0	0	0	0	0	0	0	0.00
Maun East	0	0	0	0	0	0	0	0.00
Kwebe	0	0	0	0	0	0	0	0.00
Maun	26	5	8	17	66	9	43	0.02
Shorobe	0	0	0	0	0	0	0	0.00
Maun Southeast	0	0	0	0	0	0	0	0.00
Maun West	21	2	13	28	136	0	49	0.01
NG District Subtotal	**151**	**26**	**28**	**57**	**38**	**94**	**208**	**0.00**
TOTAL	**226**	**40**	**41**	**81**	**36**	**145**	**307**	**0.00**

Figure 17. Estimated density and observations for fresh elephant carcasses (cat. 1) on the 2018 dry-season aerial survey of northern Botswana.

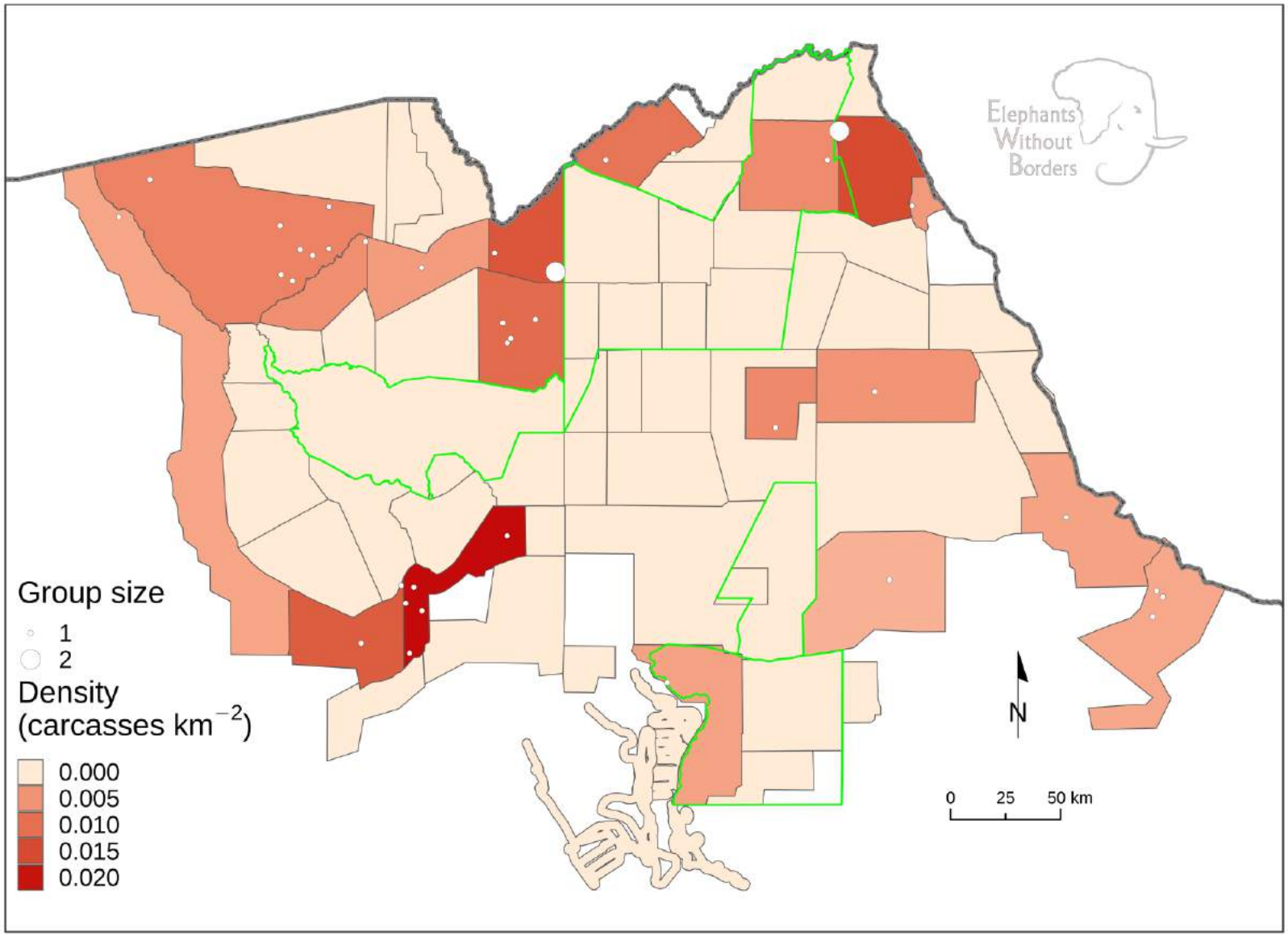


Table 18. Dry season population estimates for recent elephant carcasses (category 2)

Stratum	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density (animals km^{-2})
Chobe (CH) district								
CH 1 Chobe Enclave	0	0	0	0	0	0	0	0.00
CH 2 Chobe FR (high density)	0	0	0	0	0	0	0	0.00
CH 2 Chobe FR (low density)	0	0	0	0	0	0	0	0.00
CH 4 Kasane FR	0	0	0	0	0	0	0	0.00
CH 5 N Plains	0	0	0	0	0	0	0	0.00
CH 7 & 8	40	3	27	60	148	0	100	0.03
CH 11	18	1	17	42	238	0	60	0.02
CH 12	60	5	47	102	170	0	162	0.04
Nogatsaa C	20	2	13	29	141	0	49	0.02
Chinamba (low density)	0	0	0	0	0	0	0	0.00
Chinamba (high density)	0	0	0	0	0	0	0	0.00
Chobe Mababe	0	0	0	0	0	0	0	0.00
Chobe River	11	2	7	14	127	0	24	0.01
Kazuma FR (total count)	0	0	0	0	0	0	0	0.00
Nogatsaa A and B	0	0	0	0	0	0	0	0.00
Savute East	26	3	12	28	108	0	53	0.03
Savute North	16	3	8	17	102	0	33	0.01
Savute South (high density)	11	2	6	15	140	0	26	0.02
Savute South (low density)	20	2	12	29	146	0	49	0.02
Sibuyu FR	5	1	5	10	189	0	15	0.00
CH District Subtotal	**226**	**24**	**62**	**128**	**56**	**99**	**354**	**0.01**
Central (CT) district								
CT 1 & 2 (high density)	11	1	11	26	227	0	37	0.00
CT 1 & 2 (low density)	0	0	0	0	0	0	0	0.00
CT 3	0	0	0	0	0	0	0	0.00
Ngwasha & Sepako	0	0	0	0	0	0	0	0.00
Mak. NP East	0	0	0	0	0	0	0	0.00
Mak. NP East (salt pans)	0	0	0	0	0	0	0	0.00
Mak. NP West	0	0	0	0	0	0	0	0.00
CT 4 & 7 (recce count)	1	1	0	0	0	1	1	0.00
Boteti River (recce count)	0	0	0	0	0	0	0	0.00
Gweta (total count)	0	0	0	0	0	0	0	0.00
Hainaveld (recce count)	0	0	0	0	0	0	0	0.00
Nata (recce count)	1	1	0	0	0	1	1	0.00
Rakops (recce count)	0	0	0	0	0	0	0	0.00
CT District Subtotal	**13**	**3**	**11**	**138**	**1,036**	**3**	**151**	**0.00**
Ngamiland (NG) district								
Moremi GR NG 28	0	0	0	0	0	0	0	0.00
NG 7 & 8 West Okavango	11	1	11	22	192	0	34	0.00
NG 10 & 11	101	20	20	40	39	61	142	0.02
NG 12	21	4	11	23	108	0	45	0.02
NG 13	66	5	23	48	74	17	114	0.02
NG 14 Kwando (high density)	0	0	0	0	0	0	0	0.00
NG 14 Kwando (low density)	11	1	9	24	220	0	35	0.01
NG 15 Linyanti	21	4	8	17	78	5	38	0.02
NG 16 Selinda	5	1	5	9	182	0	14	0.00
NG 18 & 19 Khwai	86	17	21	45	52	42	131	0.05
NG 20 & 21 Splash	5	1	5	10	186	0	15	0.00
NG 22 Vumbra	0	0	0	0	0	0	0	0.00
NG 23 Duba Plains	0	0	0	0	0	0	0	0.00

Stratum	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density (animals km^{-2})
NG 24 Jedibe	0	0	0	0	0	0	0	0.00
NG 25 Jao	0	0	0	0	0	0	0	0.00
NG 26 Abu / EBS	0	0	0	0	0	0	0	0.00
NG 27 A & B & NG 30	0	0	0	0	0	0	0	0.00
NG 29	0	0	0	0	0	0	0	0.00
NG 31 & 17 Chitabe	0	0	0	0	0	0	0	0.00
NG 32 Stanleys	0	0	0	0	0	0	0	0.00
NG 33 & 34	0	0	0	0	0	0	0	0.00
NG 41 Mababe (high density)	0	0	0	0	0	0	0	0.00
NG 41 Mababe (low density)	0	0	0	0	0	0	0	0.00
NG 42 (high density)	12	2	7	15	131	0	27	0.01
NG 42 (low density)	0	0	0	0	0	0	0	0.00
NG 43 (high density)	0	0	0	0	0	0	0	0.00
NG 43 (low density)	0	0	0	0	0	0	0	0.00
NG 47 & 49	0	0	0	0	0	0	0	0.00
Nxai Pan NP (high density)	0	0	0	0	0	0	0	0.00
Nxai Pan NP (low density)	0	0	0	0	0	0	0	0.00
Maun East	0	0	0	0	0	0	0	0.00
Kwebe	0	0	0	0	0	0	0	0.00
Maun	21	4	11	23	111	0	44	0.02
Shorobe	0	0	0	0	0	0	0	0.00
Maun Southeast	0	0	0	0	0	0	0	0.00
Maun West	10	1	10	21	204	0	31	0.01
NG District Subtotal	**372**	**61**	**46**	**91**	**25**	**280**	**463**	**0.01**
TOTAL	**611**	**88**	**78**	**154**	**25**	**457**	**765**	**0.01**

Figure 18. Estimated density and observations for recent elephant carcasses (cat. 2) on the 2018 dry-season aerial survey of northern Botswana.

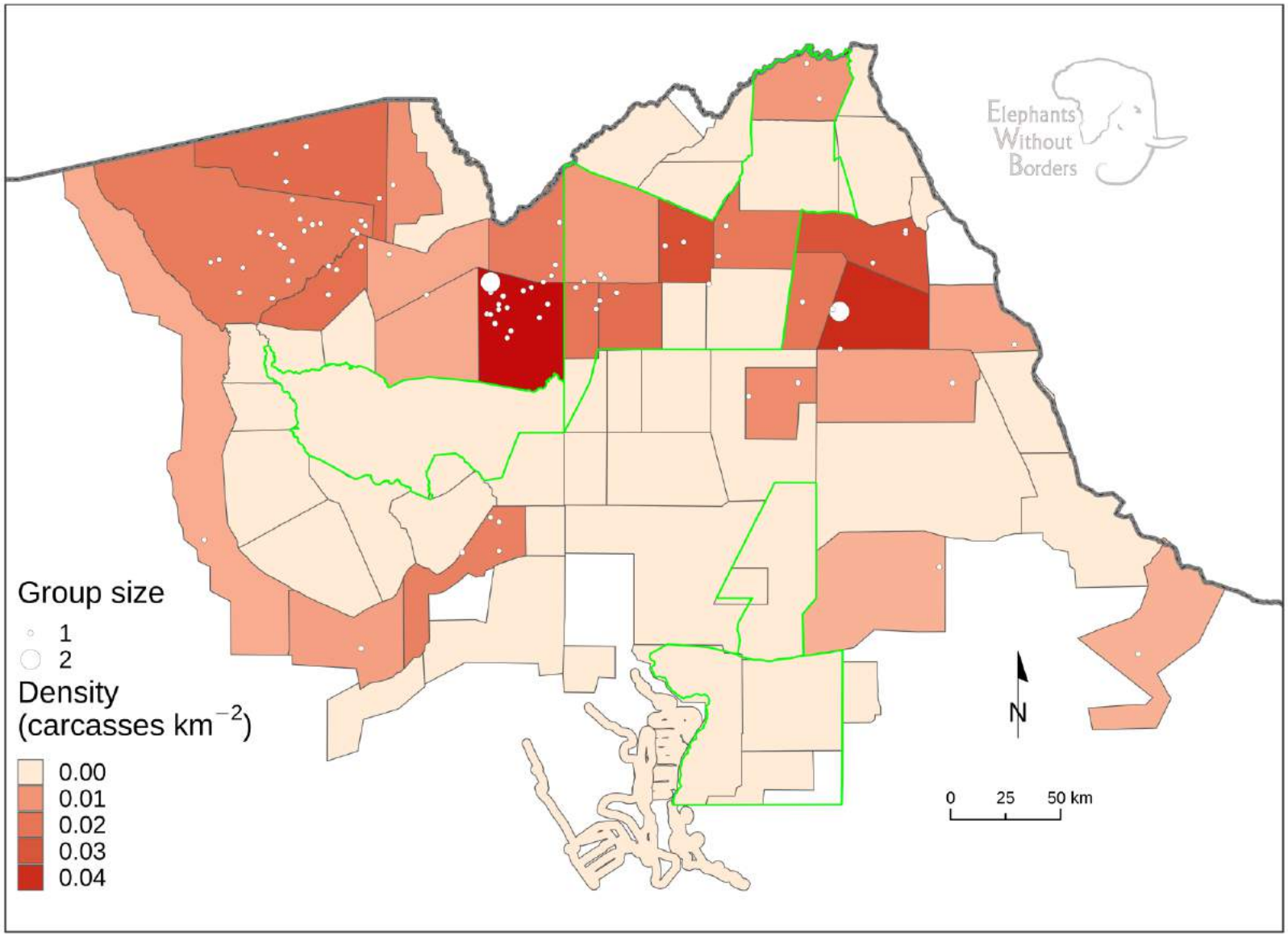


Table 19. Dry season population estimates for fresh/recent elephant carcass (category 1 & 2)

Stratum	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density (animals km^{-2})
Chobe (CH) district								
CH 1 Chobe Enclave	12	2	7	15	130	0	27	0.01
CH 2 Chobe FR (high density)	0	0	0	0	0	0	0	0.00
CH 2 Chobe FR (low density)	0	0	0	0	0	0	0	0.00
CH 4 Kasane FR	0	0	0	0	0	0	0	0.00
CH 5 N Plains	24	2	23	52	216	0	75	0.01
CH 7 & 8	40	3	27	60	148	0	100	0.03
CH 11	18	1	17	42	238	0	60	0.02
CH 12	60	5	47	102	170	0	162	0.04
Nogatsaa C	20	2	13	29	141	0	49	0.02
Chinamba (low density)	0	0	0	0	0	0	0	0.00
Chinamba (high density)	0	0	0	0	0	0	0	0.00
Chobe Mababe	0	0	0	0	0	0	0	0.00
Chobe River	11	2	7	14	127	0	24	0.01
Kazuma FR (total count)	1	1	0	0	0	1	1	0.00
Nogatsaa A and B	11	1	10	21	200	0	32	0.01
Savute East	26	3	12	28	108	0	53	0.03
Savute North	16	3	8	17	102	0	33	0.01
Savute South (high density)	11	2	6	15	140	0	26	0.02
Savute South (low density)	20	2	12	29	146	0	49	0.02
Sibuyu FR	5	1	5	10	189	0	15	0.00
CH District Subtotal	**273**	**30**	**67**	**136**	**50**	**138**	**409**	**0.01**
Central (CT) district								
CT 1 & 2 (high density)	23	2	14	34	149	0	56	0.01
CT 1 & 2 (low density)	0	0	0	0	0	0	0	0.00
CT 3	0	0	0	0	0	0	0	0.00
Ngwasha & Sepako	6	1	5	10	184	0	16	0.00
Mak. NP East	0	0	0	0	0	0	0	0.00
Mak. NP East (salt pans)	0	0	0	0	0	0	0	0.00
Mak. NP West	6	1	5	10	184	0	16	0.00
CT 4 & 7 (recce count)	2	2	0	0	0	2	2	0.00
Boteti River (recce count)	0	0	0	0	0	0	0	0.00
Gweta (total count)	0	0	0	0	0	0	0	0.00
Hainaveld (recce count)	0	0	0	0	0	0	0	0.00
Nata (recce count)	5	5	0	0	0	5	5	0.00
Rakops (recce count)	0	0	0	0	0	0	0	0.00
CT District Subtotal	**41**	**11**	**16**	**50**	**122**	**11**	**91**	**0.00**
Ngamiland (NG) district								
Moremi GR NG 28	0	0	0	0	0	0	0	0.00
NG 7 & 8 West Okavango	23	2	15	31	134	0	54	0.00
NG 10 & 11	142	28	28	56	39	86	198	0.03
NG 12	27	5	12	24	91	2	51	0.03
NG 13	66	5	23	48	74	17	114	0.02
NG 14 Kwando (high density)	0	0	0	0	0	0	0	0.00
NG 14 Kwando (low density)	11	1	9	24	220	0	35	0.01
NG 15 Linyanti	37	7	15	31	84	6	69	0.03
NG 16 Selinda	10	2	6	13	128	0	23	0.01
NG 18 & 19 Khwai	107	21	24	49	46	57	156	0.06
NG 20 & 21 Splash	5	1	5	10	186	0	15	0.00
NG 22 Vumbra	0	0	0	0	0	0	0	0.00
NG 23 Duba Plains	0	0	0	0	0	0	0	0.00

Stratum	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density (animals km^{-2})
NG 24 Jedibe	0	0	0	0	0	0	0	0.00
NG 25 Jao	0	0	0	0	0	0	0	0.00
NG 26 Abu / EBS	0	0	0	0	0	0	0	0.00
NG 27 A & B & NG 30	0	0	0	0	0	0	0	0.00
NG 29	0	0	0	0	0	0	0	0.00
NG 31 & 17 Chitabe	0	0	0	0	0	0	0	0.00
NG 32 Stanleys	0	0	0	0	0	0	0	0.00
NG 33 & 34	0	0	0	0	0	0	0	0.00
NG 41 Mababe (high density)	0	0	0	0	0	0	0	0.00
NG 41 Mababe (low density)	0	0	0	0	0	0	0	0.00
NG 42 (high density)	17	3	9	18	104	0	36	0.02
NG 42 (low density)	0	0	0	0	0	0	0	0.00
NG 43 (high density)	0	0	0	0	0	0	0	0.00
NG 43 (low density)	0	0	0	0	0	0	0	0.00
NG 47 & 49	0	0	0	0	0	0	0	0.00
Nxai Pan NP (high density)	0	0	0	0	0	0	0	0.00
Nxai Pan NP (low density)	0	0	0	0	0	0	0	0.00
Maun East	0	0	0	0	0	0	0	0.00
Kwebe	0	0	0	0	0	0	0	0.00
Maun	47	9	12	25	54	21	72	0.04
Shorobe	0	0	0	0	0	0	0	0.00
Maun Southeast	0	0	0	0	0	0	0	0.00
Maun West	31	3	21	45	145	0	76	0.02
NG District Subtotal	**523**	**87**	**57**	**114**	**22**	**409**	**637**	**0.01**
TOTAL	**837**	**128**	**90**	**177**	**21**	**661**	**1,014**	**0.01**

Figure 19. Estimated density and observations for fresh/recent elephant carcasses on the 2018 dry-season aerial survey of northern Botswana.

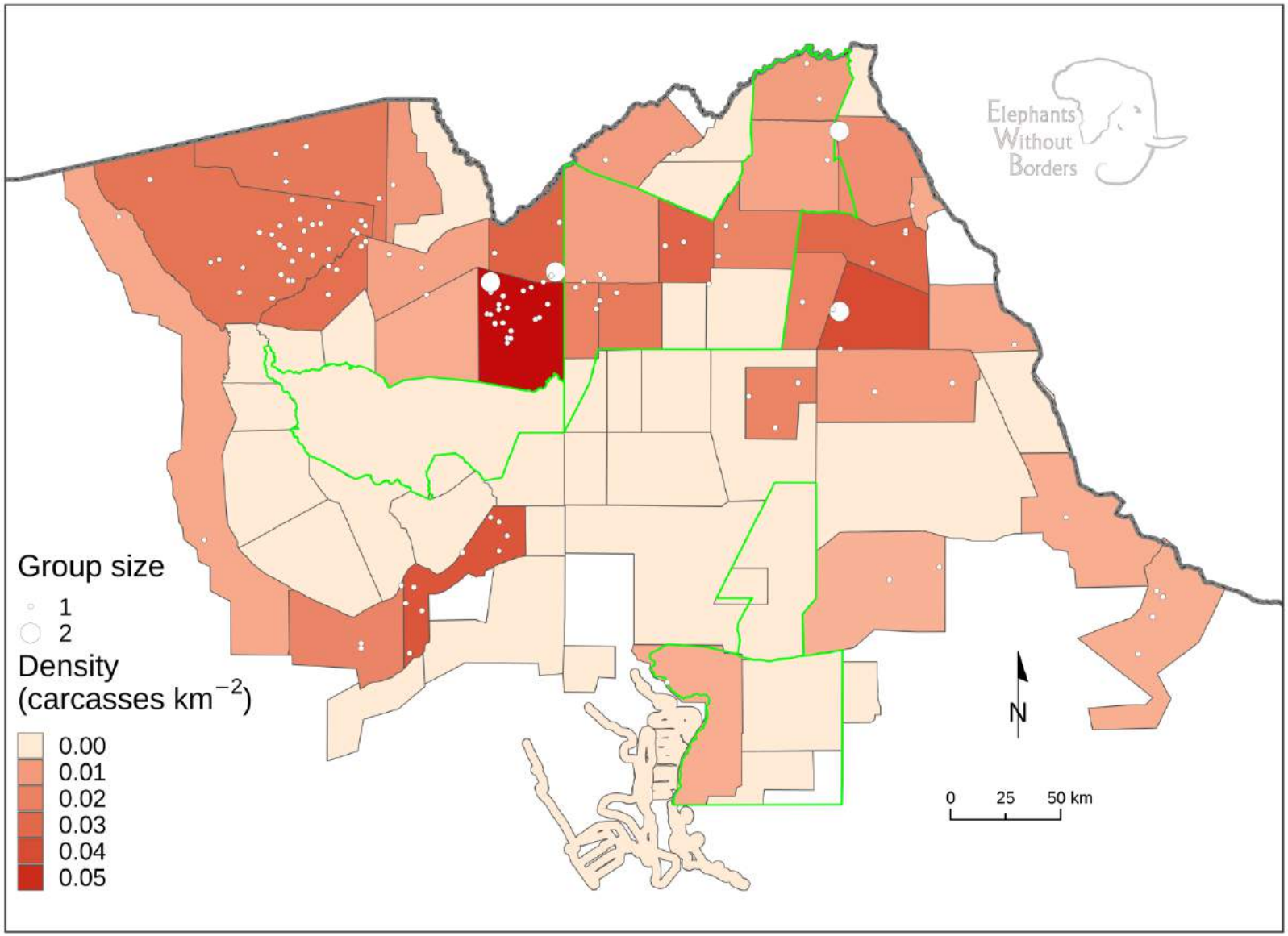


Table 20. Dry season population estimates for old elephant carcasses (category 3)

Stratum	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density (animals km^{-2})
Chobe (CH) district								
CH 1 Chobe Enclave	209	36	40	82	39	127	291	0.17
CH 2 Chobe FR (high density)	393	66	53	112	29	280	505	0.59
CH 2 Chobe FR (low density)	115	10	30	76	66	39	192	0.14
CH 4 Kasane FR	90	15	23	50	55	40	140	0.21
CH 5 N Plains	155	13	39	87	56	68	242	0.10
CH 7 & 8	295	22	90	198	67	97	493	0.22
CH 11	106	6	39	95	89	11	201	0.12
CH 12	108	9	34	74	69	33	182	0.07
Nogatsaa C	102	10	31	69	67	33	171	0.10
Chinamba (low density)	69	4	50	130	187	0	199	0.05
Chinamba (high density)	0	0	0	0	0	0	0	0.00
Chobe Mababe	43	8	12	28	64	15	70	0.06
Chobe River	591	111	81	168	28	423	759	0.49
Kazuma FR (total count)	29	29	0	0	0	29	29	0.12
Nogatsaa A and B	434	41	96	199	46	235	632	0.25
Savute East	111	13	22	51	46	60	162	0.14
Savute North	540	100	77	160	30	380	700	0.26
Savute South (high density)	38	7	14	32	86	5	70	0.07
Savute South (low density)	20	2	12	29	147	0	49	0.02
Sibuyu FR	32	6	13	26	82	6	58	0.03
CH District Subtotal	**3,479**	**508**	**210**	**416**	**12**	**3,063**	**3,895**	**0.17**
Central (CT) district								
CT 1 & 2 (high density)	34	3	23	54	158	0	87	0.01
CT 1 & 2 (low density)	68	3	48	110	161	0	178	0.01
CT 3	12	1	12	26	214	0	39	0.01
Ngwasha & Sepako	261	46	45	93	35	169	354	0.12
Mak. NP East	0	0	0	0	0	0	0	0.00
Mak. NP East (salt pans)	0	0	0	0	0	0	0	0.00
Mak. NP West	11	2	7	14	126	0	25	0.01
CT 4 & 7 (recce count)	5	5	0	0	0	5	5	0.00
Boteti River (recce count)	0	0	0	0	0	0	0	0.00
Gweta (total count)	0	0	0	0	0	0	0	0.00
Hainaveld (recce count)	0	0	0	0	0	0	0	0.00
Nata (recce count)	5	5	0	0	0	5	5	0.00
Rakops (recce count)	1	1	0	0	0	1	1	0.00
CT District Subtotal	**398**	**66**	**71**	**157**	**39**	**241**	**555**	**0.02**
Ngamiland (NG) district								
Moremi GR NG 28	0	0	0	0	0	0	0	0.00
NG 7 & 8 West Okavango	92	8	40	80	87	12	172	0.02
NG 10 & 11	259	51	33	65	25	193	324	0.05
NG 12	102	19	19	40	39	62	142	0.10
NG 13	79	6	29	61	78	17	140	0.03
NG 14 Kwando (high density)	47	8	14	28	60	19	76	0.03
NG 14 Kwando (low density)	22	2	19	49	220	0	71	0.02
NG 15 Linyanti	117	22	40	83	71	34	201	0.10
NG 16 Selinda	5	1	5	9	184	0	15	0.00
NG 18 & 19 Khwai	81	16	23	48	60	33	130	0.04
NG 20 & 21 Splash	10	2	6	13	127	0	23	0.01
NG 22 Vumbra	0	0	0	0	0	0	0	0.00
NG 23 Duba Plains	0	0	0	0	0	0	0	0.00

Stratum	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density (animals km^{-2})
NG 24 Jedibe	0	0	0	0	0	0	0	0.00
NG 25 Jao	18	3	8	18	105	0	36	0.03
NG 26 Abu / EBS	0	0	0	0	0	0	0	0.00
NG 27 A & B & NG 30	7	1	7	14	189	0	21	0.01
NG 29	17	3	8	17	101	0	34	0.01
NG 31 & 17 Chitabe	5	1	4	10	195	0	15	0.02
NG 32 Stanleys	23	4	10	20	86	3	43	0.02
NG 33 & 34	11	2	7	15	132	0	26	0.01
NG 41 Mababe (high density)	7	1	7	17	238	0	24	0.01
NG 41 Mababe (low density)	0	0	0	0	0	0	0	0.00
NG 42 (high density)	0	0	0	0	0	0	0	0.00
NG 42 (low density)	0	0	0	0	0	0	0	0.00
NG 43 (high density)	0	0	0	0	0	0	0	0.00
NG 43 (low density)	0	0	0	0	0	0	0	0.00
NG 47 & 49	22	1	22	53	243	0	74	0.01
Nxai Pan NP (high density)	11	2	7	16	144	0	27	0.03
Nxai Pan NP (low density)	23	2	22	45	195	0	69	0.01
Maun East	17	1	17	35	209	0	52	0.01
Kwebe	25	1	26	71	285	0	96	0.03
Maun	47	9	16	33	71	13	80	0.04
Shorobe	0	0	0	0	0	0	0	0.00
Maun Southeast	11	1	10	26	240	0	37	0.02
Maun West	31	3	15	33	108	0	64	0.02
NG District Subtotal	**1,089**	**170**	**98**	**192**	**18**	**897**	**1,281**	**0.02**
TOTAL	**4,966**	**744**	**242**	**476**	**10**	**4,490**	**5,442**	**0.05**

Figure 20. Estimated density and observations for old elephant carcasses (cat. 3) on the 2018 dry-season aerial survey of northern Botswana.

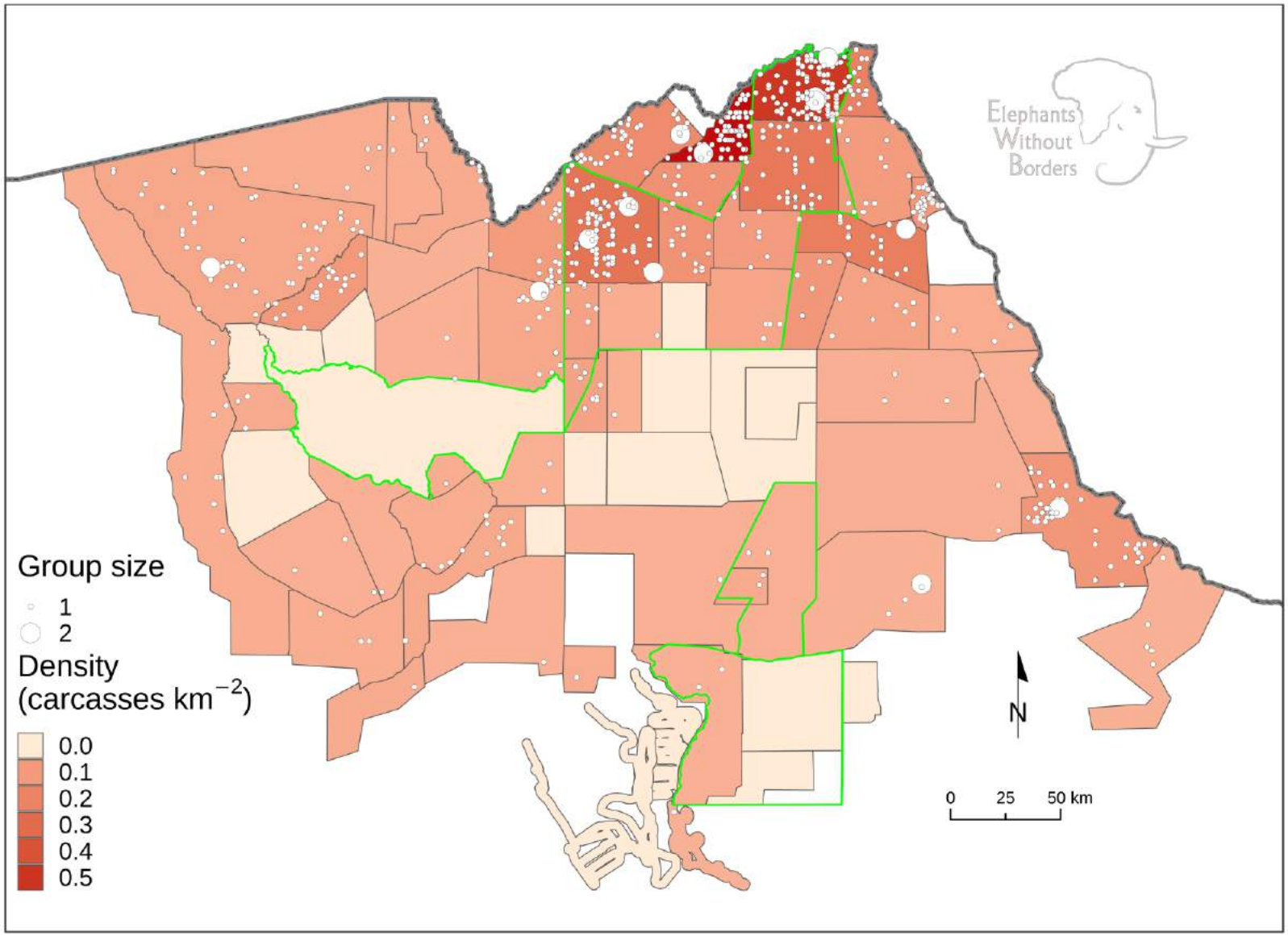


Table 21. Dry season population estimates for very old elephant carcasses (category 4)

Stratum	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density (animals km^{-2})
Chobe (CH) district								
CH 1 Chobe Enclave	255	44	43	89	35	166	344	0.20
CH 2 Chobe FR (high density)	190	32	40	84	44	107	274	0.28
CH 2 Chobe FR (low density)	58	5	22	56	98	1	114	0.07
CH 4 Kasane FR	108	18	25	54	50	55	162	0.25
CH 5 N Plains	119	10	40	90	75	30	209	0.07
CH 7 & 8	121	9	37	81	67	40	201	0.09
CH 11	0	0	0	0	0	0	0	0.00
CH 12	167	14	49	108	64	60	275	0.11
Nogatsaa C	82	8	25	56	69	26	138	0.08
Chinamba (low density)	35	2	22	55	159	0	90	0.03
Chinamba (high density)	34	3	13	36	108	0	70	0.05
Chobe Mababe	102	19	34	77	75	25	179	0.15
Chobe River	527	99	46	95	18	432	622	0.44
Kazuma FR (total count)	11	11	0	0	0	11	11	0.04
Nogatsaa A and B	370	35	62	129	35	241	499	0.21
Savute East	77	9	14	33	43	43	110	0.09
Savute North	432	80	60	125	29	307	557	0.21
Savute South (high density)	32	6	12	29	89	4	61	0.06
Savute South (low density)	10	1	9	22	224	0	32	0.01
Sibuyu FR	90	17	16	33	36	57	123	0.07
CH District Subtotal	**2,820**	**422**	**150**	**297**	**11**	**2,523**	**3,116**	**0.14**
Central (CT) district								
CT 1 & 2 (high density)	23	2	14	33	148	0	56	0.01
CT 1 & 2 (low density)	46	2	45	104	229	0	150	0.01
CT 3	0	0	0	0	0	0	0	0.00
Ngwasha & Sepako	221	39	26	54	24	167	276	0.10
Mak. NP East	0	0	0	0	0	0	0	0.00
Mak. NP East (salt pans)	0	0	0	0	0	0	0	0.00
Mak. NP West	6	1	5	11	187	0	16	0.00
CT 4 & 7 (recce count)	3	3	0	0	0	3	3	0.00
Boteti River (recce count)	0	0	0	0	0	0	0	0.00
Gweta (total count)	0	0	0	0	0	0	0	0.00
Hainaveld (recce count)	0	0	0	0	0	0	0	0.00
Nata (recce count)	5	5	0	0	0	5	5	0.00
Rakops (recce count)	1	1	0	0	0	1	1	0.00
CT District Subtotal	**304**	**53**	**55**	**136**	**45**	**169**	**440**	**0.01**
Ngamiland (NG) district								
Moremi GR NG 28	189	34	33	66	35	123	254	0.04
NG 7 & 8 West Okavango	80	7	39	78	97	3	158	0.02
NG 10 & 11	238	47	35	69	29	169	308	0.04
NG 12	91	17	18	38	41	53	129	0.09
NG 13	39	3	21	44	111	0	83	0.01
NG 14 Kwando (high density)	59	10	15	31	52	29	90	0.04
NG 14 Kwando (low density)	22	2	23	59	266	0	81	0.02
NG 15 Linyanti	106	20	22	47	44	59	154	0.09
NG 16 Selinda	97	19	20	40	41	57	137	0.07
NG 18 & 19 Khwai	36	7	14	29	80	7	64	0.02
NG 20 & 21 Splash	72	14	17	35	48	38	107	0.04
NG 22 Vumbra	15	3	13	29	189	0	44	0.02
NG 23 Duba Plains	10	2	6	14	130	0	24	0.02

Stratum	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density (animals km^{-2})
NG 24 Jedibe	5	1	5	10	195	0	16	0.01
NG 25 Jao	35	6	9	20	56	15	55	0.06
NG 26 Abu / EBS	73	13	15	32	43	42	105	0.04
NG 27 A & B & NG 30	21	3	11	23	105	0	44	0.02
NG 29	135	24	30	62	46	73	198	0.07
NG 31 & 17 Chitabe	30	6	11	25	82	5	55	0.11
NG 32 Stanleys	154	27	36	75	49	79	229	0.13
NG 33 & 34	85	15	21	46	54	39	130	0.09
NG 41 Mababe (high density)	86	12	15	37	43	49	124	0.15
NG 41 Mababe (low density)	43	3	28	73	169	0	115	0.04
NG 42 (high density)	41	7	14	30	74	11	71	0.04
NG 42 (low density)	55	3	25	57	103	0	112	0.03
NG 43 (high density)	80	6	15	47	58	33	127	0.12
NG 43 (low density)	16	1	15	35	223	0	51	0.01
NG 47 & 49	22	1	22	52	238	0	73	0.01
Nxai Pan NP (high density)	0	0	0	0	0	0	0	0.00
Nxai Pan NP (low density)	0	0	0	0	0	0	0	0.00
Maun East	51	3	28	61	120	0	111	0.02
Kwebe	50	2	30	83	166	0	133	0.06
Maun	47	9	16	33	71	13	80	0.04
Shorobe	0	0	0	0	0	0	0	0.00
Maun Southeast	0	0	0	0	0	0	0	0.00
Maun West	31	3	16	34	109	0	64	0.02
NG District Subtotal	**2,117**	**330**	**123**	**241**	**11**	**1,875**	**2,358**	**0.04**
TOTAL	**5,241**	**805**	**202**	**395**	**8**	**4,845**	**5,636**	**0.05**

Figure 21. Estimated density and observations for v. old elephant carcasses (cat. 4) on the 2018 dry-season aerial survey of northern Botswana.

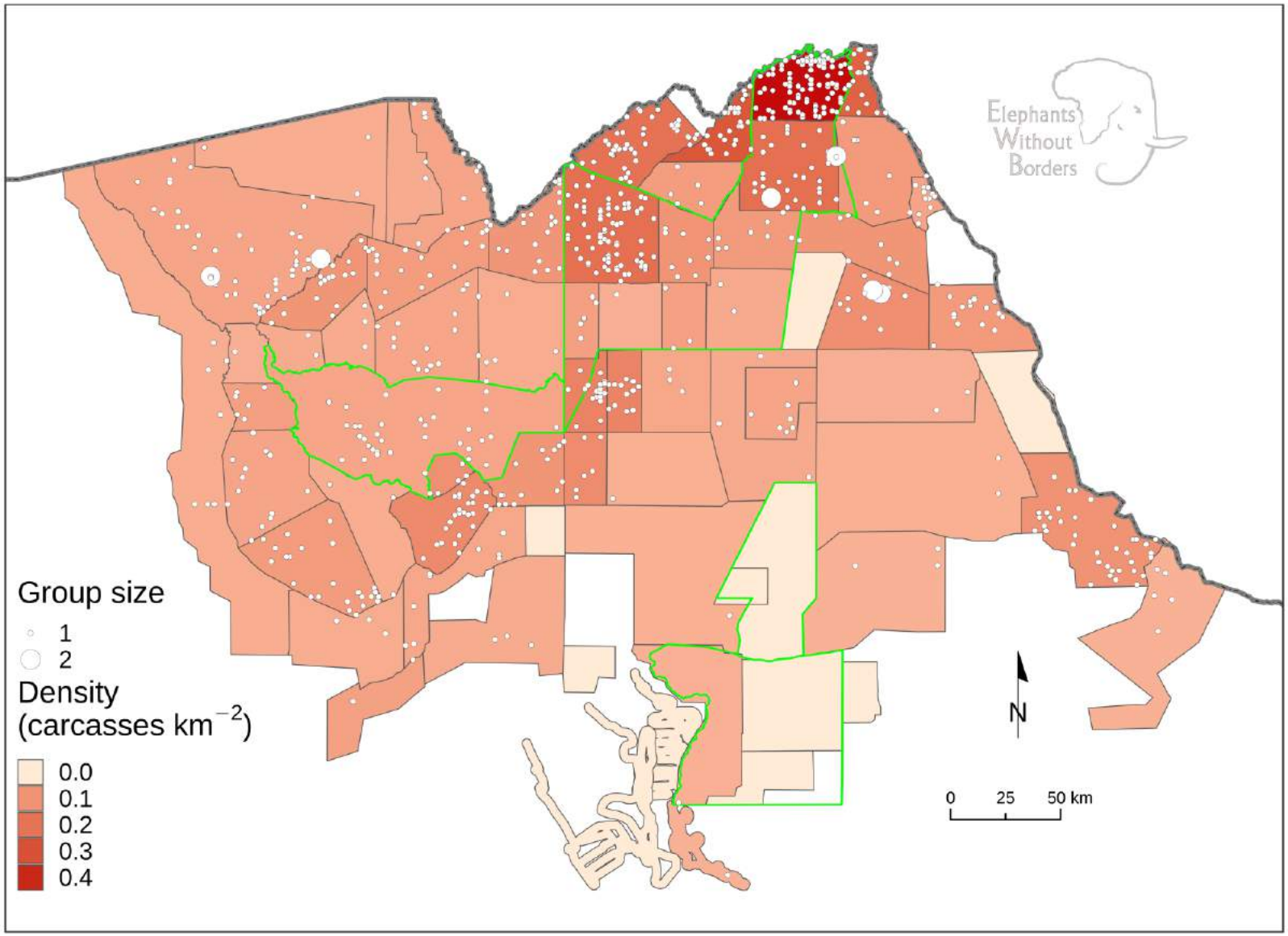


Table 22. Dry season population estimates for all elephant carcasses (category 1, 2, 3, and 4)

Stratum	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density (animals km^{-2})
Chobe (CH) district								
CH 1 Chobe Enclave	476	82	62	129	27	346	605	0.38
CH 2 Chobe FR (high density)	583	98	68	144	25	439	727	0.87
CH 2 Chobe FR (low density)	173	15	40	102	59	71	275	0.21
CH 4 Kasane FR	198	33	31	66	33	132	264	0.46
CH 5 N Plains	298	25	76	169	57	129	468	0.19
CH 7 & 8	456	34	115	253	55	203	709	0.34
CH 11	124	7	35	85	68	40	209	0.14
CH 12	335	28	68	148	44	187	482	0.23
Nogatsaa C	204	20	38	84	41	120	289	0.19
Chinamba (low density)	104	6	46	119	114	0	223	0.08
Chinamba (high density)	34	3	13	36	108	0	70	0.05
Chobe Mababe	145	27	37	84	58	61	228	0.21
Chobe River	1,129	212	102	212	19	917	1,341	0.94
Kazuma FR (total count)	41	41	0	0	0	41	41	0.16
Nogatsaa A and B	814	77	105	218	27	597	1,032	0.47
Savute East	213	25	34	79	37	133	292	0.26
Savute North	988	183	87	181	18	807	1,169	0.48
Savute South (high density)	81	15	17	41	50	40	122	0.15
Savute South (low density)	49	5	20	46	94	3	96	0.06
Sibuyu FR	127	24	22	45	36	82	172	0.11
CH District Subtotal	**6,572**	**960**	**269**	**531**	**8**	**6,041**	**7,103**	**0.32**
Central (CT) district								
CT 1 & 2 (high density)	79	7	25	60	76	19	139	0.03
CT 1 & 2 (low density)	114	5	90	208	183	0	322	0.02
CT 3	12	1	12	26	214	0	39	0.01
Ngwasha & Sepako	488	86	54	110	23	378	599	0.22
Mak. NP East	0	0	0	0	0	0	0	0.00
Mak. NP East (salt pans)	0	0	0	0	0	0	0	0.00
Mak. NP West	23	4	10	20	88	3	42	0.01
CT 4 & 7 (recce count)	10	10	0	0	0	10	10	0.00
Boteti River (recce count)	0	0	0	0	0	0	0	0.00
Gweta (total count)	0	0	0	0	0	0	0	0.00
Hainaveld (recce count)	0	0	0	0	0	0	0	0.00
Nata (recce count)	15	15	0	0	0	15	15	0.01
Rakops (recce count)	2	2	0	0	0	2	2	0.00
CT District Subtotal	**743**	**130**	**109**	**255**	**34**	**488**	**997**	**0.03**
Ngamiland (NG) district								
Moremi GR NG 28	189	34	33	66	35	123	254	0.04
NG 7 & 8 West Okavango	195	17	65	130	66	66	325	0.04
NG 10 & 11	639	126	61	123	19	517	762	0.11
NG 12	220	41	33	68	31	152	288	0.22
NG 13	184	14	36	76	41	108	259	0.06
NG 14 Kwando (high density)	107	18	22	44	42	62	151	0.08
NG 14 Kwando (low density)	55	5	32	83	151	0	139	0.06
NG 15 Linyanti	261	49	65	136	52	125	397	0.22
NG 16 Selinda	113	22	23	47	42	65	160	0.08
NG 18 & 19 Khwai	223	44	27	56	25	167	280	0.12
NG 20 & 21 Splash	88	17	21	43	49	44	131	0.05
NG 22 Vumbra	15	3	13	29	189	0	44	0.02
NG 23 Duba Plains	10	2	6	14	130	0	24	0.02

Stratum	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density (animals km^{-2})
NG 24 Jedibe	5	1	5	10	195	0	16	0.01
NG 25 Jao	53	9	10	22	41	31	74	0.09
NG 26 Abu / EBS	73	13	15	32	43	42	105	0.04
NG 27 A & B & NG 30	29	4	12	25	88	3	54	0.02
NG 29	152	27	31	64	42	88	217	0.08
NG 31 & 17 Chitabe	35	7	11	24	69	11	59	0.12
NG 32 Stanleys	177	31	37	77	44	100	254	0.15
NG 33 & 34	96	17	24	51	53	45	147	0.10
NG 41 Mababe (high density)	94	13	16	41	44	53	135	0.16
NG 41 Mababe (low density)	43	3	28	73	169	0	115	0.04
NG 42 (high density)	58	10	19	42	71	17	100	0.06
NG 42 (low density)	55	3	25	57	103	0	112	0.03
NG 43 (high density)	80	6	15	47	58	33	127	0.12
NG 43 (low density)	16	1	15	35	223	0	51	0.01
NG 47 & 49	43	2	30	72	165	0	115	0.01
Nxai Pan NP (high density)	11	2	7	16	144	0	27	0.03
Nxai Pan NP (low density)	23	2	22	45	195	0	69	0.01
Maun East	68	4	32	68	101	0	136	0.03
Kwebe	75	3	51	140	188	0	215	0.08
Maun	140	27	32	65	47	75	205	0.11
Shorobe	0	0	0	0	0	0	0	0.00
Maun Southeast	11	1	10	26	240	0	37	0.02
Maun West	93	9	33	71	77	22	164	0.06
NG District Subtotal	**3,729**	**587**	**180**	**353**	**9**	**3,376**	**4,082**	**0.06**
TOTAL	**11,044**	**1,677**	**341**	**670**	**6**	**10,374**	**11,713**	**0.11**

Figure 22. Estimated density and observations for all elephant carcasses (cat. 1, 2, 3, & 4) on the 2018 dry-season aerial survey of N. Botswana.

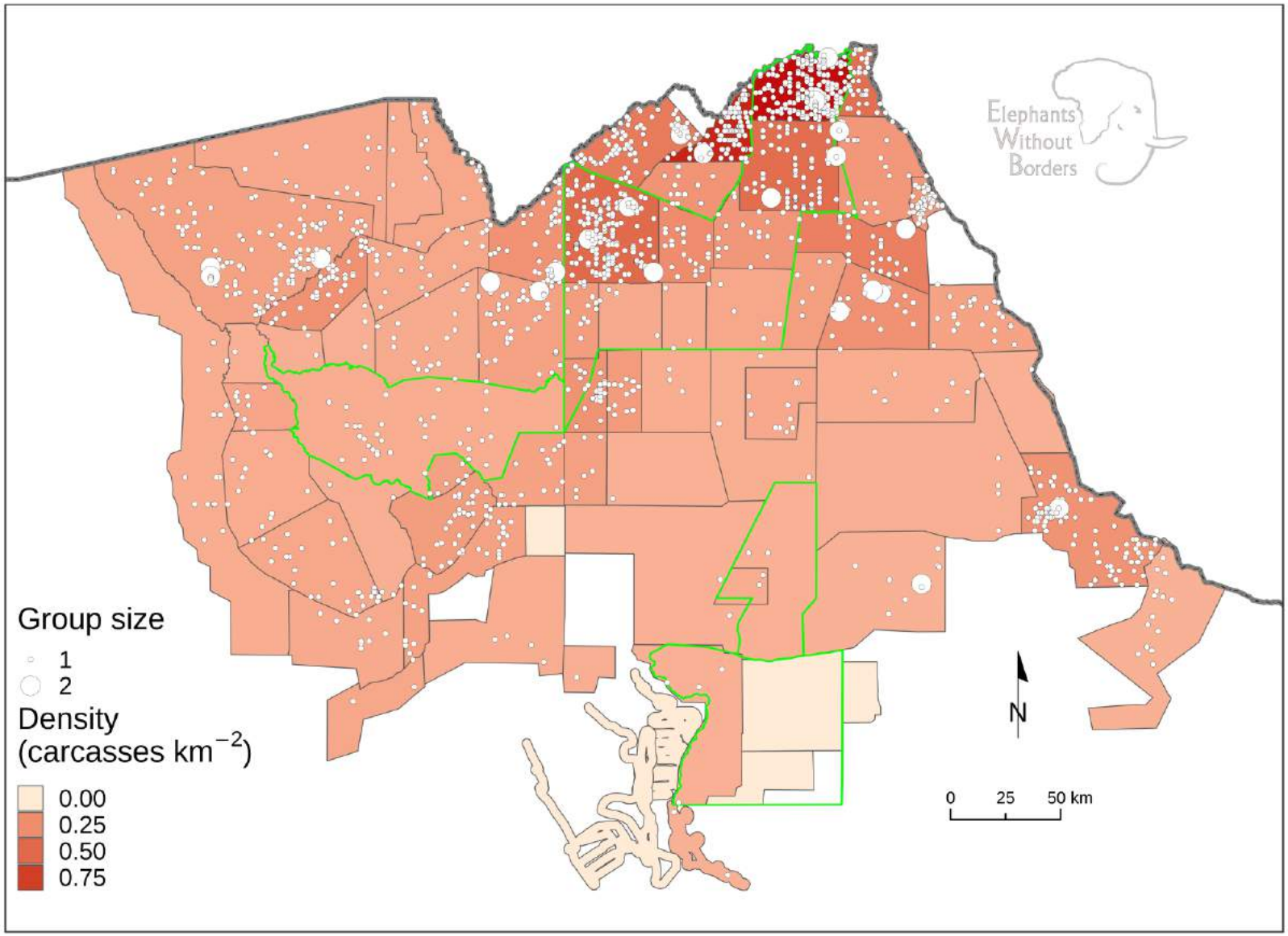


Table 23. Dry season population estimates for buffalo

Stratum	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density (animals km^{-2})
Chobe (CH) district								
CH 1 Chobe Enclave	790	790	0	0	0	790	790	0.63
CH 2 Chobe FR (high density)	319	319	0	0	0	319	319	0.48
CH 2 Chobe FR (low density)	0	0	0	0	0	0	0	0.00
CH 4 Kasane FR	0	0	0	0	0	0	0	0.00
CH 5 N Plains	105	105	0	0	0	105	105	0.07
CH 7 & 8	95	95	0	0	0	95	95	0.07
CH 11	0	0	0	0	0	0	0	0.00
CH 12	5	5	0	0	0	5	5	0.00
Nogatsaa C	48	48	0	0	0	48	48	0.05
Chinamba (low density)	0	0	0	0	0	0	0	0.00
Chinamba (high density)	2	2	0	0	0	2	2	0.00
Chobe Mababe	870	870	0	0	0	870	870	1.29
Chobe River	938	938	0	0	0	938	938	0.78
Kazuma FR (total count)	0	0	0	0	0	0	0	0.00
Nogatsaa A and B	66	66	0	0	0	66	66	0.04
Savute East	138	138	0	0	0	138	138	0.17
Savute North	61	61	0	0	0	61	61	0.03
Savute South (high density)	0	0	0	0	0	0	0	0.00
Savute South (low density)	4	4	0	0	0	4	4	0.00
Sibuyu FR	4	4	0	0	0	4	4	0.00
CH District Subtotal	**3,445**	**3,445**	**0**	**0**	**0**	**3,445**	**3,445**	**0.17**
Central (CT) district								
CT 1 & 2 (high density)	0	0	0	0	0	0	0	0.00
CT 1 & 2 (low density)	0	0	0	0	0	0	0	0.00
CT 3	0	0	0	0	0	0	0	0.00
Ngwasha & Sepako	252	252	0	0	0	252	252	0.11
Mak. NP East	0	0	0	0	0	0	0	0.00
Mak. NP East (salt pans)	0	0	0	0	0	0	0	0.00
Mak. NP West	0	0	0	0	0	0	0	0.00
CT 4 & 7 (recce count)	0	0	0	0	0	0	0	0.00
Boteti River (recce count)	0	0	0	0	0	0	0	0.00
Gweta (total count)	0	0	0	0	0	0	0	0.00
Hainaveld (recce count)	0	0	0	0	0	0	0	0.00
Nata (recce count)	0	0	0	0	0	0	0	0.00
Rakops (recce count)	0	0	0	0	0	0	0	0.00
CT District Subtotal	**252**	**252**	**0**	**0**	**0**	**252**	**252**	**0.01**
Ngamiland (NG) district								
Moremi GR NG 28	4,028	4,028	0	0	0	4,028	4,028	0.82
NG 7 & 8 West Okavango	0	0	0	0	0	0	0	0.00
NG 10 & 11	0	0	0	0	0	0	0	0.00
NG 12	134	134	0	0	0	134	134	0.14
NG 13	3	3	0	0	0	3	3	0.00
NG 14 Kwando (high density)	53	53	0	0	0	53	53	0.04
NG 14 Kwando (low density)	724	724	0	0	0	724	724	0.72
NG 15 Linyanti	47	47	0	0	0	47	47	0.04
NG 16 Selinda	327	327	0	0	0	327	327	0.23
NG 18 & 19 Khwai	320	320	0	0	0	320	320	0.17
NG 20 & 21 Splash	116	116	0	0	0	116	116	0.06
NG 22 Vumbra	425	425	0	0	0	425	425	0.67
NG 23 Duba Plains	267	267	0	0	0	267	267	0.56

Stratum	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density (animals km^{-2})
NG 24 Jedibe	0	0	0	0	0	0	0	0.00
NG 25 Jao	73	73	0	0	0	73	73	0.12
NG 26 Abu / EBS	3,509	3,509	0	0	0	3,509	3,509	2.02
NG 27 A & B & NG 30	2,539	2,539	0	0	0	2,539	2,539	1.86
NG 29	4,149	4,149	0	0	0	4,149	4,149	2.24
NG 31 & 17 Chitabe	172	172	0	0	0	172	172	0.61
NG 32 Stanleys	4,357	4,357	0	0	0	4,357	4,357	3.59
NG 33 & 34	37	37	0	0	0	37	37	0.04
NG 41 Mababe (high density)	3,498	3,498	0	0	0	3,498	3,498	5.92
NG 41 Mababe (low density)	0	0	0	0	0	0	0	0.00
NG 42 (high density)	10	10	0	0	0	10	10	0.01
NG 42 (low density)	0	0	0	0	0	0	0	0.00
NG 43 (high density)	0	0	0	0	0	0	0	0.00
NG 43 (low density)	0	0	0	0	0	0	0	0.00
NG 47 & 49	0	0	0	0	0	0	0	0.00
Nxai Pan NP (high density)	0	0	0	0	0	0	0	0.00
Nxai Pan NP (low density)	0	0	0	0	0	0	0	0.00
Maun East	0	0	0	0	0	0	0	0.00
Kwebe	0	0	0	0	0	0	0	0.00
Maun	49	49	0	0	0	49	49	0.04
Shorobe	0	0	0	0	0	0	0	0.00
Maun Southeast	0	0	0	0	0	0	0	0.00
Maun West	0	0	0	0	0	0	0	0.00
NG District Subtotal	**24,837**	**24,837**	**0**	**0**	**0**	**24,837**	**24,837**	**0.43**
TOTAL	**28,534**	**28,534**	**0**	**0**	**0**	**28,534**	**28,534**	**0.28**

Figure 23. Estimated density and observations for buffalo on the 2018 dry-season aerial survey of northern Botswana.

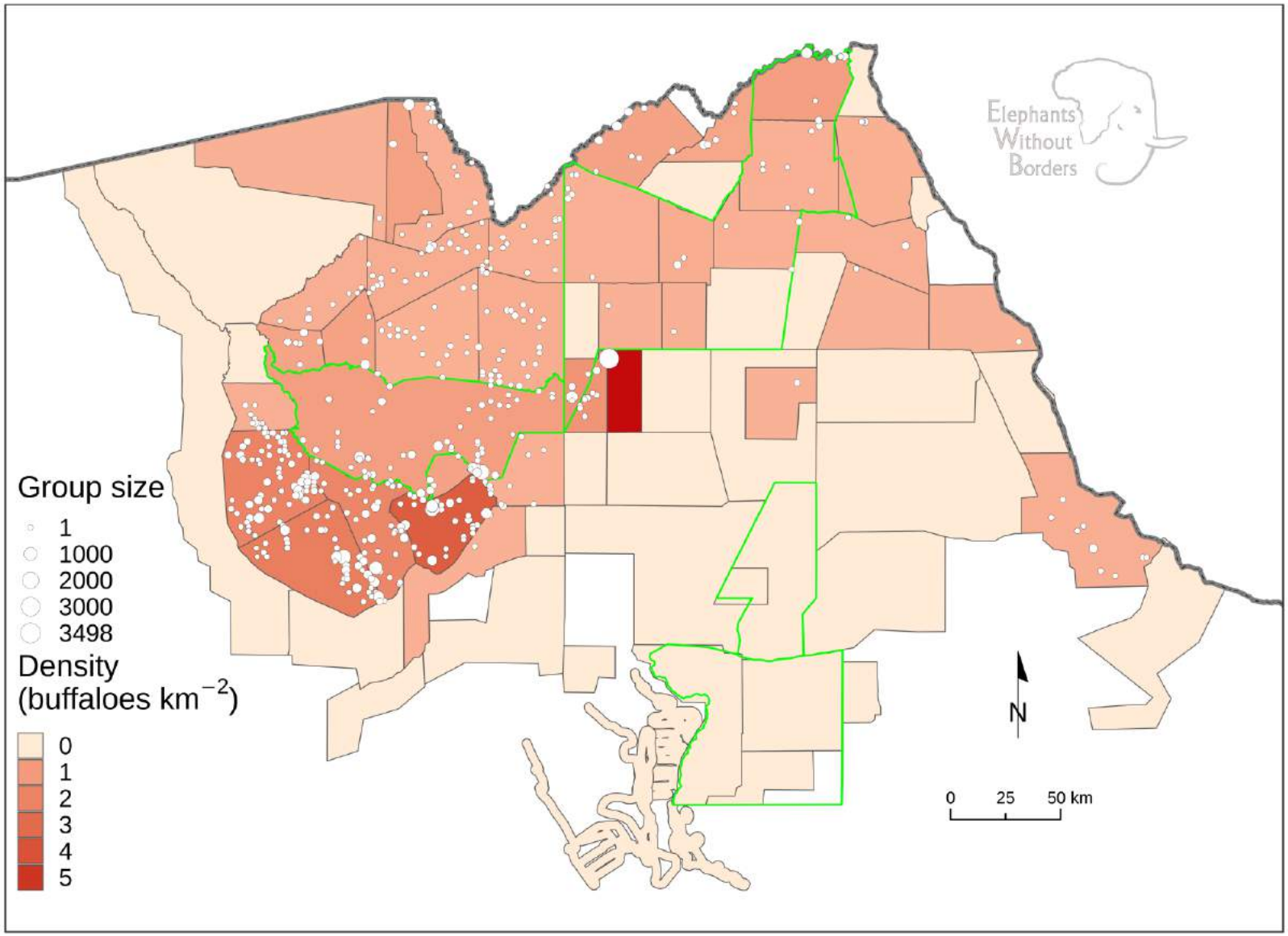


Table 24. Dry season population estimates for duiker

Stratum	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density (animals km^{-2})
Chobe (CH) district								
CH 1 Chobe Enclave	0	0	0	0	0	0	0	0.00
CH 2 Chobe FR (high density)	0	0	0	0	0	0	0	0.00
CH 2 Chobe FR (low density)	0	0	0	0	0	0	0	0.00
CH 4 Kasane FR	0	0	0	0	0	0	0	0.00
CH 5 N Plains	0	0	0	0	0	0	0	0.00
CH 7 & 8	0	0	0	0	0	0	0	0.00
CH 11	0	0	0	0	0	0	0	0.00
CH 12	12	1	11	25	209	0	37	0.01
Nogatsaa C	0	0	0	0	0	0	0	0.00
Chinamba (low density)	17	1	17	43	248	0	60	0.01
Chinamba (high density)	0	0	0	0	0	0	0	0.00
Chobe Mababe	0	0	0	0	0	0	0	0.00
Chobe River	0	0	0	0	0	0	0	0.00
Kazuma FR (total count)	0	0	0	0	0	0	0	0.00
Nogatsaa A and B	0	0	0	0	0	0	0	0.00
Savute East	0	0	0	0	0	0	0	0.00
Savute North	5	1	5	10	186	0	15	0.00
Savute South (high density)	0	0	0	0	0	0	0	0.00
Savute South (low density)	0	0	0	0	0	0	0	0.00
Sibuyu FR	5	1	5	10	184	0	15	0.00
CH District Subtotal	**40**	**4**	**21**	**51**	**129**	**4**	**91**	**0.00**
Central (CT) district								
CT 1 & 2 (high density)	23	2	14	34	149	0	56	0.01
CT 1 & 2 (low density)	46	2	44	101	221	0	146	0.01
CT 3	0	0	0	0	0	0	0	0.00
Ngwasha & Sepako	0	0	0	0	0	0	0	0.00
Mak. NP East	0	0	0	0	0	0	0	0.00
Mak. NP East (salt pans)	0	0	0	0	0	0	0	0.00
Mak. NP West	0	0	0	0	0	0	0	0.00
CT 4 & 7 (recce count)	0	0	0	0	0	0	0	0.00
Boteti River (recce count)	0	0	0	0	0	0	0	0.00
Gweta (total count)	0	0	0	0	0	0	0	0.00
Hainaveld (recce count)	0	0	0	0	0	0	0	0.00
Nata (recce count)	0	0	0	0	0	0	0	0.00
Rakops (recce count)	0	0	0	0	0	0	0	0.00
CT District Subtotal	**68**	**4**	**46**	**392**	**575**	**4**	**460**	**0.00**
Ngamiland (NG) district								
Moremi GR NG 28	0	0	0	0	0	0	0	0.00
NG 7 & 8 West Okavango	11	1	11	22	191	0	33	0.00
NG 10 & 11	30	6	15	31	101	0	61	0.01
NG 12	0	0	0	0	0	0	0	0.00
NG 13	26	2	17	36	139	0	63	0.01
NG 14 Kwando (high density)	12	2	11	22	187	0	34	0.01
NG 14 Kwando (low density)	0	0	0	0	0	0	0	0.00
NG 15 Linyanti	0	0	0	0	0	0	0	0.00
NG 16 Selinda	0	0	0	0	0	0	0	0.00
NG 18 & 19 Khwai	0	0	0	0	0	0	0	0.00
NG 20 & 21 Splash	5	1	5	9	184	0	15	0.00
NG 22 Vumbra	0	0	0	0	0	0	0	0.00
NG 23 Duba Plains	0	0	0	0	0	0	0	0.00

Stratum	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density (animals km^{-2})
NG 24 Jedibe	0	0	0	0	0	0	0	0.00
NG 25 Jao	0	0	0	0	0	0	0	0.00
NG 26 Abu / EBS	0	0	0	0	0	0	0	0.00
NG 27 A & B & NG 30	0	0	0	0	0	0	0	0.00
NG 29	6	1	5	10	183	0	16	0.00
NG 31 & 17 Chitabe	0	0	0	0	0	0	0	0.00
NG 32 Stanleys	0	0	0	0	0	0	0	0.00
NG 33 & 34	0	0	0	0	0	0	0	0.00
NG 41 Mababe (high density)	0	0	0	0	0	0	0	0.00
NG 41 Mababe (low density)	0	0	0	0	0	0	0	0.00
NG 42 (high density)	47	8	20	43	93	3	90	0.05
NG 42 (low density)	0	0	0	0	0	0	0	0.00
NG 43 (high density)	0	0	0	0	0	0	0	0.00
NG 43 (low density)	0	0	0	0	0	0	0	0.00
NG 47 & 49	0	0	0	0	0	0	0	0.00
Nxai Pan NP (high density)	0	0	0	0	0	0	0	0.00
Nxai Pan NP (low density)	35	3	17	36	104	0	71	0.02
Maun East	17	1	17	35	209	0	52	0.01
Kwebe	0	0	0	0	0	0	0	0.00
Maun	5	1	5	9	179	0	14	0.00
Shorobe	0	0	0	0	0	0	0	0.00
Maun Southeast	0	0	0	0	0	0	0	0.00
Maun West	0	0	0	0	0	0	0	0.00
NG District Subtotal	**194**	**26**	**43**	**86**	**44**	**109**	**280**	**0.00**
TOTAL	**303**	**34**	**66**	**132**	**44**	**170**	**435**	**0.00**

Figure 24. Estimated density and observations for duiker on the 2018 dry-season aerial survey of northern Botswana.

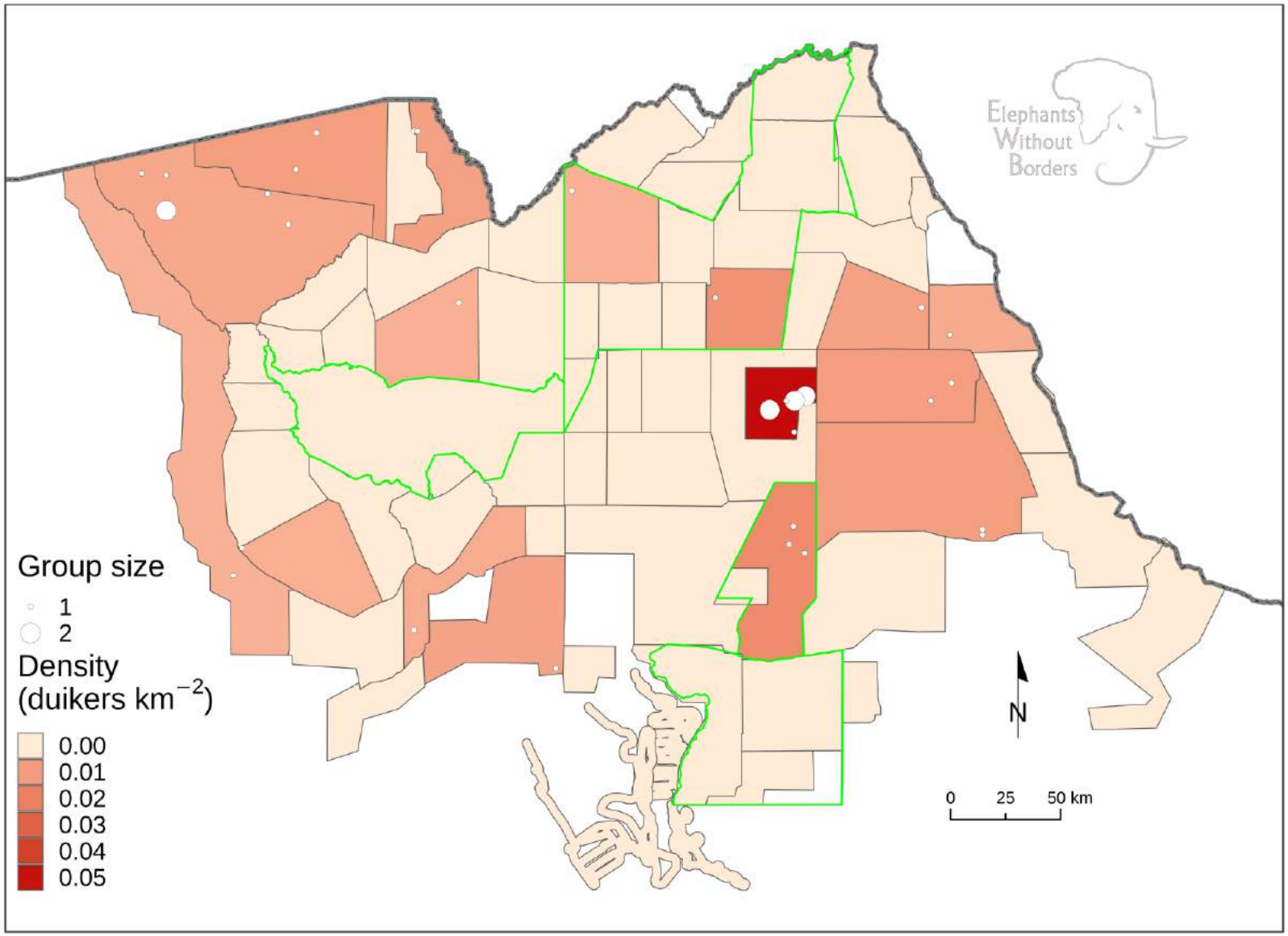


Table 25. Dry season population estimates for eland

Stratum	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density (animals km^{-2})
Chobe (CH) district								
CH 1 Chobe Enclave	215	37	184	380	177	0	594	0.17
CH 2 Chobe FR (high density)	18	3	17	36	200	0	54	0.03
CH 2 Chobe FR (low density)	0	0	0	0	0	0	0	0.00
CH 4 Kasane FR	0	0	0	0	0	0	0	0.00
CH 5 N Plains	36	3	24	55	152	0	90	0.02
CH 7 & 8	295	22	278	613	208	0	908	0.22
CH 11	302	17	287	701	232	0	1,003	0.34
CH 12	0	0	0	0	0	0	0	0.00
Nogatsaa C	163	16	150	333	204	0	497	0.15
Chinamba (low density)	17	1	17	43	249	0	61	0.01
Chinamba (high density)	0	0	0	0	0	0	0	0.00
Chobe Mababe	0	0	0	0	0	0	0	0.00
Chobe River	16	3	11	22	138	0	38	0.01
Kazuma FR (total count)	11	11	0	0	0	11	11	0.04
Nogatsaa A and B	42	4	40	83	197	0	126	0.02
Savute East	102	12	56	133	130	0	235	0.13
Savute North	130	24	69	144	111	0	274	0.06
Savute South (high density)	49	9	31	73	150	0	121	0.09
Savute South (low density)	0	0	0	0	0	0	0	0.00
Sibuyu FR	53	10	38	79	150	0	132	0.04
CH District Subtotal	**1,448**	**172**	**478**	**965**	**67**	**484**	**2,413**	**0.07**
Central (CT) district								
CT 1 & 2 (high density)	0	0	0	0	0	0	0	0.00
CT 1 & 2 (low density)	46	2	47	108	237	0	153	0.01
CT 3	0	0	0	0	0	0	0	0.00
Ngwasha & Sepako	11	2	10	21	185	0	32	0.01
Mak. NP East	0	0	0	0	0	0	0	0.00
Mak. NP East (salt pans)	0	0	0	0	0	0	0	0.00
Mak. NP West	0	0	0	0	0	0	0	0.00
CT 4 & 7 (recce count)	0	0	0	0	0	0	0	0.00
Boteti River (recce count)	0	0	0	0	0	0	0	0.00
Gweta (total count)	0	0	0	0	0	0	0	0.00
Hainaveld (recce count)	0	0	0	0	0	0	0	0.00
Nata (recce count)	0	0	0	0	0	0	0	0.00
Rakops (recce count)	0	0	0	0	0	0	0	0.00
CT District Subtotal	**57**	**4**	**48**	**496**	**871**	**4**	**553**	**0.00**
Ngamiland (NG) district								
Moremi GR NG 28	0	0	0	0	0	0	0	0.00
NG 7 & 8 West Okavango	0	0	0	0	0	0	0	0.00
NG 10 & 11	0	0	0	0	0	0	0	0.00
NG 12	5	1	5	10	186	0	15	0.01
NG 13	13	1	13	27	202	0	40	0.00
NG 14 Kwando (high density)	0	0	0	0	0	0	0	0.00
NG 14 Kwando (low density)	55	5	50	129	233	0	184	0.06
NG 15 Linyanti	0	0	0	0	0	0	0	0.00
NG 16 Selinda	72	14	48	99	138	0	170	0.05
NG 18 & 19 Khwai	25	5	13	27	107	0	52	0.01
NG 20 & 21 Splash	62	12	29	59	95	3	121	0.03
NG 22 Vumbra	0	0	0	0	0	0	0	0.00
NG 23 Duba Plains	0	0	0	0	0	0	0	0.00

Stratum	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density (animals km^{-2})
NG 24 Jedibe	0	0	0	0	0	0	0	0.00
NG 25 Jao	0	0	0	0	0	0	0	0.00
NG 26 Abu / EBS	0	0	0	0	0	0	0	0.00
NG 27 A & B & NG 30	0	0	0	0	0	0	0	0.00
NG 29	0	0	0	0	0	0	0	0.00
NG 31 & 17 Chitabe	0	0	0	0	0	0	0	0.00
NG 32 Stanleys	0	0	0	0	0	0	0	0.00
NG 33 & 34	322	57	240	511	159	0	833	0.35
NG 41 Mababe (high density)	0	0	0	0	0	0	0	0.00
NG 41 Mababe (low density)	0	0	0	0	0	0	0	0.00
NG 42 (high density)	12	2	11	23	196	0	34	0.01
NG 42 (low density)	0	0	0	0	0	0	0	0.00
NG 43 (high density)	27	2	26	82	306	0	109	0.04
NG 43 (low density)	0	0	0	0	0	0	0	0.00
NG 47 & 49	0	0	0	0	0	0	0	0.00
Nxai Pan NP (high density)	0	0	0	0	0	0	0	0.00
Nxai Pan NP (low density)	0	0	0	0	0	0	0	0.00
Maun East	0	0	0	0	0	0	0	0.00
Kwebe	0	0	0	0	0	0	0	0.00
Maun	0	0	0	0	0	0	0	0.00
Shorobe	0	0	0	0	0	0	0	0.00
Maun Southeast	0	0	0	0	0	0	0	0.00
Maun West	0	0	0	0	0	0	0	0.00
NG District Subtotal	**593**	**99**	**253**	**565**	**95**	**99**	**1,158**	**0.01**
TOTAL	**2,098**	**275**	**544**	**1,077**	**51**	**1,021**	**3,175**	**0.02**

Figure 25. Estimated density and observations for eland on the 2018 dry-season aerial survey of northern Botswana.

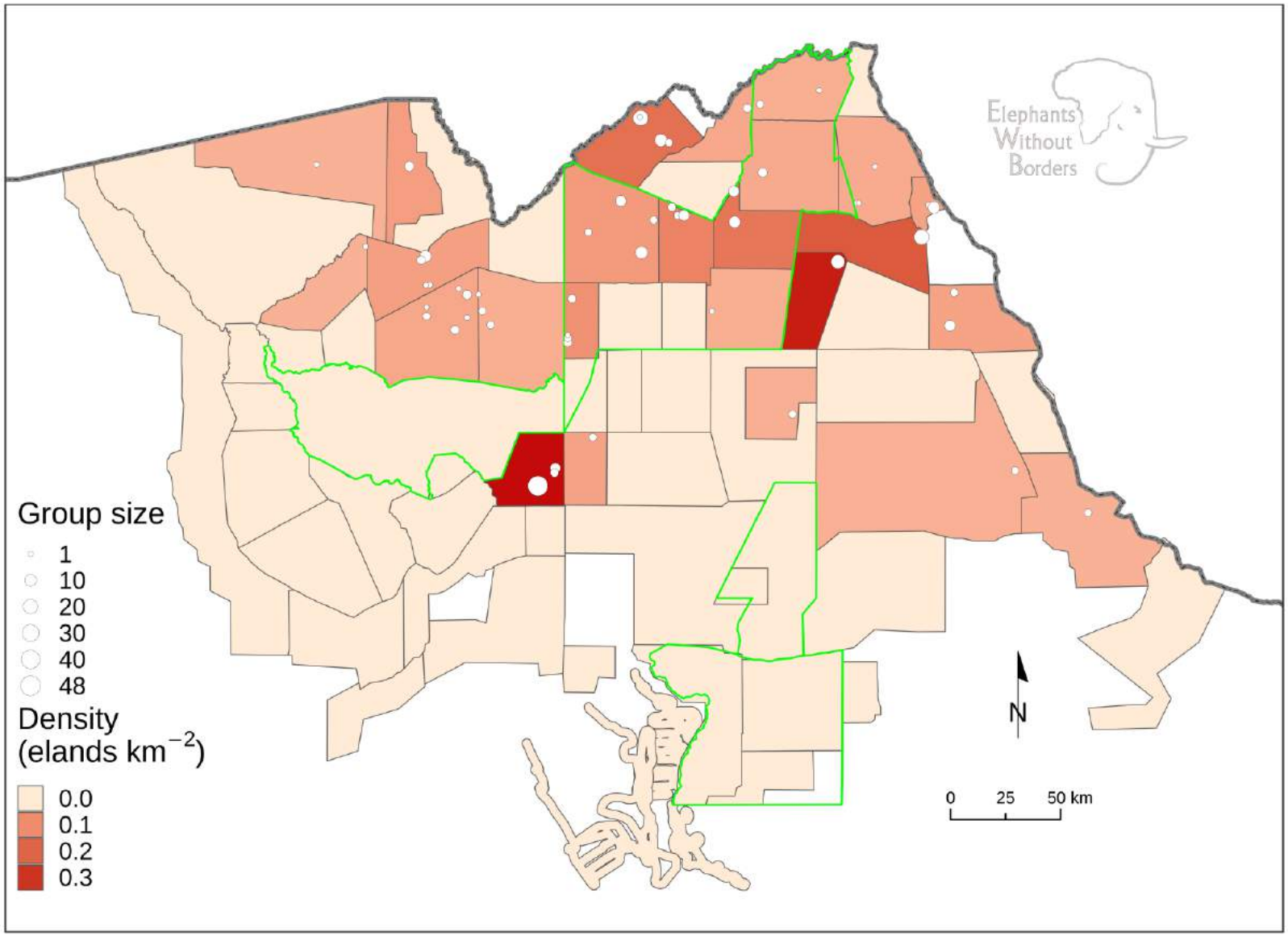


Table 26. Dry season population estimates for gemsbok

Stratum	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density (animals km^{-2})
Chobe (CH) district								
CH 1 Chobe Enclave	0	0	0	0	0	0	0	0.00
CH 2 Chobe FR (high density)	0	0	0	0	0	0	0	0.00
CH 2 Chobe FR (low density)	0	0	0	0	0	0	0	0.00
CH 4 Kasane FR	0	0	0	0	0	0	0	0.00
CH 5 N Plains	24	2	22	50	209	0	74	0.01
CH 7 & 8	0	0	0	0	0	0	0	0.00
CH 11	0	0	0	0	0	0	0	0.00
CH 12	0	0	0	0	0	0	0	0.00
Nogatsaa C	0	0	0	0	0	0	0	0.00
Chinamba (low density)	0	0	0	0	0	0	0	0.00
Chinamba (high density)	0	0	0	0	0	0	0	0.00
Chobe Mababe	0	0	0	0	0	0	0	0.00
Chobe River	0	0	0	0	0	0	0	0.00
Kazuma FR (total count)	0	0	0	0	0	0	0	0.00
Nogatsaa A and B	0	0	0	0	0	0	0	0.00
Savute East	0	0	0	0	0	0	0	0.00
Savute North	0	0	0	0	0	0	0	0.00
Savute South (high density)	11	2	10	23	213	0	34	0.02
Savute South (low density)	59	6	56	133	224	0	192	0.07
Sibuyu FR	0	0	0	0	0	0	0	0.00
CH District Subtotal	**94**	**10**	**61**	**205**	**219**	**10**	**299**	**0.00**
Central (CT) district								
CT 1 & 2 (high density)	0	0	0	0	0	0	0	0.00
CT 1 & 2 (low density)	0	0	0	0	0	0	0	0.00
CT 3	0	0	0	0	0	0	0	0.00
Ngwasha & Sepako	68	12	33	68	99	0	136	0.03
Mak. NP East	1,810	146	649	1,467	81	342	3,277	0.92
Mak. NP East (salt pans)	0	0	0	0	0	0	0	0.00
Mak. NP West	992	176	211	429	43	563	1,421	0.48
CT 4 & 7 (recce count)	3	3	0	0	0	3	3	0.00
Boteti River (recce count)	0	0	0	0	0	0	0	0.00
Gweta (total count)	0	0	0	0	0	0	0	0.00
Hainaveld (recce count)	0	0	0	0	0	0	0	0.00
Nata (recce count)	0	0	0	0	0	0	0	0.00
Rakops (recce count)	0	0	0	0	0	0	0	0.00
CT District Subtotal	**2,873**	**337**	**683**	**2,491**	**87**	**382**	**5,364**	**0.12**
Ngamiland (NG) district								
Moremi GR NG 28	0	0	0	0	0	0	0	0.00
NG 7 & 8 West Okavango	0	0	0	0	0	0	0	0.00
NG 10 & 11	0	0	0	0	0	0	0	0.00
NG 12	0	0	0	0	0	0	0	0.00
NG 13	0	0	0	0	0	0	0	0.00
NG 14 Kwando (high density)	0	0	0	0	0	0	0	0.00
NG 14 Kwando (low density)	0	0	0	0	0	0	0	0.00
NG 15 Linyanti	0	0	0	0	0	0	0	0.00
NG 16 Selinda	0	0	0	0	0	0	0	0.00
NG 18 & 19 Khwai	0	0	0	0	0	0	0	0.00
NG 20 & 21 Splash	0	0	0	0	0	0	0	0.00
NG 22 Vumbra	0	0	0	0	0	0	0	0.00
NG 23 Duba Plains	0	0	0	0	0	0	0	0.00

Stratum	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density (animals km^{-2})
NG 24 Jedibe	0	0	0	0	0	0	0	0.00
NG 25 Jao	0	0	0	0	0	0	0	0.00
NG 26 Abu / EBS	0	0	0	0	0	0	0	0.00
NG 27 A & B & NG 30	0	0	0	0	0	0	0	0.00
NG 29	6	1	5	10	184	0	16	0.00
NG 31 & 17 Chitabe	0	0	0	0	0	0	0	0.00
NG 32 Stanleys	0	0	0	0	0	0	0	0.00
NG 33 & 34	0	0	0	0	0	0	0	0.00
NG 41 Mababe (high density)	0	0	0	0	0	0	0	0.00
NG 41 Mababe (low density)	0	0	0	0	0	0	0	0.00
NG 42 (high density)	0	0	0	0	0	0	0	0.00
NG 42 (low density)	0	0	0	0	0	0	0	0.00
NG 43 (high density)	40	3	25	78	196	0	118	0.06
NG 43 (low density)	0	0	0	0	0	0	0	0.00
NG 47 & 49	239	11	217	514	215	0	753	0.06
Nxai Pan NP (high density)	39	7	25	60	152	0	99	0.12
Nxai Pan NP (low density)	12	1	11	23	198	0	35	0.01
Maun East	0	0	0	0	0	0	0	0.00
Kwebe	0	0	0	0	0	0	0	0.00
Maun	0	0	0	0	0	0	0	0.00
Shorobe	0	0	0	0	0	0	0	0.00
Maun Southeast	0	0	0	0	0	0	0	0.00
Maun West	0	0	0	0	0	0	0	0.00
NG District Subtotal	**335**	**23**	**221**	**599**	**179**	**23**	**934**	**0.01**
TOTAL	**3,302**	**370**	**720**	**1,537**	**47**	**1,766**	**4,839**	**0.03**

Figure 26. Estimated density and observations for gemsbok on the 2018 dry-season aerial survey of northern Botswana.

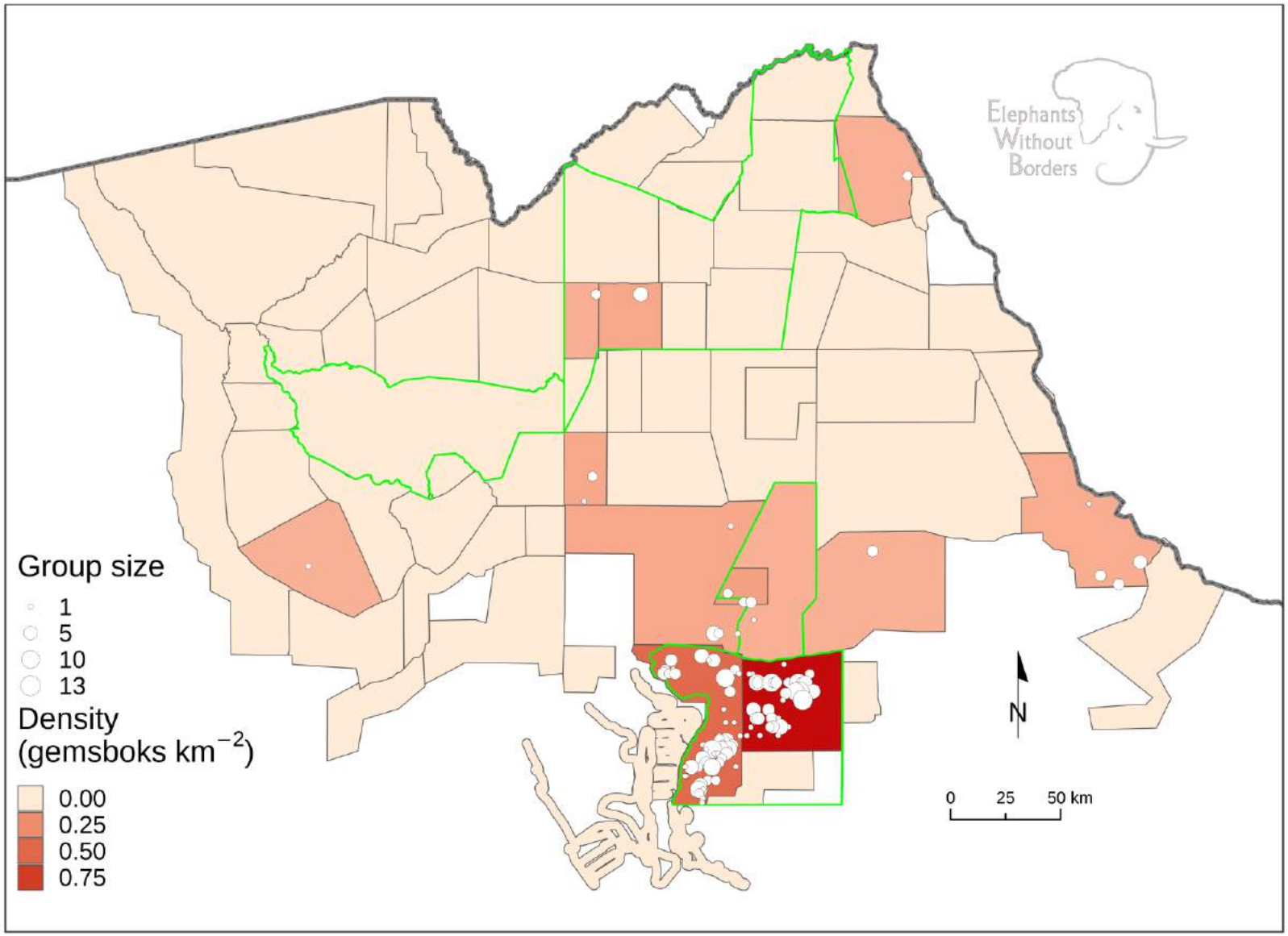


Table 27. Dry season population estimates for giraffe

Stratum	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density (animals km^{-2})
Chobe (CH) district								
CH 1 Chobe Enclave	197	34	54	111	57	86	309	0.16
CH 2 Chobe FR (high density)	24	4	12	24	103	0	48	0.04
CH 2 Chobe FR (low density)	0	0	0	0	0	0	0	0.00
CH 4 Kasane FR	66	11	21	45	69	21	111	0.15
CH 5 N Plains	83	7	46	103	123	0	186	0.05
CH 7 & 8	13	1	13	29	216	0	42	0.01
CH 11	35	2	34	82	232	0	118	0.04
CH 12	48	4	27	58	122	0	106	0.03
Nogatsaa C	10	1	10	22	212	0	32	0.01
Chinamba (low density)	52	3	51	131	251	0	183	0.04
Chinamba (high density)	0	0	0	0	0	0	0	0.00
Chobe Mababe	327	61	217	492	150	0	819	0.49
Chobe River	117	22	54	111	95	6	228	0.10
Kazuma FR (total count)	15	15	0	0	0	15	15	0.06
Nogatsaa A and B	180	17	87	181	101	0	361	0.10
Savute East	34	4	17	41	121	0	75	0.04
Savute North	178	33	48	100	56	79	278	0.09
Savute South (high density)	113	21	44	104	92	9	218	0.21
Savute South (low density)	40	4	20	47	120	0	87	0.05
Sibuyu FR	5	1	5	10	187	0	15	0.00
CH District Subtotal	**1,539**	**245**	**270**	**548**	**36**	**991**	**2,086**	**0.07**
Central (CT) district								
CT 1 & 2 (high density)	294	26	161	380	129	0	673	0.12
CT 1 & 2 (low density)	68	3	68	156	229	0	225	0.01
CT 3	74	6	40	90	122	0	163	0.06
Ngwasha & Sepako	244	43	67	137	56	107	381	0.11
Mak. NP East	25	2	16	35	143	0	60	0.01
Mak. NP East (salt pans)	0	0	0	0	0	0	0	0.00
Mak. NP West	468	83	104	211	45	257	679	0.22
CT 4 & 7 (recce count)	0	0	0	0	0	0	0	0.00
Boteti River (recce count)	0	0	0	0	0	0	0	0.00
Gweta (total count)	0	0	0	0	0	0	0	0.00
Hainaveld (recce count)	0	0	0	0	0	0	0	0.00
Nata (recce count)	0	0	0	0	0	0	0	0.00
Rakops (recce count)	0	0	0	0	0	0	0	0.00
CT District Subtotal	**1,172**	**163**	**218**	**468**	**40**	**704**	**1,641**	**0.05**
Ngamiland (NG) district								
Moremi GR NG 28	1,121	202	169	338	30	783	1,459	0.23
NG 7 & 8 West Okavango	0	0	0	0	0	0	0	0.00
NG 10 & 11	0	0	0	0	0	0	0	0.00
NG 12	21	4	13	28	128	0	49	0.02
NG 13	0	0	0	0	0	0	0	0.00
NG 14 Kwando (high density)	172	29	75	153	89	19	324	0.12
NG 14 Kwando (low density)	33	3	23	59	177	0	92	0.03
NG 15 Linyanti	165	31	67	141	85	24	306	0.14
NG 16 Selinda	138	27	43	88	64	50	226	0.10
NG 18 & 19 Khwai	168	33	66	137	82	30	305	0.09
NG 20 & 21 Splash	274	53	85	176	64	98	449	0.15
NG 22 Vumbra	61	12	27	59	97	2	119	0.10
NG 23 Duba Plains	16	3	10	21	137	0	37	0.03

Stratum	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density (animals km^{-2})
NG 24 Jedibe	0	0	0	0	0	0	0	0.00
NG 25 Jao	12	2	11	24	207	0	36	0.02
NG 26 Abu / EBS	892	158	191	393	44	498	1,285	0.51
NG 27 A & B & NG 30	286	40	125	258	90	28	544	0.21
NG 29	288	51	77	159	55	129	447	0.16
NG 31 & 17 Chitabe	151	30	45	101	67	50	251	0.53
NG 32 Stanleys	502	88	93	192	38	310	694	0.41
NG 33 & 34	361	64	101	215	59	146	576	0.40
NG 41 Mababe (high density)	22	3	14	35	163	0	57	0.04
NG 41 Mababe (low density)	14	1	14	35	248	0	50	0.01
NG 42 (high density)	35	6	22	46	132	0	81	0.04
NG 42 (low density)	92	5	65	146	159	0	237	0.04
NG 43 (high density)	147	11	25	78	53	69	225	0.23
NG 43 (low density)	0	0	0	0	0	0	0	0.00
NG 47 & 49	434	20	268	634	146	0	1,068	0.12
Nxai Pan NP (high density)	22	4	20	47	210	0	70	0.07
Nxai Pan NP (low density)	197	17	116	243	123	0	440	0.09
Maun East	0	0	0	0	0	0	0	0.00
Kwebe	0	0	0	0	0	0	0	0.00
Maun	10	2	6	13	127	0	24	0.01
Shorobe	0	0	0	0	0	0	0	0.00
Maun Southeast	0	0	0	0	0	0	0	0.00
Maun West	0	0	0	0	0	0	0	0.00
NG District Subtotal	**5,633**	**899**	**474**	**935**	**17**	**4,697**	**6,568**	**0.10**
TOTAL	**8,343**	**1,307**	**587**	**1,154**	**14**	**7,190**	**9,497**	**0.08**

Figure 27. Estimated density and observations for giraffe on the 2018 dry-season aerial survey of northern Botswana.

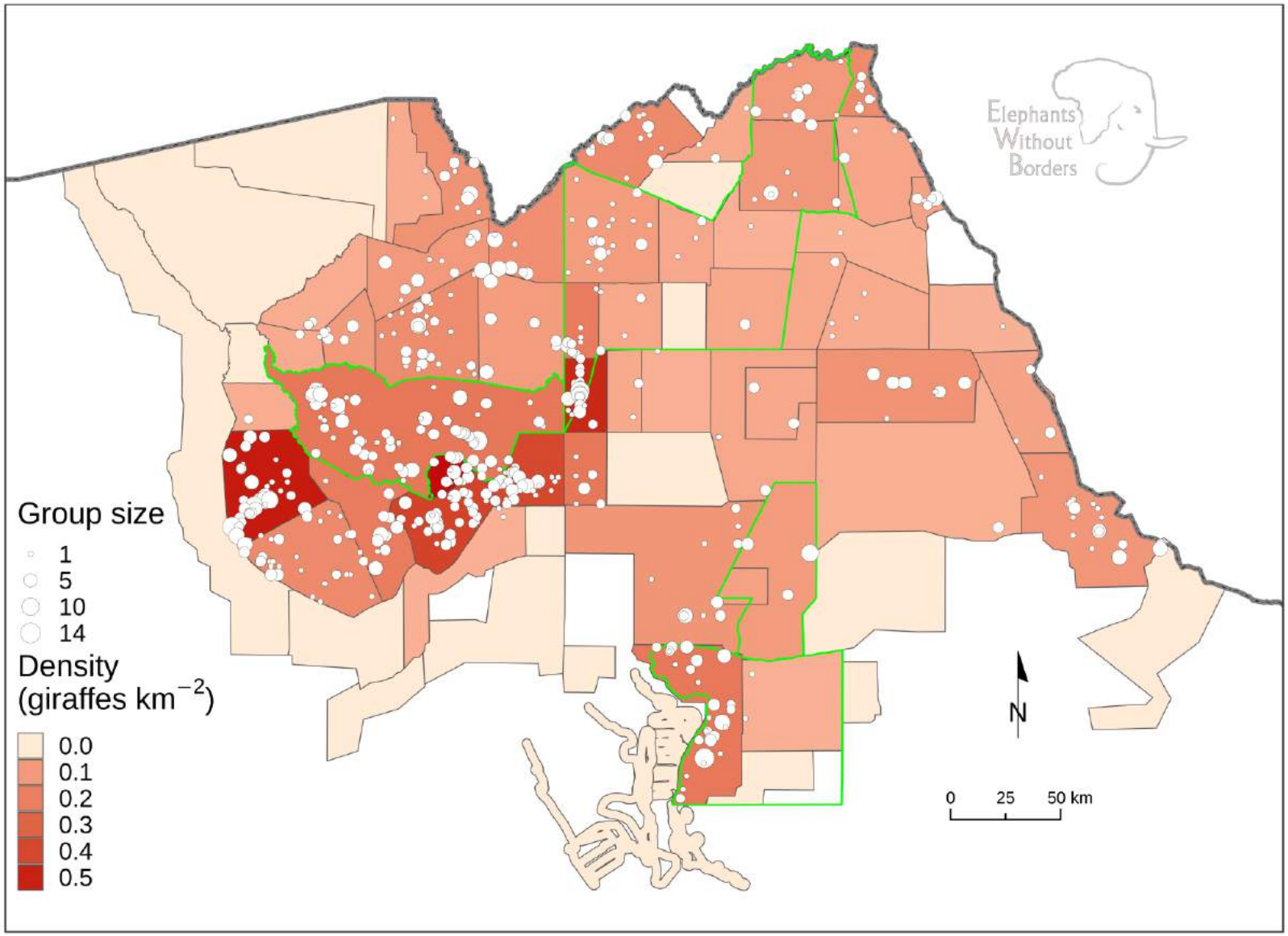


Table 28. Dry season population estimates for hippo

Stratum	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density (animals km^{-2})
Chobe (CH) district								
CH 1 Chobe Enclave	0	0	0	0	0	0	0	0.00
CH 2 Chobe FR (high density)	178	30	153	324	181	0	502	0.27
CH 2 Chobe FR (low density)	0	0	0	0	0	0	0	0.00
CH 4 Kasane FR	0	0	0	0	0	0	0	0.00
CH 5 N Plains	0	0	0	0	0	0	0	0.00
CH 7 & 8	0	0	0	0	0	0	0	0.00
CH 11	0	0	0	0	0	0	0	0.00
CH 12	0	0	0	0	0	0	0	0.00
Nogatsaa C	0	0	0	0	0	0	0	0.00
Chinamba (low density)	0	0	0	0	0	0	0	0.00
Chinamba (high density)	0	0	0	0	0	0	0	0.00
Chobe Mababe	230	43	138	311	135	0	541	0.34
Chobe River	197	37	105	218	111	0	415	0.16
Kazuma FR (total count)	0	0	0	0	0	0	0	0.00
Nogatsaa A and B	0	0	0	0	0	0	0	0.00
Savute East	17	2	16	38	223	0	55	0.02
Savute North	16	3	15	30	186	0	46	0.01
Savute South (high density)	0	0	0	0	0	0	0	0.00
Savute South (low density)	0	0	0	0	0	0	0	0.00
Sibuyu FR	0	0	0	0	0	0	0	0.00
CH District Subtotal	**639**	**115**	**232**	**509**	**80**	**130**	**1,148**	**0.03**
Central (CT) district								
CT 1 & 2 (high density)	0	0	0	0	0	0	0	0.00
CT 1 & 2 (low density)	0	0	0	0	0	0	0	0.00
CT 3	0	0	0	0	0	0	0	0.00
Ngwasha & Sepako	11	2	10	21	185	0	32	0.01
Mak. NP East	0	0	0	0	0	0	0	0.00
Mak. NP East (salt pans)	0	0	0	0	0	0	0	0.00
Mak. NP West	6	1	5	10	185	0	16	0.00
CT 4 & 7 (recce count)	0	0	0	0	0	0	0	0.00
Boteti River (recce count)	0	0	0	0	0	0	0	0.00
Gweta (total count)	0	0	0	0	0	0	0	0.00
Hainaveld (recce count)	0	0	0	0	0	0	0	0.00
Nata (recce count)	0	0	0	0	0	0	0	0.00
Rakops (recce count)	0	0	0	0	0	0	0	0.00
CT District Subtotal	**17**	**3**	**11**	**71**	**417**	**3**	**88**	**0.00**
Ngamiland (NG) district								
Moremi GR NG 28	3,136	565	386	770	25	2,366	3,906	0.64
NG 7 & 8 West Okavango	494	43	366	735	149	0	1,229	0.09
NG 10 & 11	2,035	401	387	772	38	1,263	2,806	0.36
NG 12	692	129	275	569	82	123	1,260	0.70
NG 13	0	0	0	0	0	0	0	0.00
NG 14 Kwando (high density)	805	136	174	355	44	450	1,160	0.57
NG 14 Kwando (low density)	0	0	0	0	0	0	0	0.00
NG 15 Linyanti	117	22	39	82	70	36	199	0.10
NG 16 Selinda	220	43	119	243	110	0	463	0.16
NG 18 & 19 Khwai	234	46	97	203	87	31	437	0.12
NG 20 & 21 Splash	485	94	110	227	47	259	712	0.27
NG 22 Vumbra	288	57	81	176	61	112	464	0.45
NG 23 Duba Plains	759	145	194	412	54	346	1,171	1.59

Stratum	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density (animals km^{-2})
NG 24 Jedibe	623	118	136	295	47	328	918	1.34
NG 25 Jao	579	99	247	559	96	21	1,138	0.96
NG 26 Abu / EBS	384	68	112	231	60	153	614	0.22
NG 27 A & B & NG 30	357	50	99	204	57	153	562	0.26
NG 29	107	19	49	101	95	6	209	0.06
NG 31 & 17 Chitabe	126	25	49	109	87	17	234	0.44
NG 32 Stanleys	342	60	78	161	47	181	504	0.28
NG 33 & 34	17	3	11	23	139	0	40	0.02
NG 41 Mababe (high density)	0	0	0	0	0	0	0	0.00
NG 41 Mababe (low density)	0	0	0	0	0	0	0	0.00
NG 42 (high density)	0	0	0	0	0	0	0	0.00
NG 42 (low density)	0	0	0	0	0	0	0	0.00
NG 43 (high density)	0	0	0	0	0	0	0	0.00
NG 43 (low density)	0	0	0	0	0	0	0	0.00
NG 47 & 49	0	0	0	0	0	0	0	0.00
Nxai Pan NP (high density)	0	0	0	0	0	0	0	0.00
Nxai Pan NP (low density)	0	0	0	0	0	0	0	0.00
Maun East	0	0	0	0	0	0	0	0.00
Kwebe	548	22	485	1,346	245	0	1,894	0.61
Maun	228	44	98	201	88	27	430	0.18
Shorobe	0	0	0	0	0	0	0	0.00
Maun Southeast	0	0	0	0	0	0	0	0.00
Maun West	0	0	0	0	0	0	0	0.00
NG District Subtotal	**12,576**	**2,189**	**988**	**1,954**	**16**	**10,622**	**14,530**	**0.22**
TOTAL	**13,232**	**2,307**	**1,015**	**2,001**	**15**	**11,231**	**15,233**	**0.13**

Figure 28. Estimated density and observations for hippo on the 2018 dry-season aerial survey of northern Botswana.

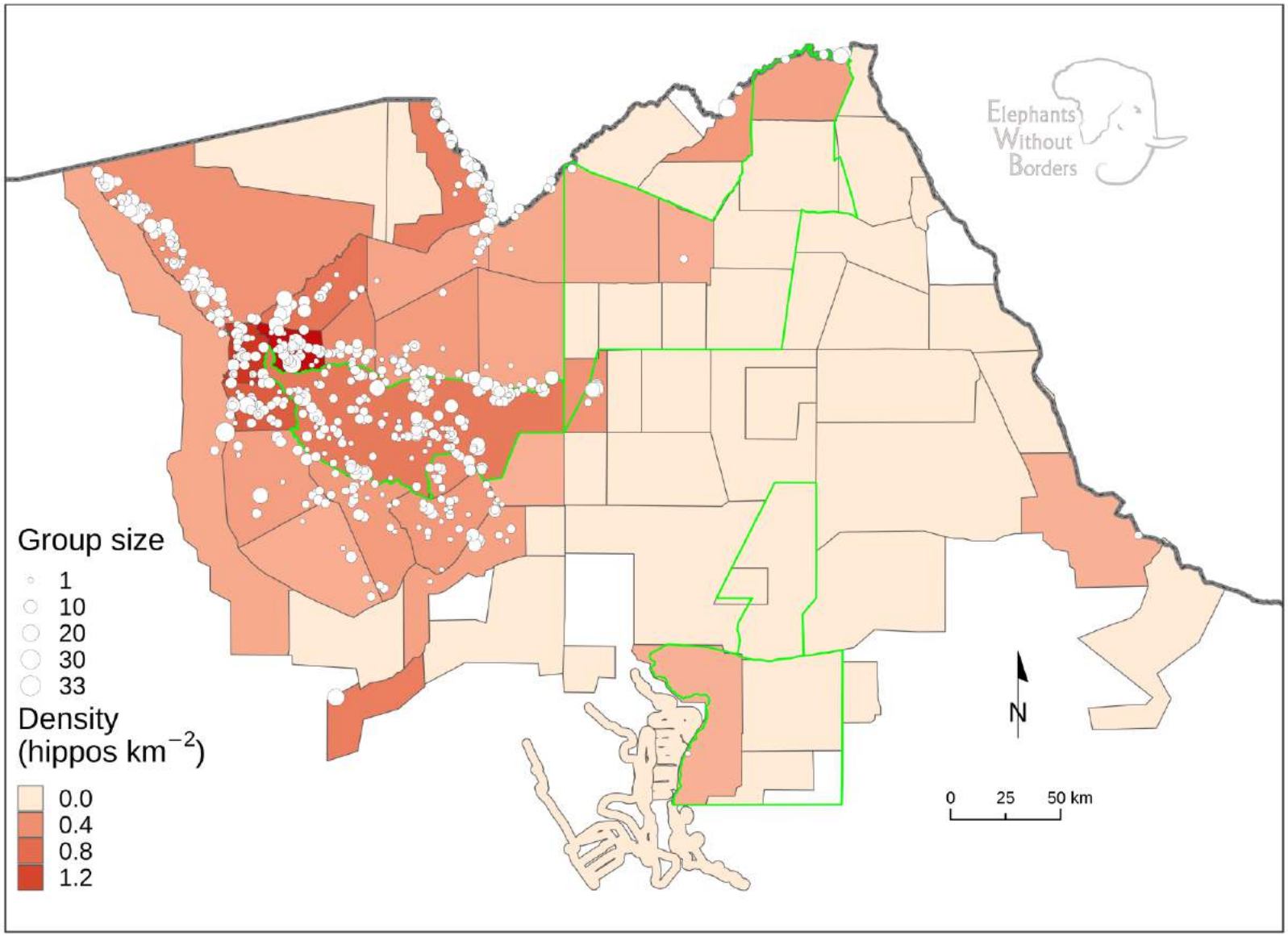


Table 29. Dry season population estimates for impala

Stratum	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density (animals km^{-2})
Chobe (CH) district								
CH 1 Chobe Enclave	197	34	93	193	98	4	390	0.16
CH 2 Chobe FR (high density)	59	10	57	120	203	0	180	0.09
CH 2 Chobe FR (low density)	0	0	0	0	0	0	0	0.00
CH 4 Kasane FR	138	23	74	160	116	0	298	0.32
CH 5 N Plains	95	8	92	205	215	0	301	0.06
CH 7 & 8	0	0	0	0	0	0	0	0.00
CH 11	0	0	0	0	0	0	0	0.00
CH 12	60	5	57	125	209	0	185	0.04
Nogatsaa C	72	7	67	149	209	0	221	0.07
Chinamba (low density)	0	0	0	0	0	0	0	0.00
Chinamba (high density)	0	0	0	0	0	0	0	0.00
Chobe Mababe	1,543	288	560	1,268	82	275	2,811	2.29
Chobe River	2,455	461	615	1,276	52	1,179	3,731	2.04
Kazuma FR (total count)	5	5	0	0	0	5	5	0.02
Nogatsaa A and B	116	11	110	229	197	0	346	0.07
Savute East	60	7	56	132	221	0	191	0.07
Savute North	507	94	198	411	81	96	919	0.25
Savute South (high density)	345	64	130	306	89	39	651	0.64
Savute South (low density)	553	56	261	618	112	0	1,171	0.63
Sibuyu FR	69	13	52	108	156	0	176	0.06
CH District Subtotal	**6,275**	**1,086**	**932**	**1,884**	**30**	**4,391**	**8,159**	**0.30**
Central (CT) district								
CT 1 & 2 (high density)	282	25	178	421	149	0	703	0.12
CT 1 & 2 (low density)	114	5	109	252	221	0	366	0.02
CT 3	0	0	0	0	0	0	0	0.00
Ngwasha & Sepako	216	38	116	237	110	0	453	0.10
Mak. NP East	0	0	0	0	0	0	0	0.00
Mak. NP East (salt pans)	0	0	0	0	0	0	0	0.00
Mak. NP West	68	12	52	105	155	0	173	0.03
CT 4 & 7 (recce count)	0	0	0	0	0	0	0	0.00
Boteti River (recce count)	0	0	0	0	0	0	0	0.00
Gweta (total count)	4	4	0	0	0	4	4	0.01
Hainaveld (recce count)	0	0	0	0	0	0	0	0.00
Nata (recce count)	0	0	0	0	0	0	0	0.00
Rakops (recce count)	0	0	0	0	0	0	0	0.00
CT District Subtotal	**684**	**84**	**244**	**563**	**82**	**121**	**1,246**	**0.03**
Ngamiland (NG) district								
Moremi GR NG 28	27,638	4,980	2,687	5,364	19	22,274	33,001	5.63
NG 7 & 8 West Okavango	735	64	310	622	85	114	1,357	0.14
NG 10 & 11	0	0	0	0	0	0	0	0.00
NG 12	434	81	202	418	96	16	852	0.44
NG 13	0	0	0	0	0	0	0	0.00
NG 14 Kwando (high density)	2,481	419	586	1,193	48	1,288	3,674	1.75
NG 14 Kwando (low density)	0	0	0	0	0	0	0	0.00
NG 15 Linyanti	1,581	297	428	903	57	677	2,484	1.34
NG 16 Selinda	614	120	234	478	78	136	1,093	0.44
NG 18 & 19 Khwai	630	124	194	405	64	224	1,035	0.33
NG 20 & 21 Splash	1,806	350	486	1,003	56	803	2,810	0.99
NG 22 Vumbra	566	112	161	351	62	215	917	0.89
NG 23 Duba Plains	335	64	189	402	120	0	737	0.70

Stratum	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density (animals km^{-2})
NG 24 Jedibe	0	0	0	0	0	0	0	0.00
NG 25 Jao	375	64	176	399	106	0	773	0.62
NG 26 Abu / EBS	6,653	1,179	970	1,997	30	4,656	8,650	3.83
NG 27 A & B & NG 30	10,452	1,462	1,470	3,034	29	7,419	13,486	7.67
NG 29	5,294	938	730	1,504	28	3,790	6,797	2.85
NG 31 & 17 Chitabe	1,903	379	403	898	47	1,005	2,801	6.74
NG 32 Stanleys	6,820	1,196	1,324	2,738	40	4,082	9,558	5.61
NG 33 & 34	1,705	302	449	956	56	749	2,661	1.86
NG 41 Mababe (high density)	58	8	53	137	238	0	195	0.10
NG 41 Mababe (low density)	0	0	0	0	0	0	0	0.00
NG 42 (high density)	0	0	0	0	0	0	0	0.00
NG 42 (low density)	0	0	0	0	0	0	0	0.00
NG 43 (high density)	67	5	64	204	305	0	271	0.10
NG 43 (low density)	0	0	0	0	0	0	0	0.00
NG 47 & 49	0	0	0	0	0	0	0	0.00
Nxai Pan NP (high density)	0	0	0	0	0	0	0	0.00
Nxai Pan NP (low density)	23	2	22	47	201	0	70	0.01
Maun East	0	0	0	0	0	0	0	0.00
Kwebe	0	0	0	0	0	0	0	0.00
Maun	0	0	0	0	0	0	0	0.00
Shorobe	0	0	0	0	0	0	0	0.00
Maun Southeast	0	0	0	0	0	0	0	0.00
Maun West	567	55	314	677	120	0	1,244	0.35
NG District Subtotal	**70,735**	**12,201**	**3,763**	**7,514**	**11**	**63,221**	**78,250**	**1.21**
TOTAL	**77,694**	**13,371**	**3,884**	**7,679**	**10**	**70,015**	**85,374**	**0.75**

Figure 29. Estimated density and observations for impala on the 2018 dry-season aerial survey of northern Botswana.

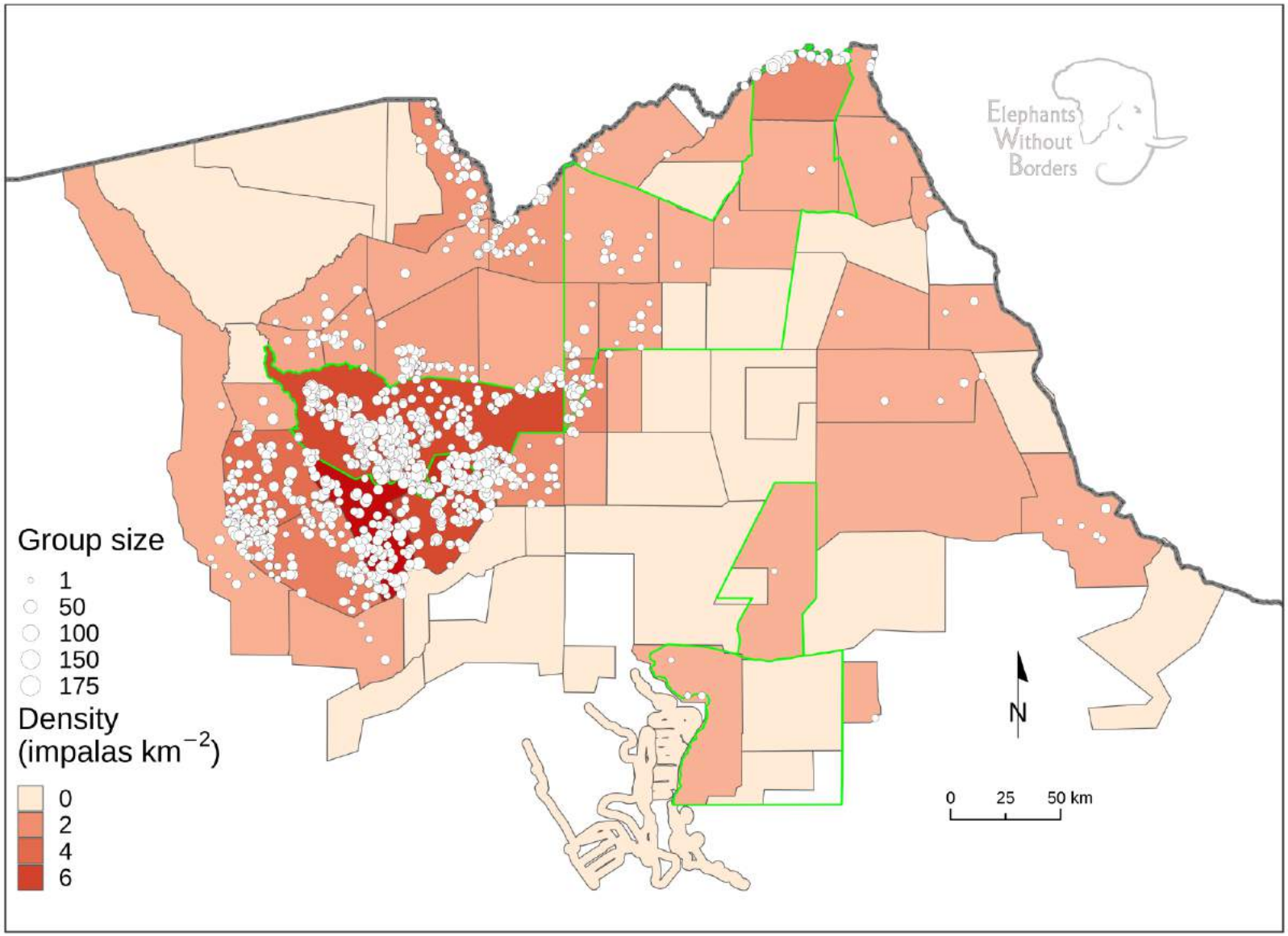


Table 30. Dry season population estimates for kudu

Stratum	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density (animals km^{-2})
Chobe (CH) district								
CH 1 Chobe Enclave	29	5	18	38	131	0	67	0.02
CH 2 Chobe FR (high density)	30	5	25	54	181	0	84	0.04
CH 2 Chobe FR (low density)	0	0	0	0	0	0	0	0.00
CH 4 Kasane FR	24	4	22	47	197	0	71	0.06
CH 5 N Plains	0	0	0	0	0	0	0	0.00
CH 7 & 8	0	0	0	0	0	0	0	0.00
CH 11	0	0	0	0	0	0	0	0.00
CH 12	0	0	0	0	0	0	0	0.00
Nogatsaa C	0	0	0	0	0	0	0	0.00
Chinamba (low density)	0	0	0	0	0	0	0	0.00
Chinamba (high density)	0	0	0	0	0	0	0	0.00
Chobe Mababe	96	18	50	113	117	0	210	0.14
Chobe River	101	19	44	91	90	10	192	0.08
Kazuma FR (total count)	7	7	0	0	0	7	7	0.03
Nogatsaa A and B	42	4	41	85	200	0	127	0.02
Savute East	0	0	0	0	0	0	0	0.00
Savute North	38	7	19	40	106	0	78	0.02
Savute South (high density)	49	9	44	104	214	0	152	0.09
Savute South (low density)	20	2	19	44	224	0	64	0.02
Sibuyu FR	58	11	38	79	136	0	137	0.05
CH District Subtotal	**494**	**91**	**108**	**216**	**44**	**278**	**710**	**0.02**
Central (CT) district								
CT 1 & 2 (high density)	147	13	93	219	149	0	366	0.06
CT 1 & 2 (low density)	68	3	48	111	162	0	179	0.01
CT 3	0	0	0	0	0	0	0	0.00
Ngwasha & Sepako	51	9	23	47	92	4	98	0.02
Mak. NP East	25	2	24	53	216	0	78	0.01
Mak. NP East (salt pans)	0	0	0	0	0	0	0	0.00
Mak. NP West	659	117	113	230	35	429	890	0.32
CT 4 & 7 (recce count)	17	17	0	0	0	17	17	0.01
Boteti River (recce count)	6	6	0	0	0	6	6	0.01
Gweta (total count)	8	8	0	0	0	8	8	0.02
Hainaveld (recce count)	0	0	0	0	0	0	0	0.00
Nata (recce count)	2	2	0	0	0	2	2	0.00
Rakops (recce count)	0	0	0	0	0	0	0	0.00
CT District Subtotal	**984**	**177**	**158**	**351**	**36**	**633**	**1,334**	**0.04**
Ngamiland (NG) district								
Moremi GR NG 28	855	154	161	322	38	533	1,176	0.17
NG 7 & 8 West Okavango	735	64	236	473	64	262	1,209	0.14
NG 10 & 11	0	0	0	0	0	0	0	0.00
NG 12	161	30	65	135	84	25	296	0.16
NG 13	13	1	12	26	201	0	39	0.00
NG 14 Kwando (high density)	213	36	82	167	78	46	380	0.15
NG 14 Kwando (low density)	122	11	59	153	126	0	274	0.12
NG 15 Linyanti	64	12	37	79	123	0	143	0.05
NG 16 Selinda	72	14	41	84	117	0	155	0.05
NG 18 & 19 Khwai	51	10	27	56	111	0	107	0.03
NG 20 & 21 Splash	201	39	47	98	48	104	299	0.11
NG 22 Vumbra	71	14	46	100	141	0	170	0.11
NG 23 Duba Plains	47	9	33	71	150	0	118	0.10

Stratum	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density (animals km^{-2})
NG 24 Jedibe	0	0	0	0	0	0	0	0.00
NG 25 Jao	6	1	5	12	207	0	18	0.01
NG 26 Abu / EBS	1,196	212	147	303	25	894	1,499	0.69
NG 27 A & B & NG 30	207	29	100	206	99	1	413	0.15
NG 29	463	82	108	222	48	241	685	0.25
NG 31 & 17 Chitabe	35	7	20	45	129	0	80	0.12
NG 32 Stanleys	342	60	111	230	67	112	572	0.28
NG 33 & 34	51	9	20	43	85	8	94	0.06
NG 41 Mababe (high density)	43	6	40	103	238	0	146	0.07
NG 41 Mababe (low density)	0	0	0	0	0	0	0	0.00
NG 42 (high density)	0	0	0	0	0	0	0	0.00
NG 42 (low density)	0	0	0	0	0	0	0	0.00
NG 43 (high density)	0	0	0	0	0	0	0	0.00
NG 43 (low density)	0	0	0	0	0	0	0	0.00
NG 47 & 49	217	10	194	460	212	0	677	0.06
Nxai Pan NP (high density)	11	2	10	24	213	0	35	0.03
Nxai Pan NP (low density)	0	0	0	0	0	0	0	0.00
Maun East	287	17	117	249	87	38	537	0.12
Kwebe	25	1	23	64	258	0	89	0.03
Maun	218	42	55	113	52	105	331	0.17
Shorobe	0	0	0	0	0	0	0	0.00
Maun Southeast	22	2	15	38	175	0	59	0.05
Maun West	268	26	126	273	102	0	541	0.16
NG District Subtotal	**5,996**	**900**	**485**	**955**	**16**	**5,041**	**6,951**	**0.10**
TOTAL	**7,473**	**1,168**	**521**	**1,024**	**14**	**6,449**	**8,497**	**0.07**

Figure 30. Estimated density and observations for kudu on the 2018 dry-season aerial survey of northern Botswana.

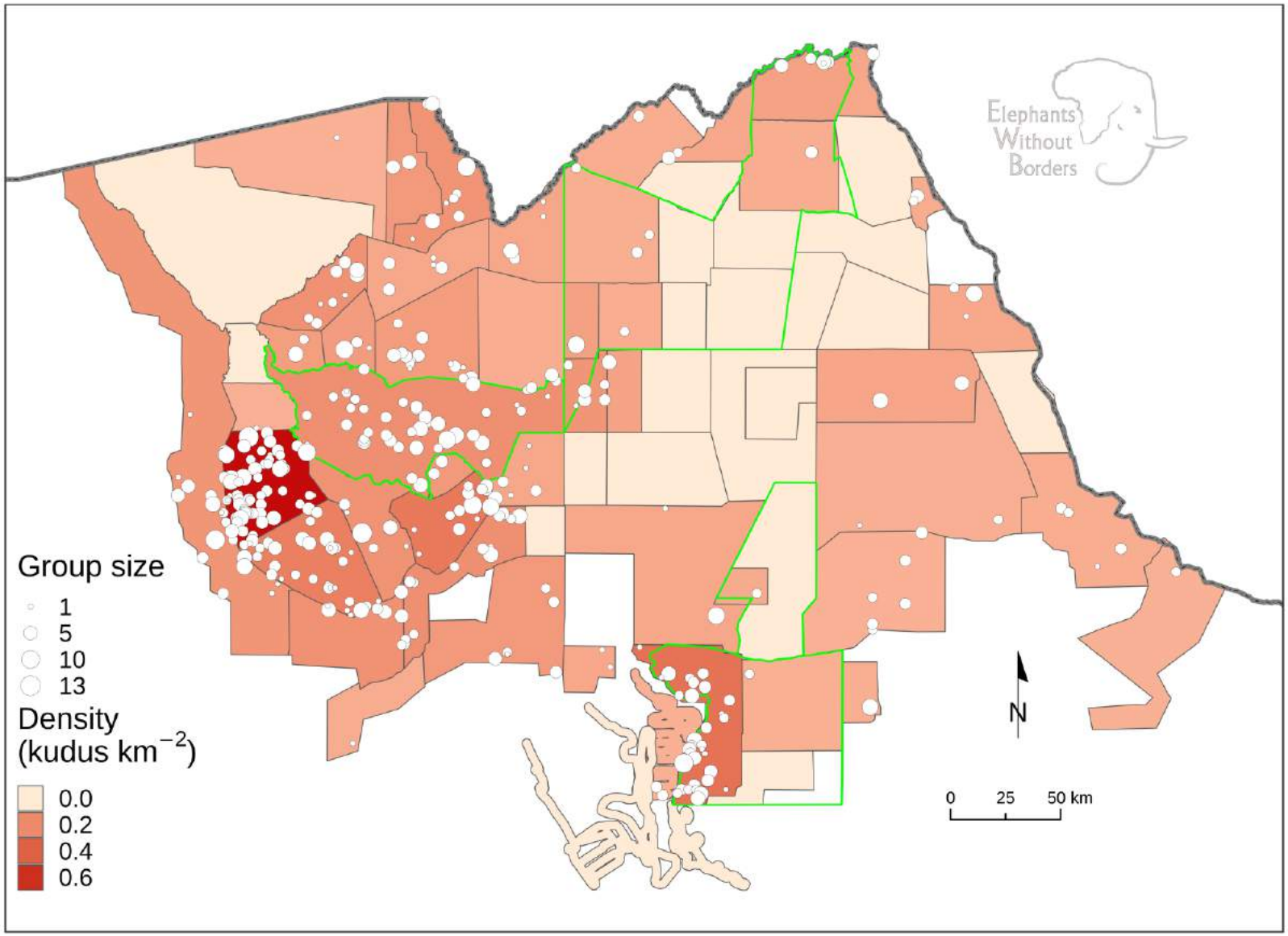


Table 31. Dry season population estimates for lechwe

Stratum	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density (animals km^{-2})
Chobe (CH) district								
CH 1 Chobe Enclave	0	0	0	0	0	0	0	0.00
CH 2 Chobe FR (high density)	0	0	0	0	0	0	0	0.00
CH 2 Chobe FR (low density)	0	0	0	0	0	0	0	0.00
CH 4 Kasane FR	0	0	0	0	0	0	0	0.00
CH 5 N Plains	0	0	0	0	0	0	0	0.00
CH 7 & 8	0	0	0	0	0	0	0	0.00
CH 11	0	0	0	0	0	0	0	0.00
CH 12	0	0	0	0	0	0	0	0.00
Nogatsaa C	0	0	0	0	0	0	0	0.00
Chinamba (low density)	0	0	0	0	0	0	0	0.00
Chinamba (high density)	0	0	0	0	0	0	0	0.00
Chobe Mababe	0	0	0	0	0	0	0	0.00
Chobe River	53	10	34	71	132	0	124	0.04
Kazuma FR (total count)	0	0	0	0	0	0	0	0.00
Nogatsaa A and B	0	0	0	0	0	0	0	0.00
Savute East	0	0	0	0	0	0	0	0.00
Savute North	43	8	39	80	186	0	124	0.02
Savute South (high density)	0	0	0	0	0	0	0	0.00
Savute South (low density)	0	0	0	0	0	0	0	0.00
Sibuyu FR	0	0	0	0	0	0	0	0.00
CH District Subtotal	**96**	**18**	**52**	**225**	**233**	**18**	**322**	**0.00**
Central (CT) district								
CT 1 & 2 (high density)	0	0	0	0	0	0	0	0.00
CT 1 & 2 (low density)	0	0	0	0	0	0	0	0.00
CT 3	0	0	0	0	0	0	0	0.00
Ngwasha & Sepako	0	0	0	0	0	0	0	0.00
Mak. NP East	0	0	0	0	0	0	0	0.00
Mak. NP East (salt pans)	0	0	0	0	0	0	0	0.00
Mak. NP West	0	0	0	0	0	0	0	0.00
CT 4 & 7 (recce count)	0	0	0	0	0	0	0	0.00
Boteti River (recce count)	0	0	0	0	0	0	0	0.00
Gweta (total count)	0	0	0	0	0	0	0	0.00
Hainaveld (recce count)	0	0	0	0	0	0	0	0.00
Nata (recce count)	0	0	0	0	0	0	0	0.00
Rakops (recce count)	0	0	0	0	0	0	0	0.00
CT District Subtotal	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0.00**
Ngamiland (NG) district								
Moremi GR NG 28	34,403	6,199	3,133	6,254	18	28,149	40,656	7.01
NG 7 & 8 West Okavango	92	8	53	106	116	0	198	0.02
NG 10 & 11	0	0	0	0	0	0	0	0.00
NG 12	509	95	245	506	99	4	1,015	0.52
NG 13	0	0	0	0	0	0	0	0.00
NG 14 Kwando (high density)	3,582	605	1,014	2,066	58	1,516	5,648	2.52
NG 14 Kwando (low density)	0	0	0	0	0	0	0	0.00
NG 15 Linyanti	1,182	222	359	758	64	424	1,939	1.00
NG 16 Selinda	1,009	197	599	1,224	121	0	2,233	0.72
NG 18 & 19 Khwai	264	52	143	298	113	0	562	0.14
NG 20 & 21 Splash	2,709	525	562	1,160	43	1,549	3,869	1.48
NG 22 Vumbra	3,952	782	533	1,161	29	2,791	5,113	6.24
NG 23 Duba Plains	6,968	1,332	1,292	2,754	40	4,214	9,722	14.57

Stratum	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density (animals km^{-2})
NG 24 Jedibe	575	109	201	435	76	141	1,010	1.23
NG 25 Jao	6,063	1,036	1,501	3,396	56	2,668	9,459	10.09
NG 26 Abu / EBS	11,337	2,009	1,752	3,608	32	7,729	14,945	6.52
NG 27 A & B & NG 30	5,705	798	1,336	2,758	48	2,947	8,463	4.19
NG 29	6,456	1,144	1,432	2,950	46	3,506	9,406	3.48
NG 31 & 17 Chitabe	1,119	223	448	998	89	122	2,117	3.97
NG 32 Stanleys	2,509	440	622	1,287	51	1,223	3,796	2.06
NG 33 & 34	0	0	0	0	0	0	0	0.00
NG 41 Mababe (high density)	0	0	0	0	0	0	0	0.00
NG 41 Mababe (low density)	0	0	0	0	0	0	0	0.00
NG 42 (high density)	0	0	0	0	0	0	0	0.00
NG 42 (low density)	0	0	0	0	0	0	0	0.00
NG 43 (high density)	0	0	0	0	0	0	0	0.00
NG 43 (low density)	0	0	0	0	0	0	0	0.00
NG 47 & 49	0	0	0	0	0	0	0	0.00
Nxai Pan NP (high density)	0	0	0	0	0	0	0	0.00
Nxai Pan NP (low density)	0	0	0	0	0	0	0	0.00
Maun East	0	0	0	0	0	0	0	0.00
Kwebe	0	0	0	0	0	0	0	0.00
Maun	0	0	0	0	0	0	0	0.00
Shorobe	0	0	0	0	0	0	0	0.00
Maun Southeast	0	0	0	0	0	0	0	0.00
Maun West	52	5	49	105	204	0	156	0.03
NG District Subtotal	**88,487**	**15,781**	**4,845**	**9,649**	**11**	**78,839**	**98,136**	**1.52**
TOTAL	**88,584**	**15,799**	**4,845**	**9,633**	**11**	**78,951**	**98,217**	**0.85**

Figure 31. Estimated density and observations for lechwe on the 2018 dry-season aerial survey of northern Botswana.

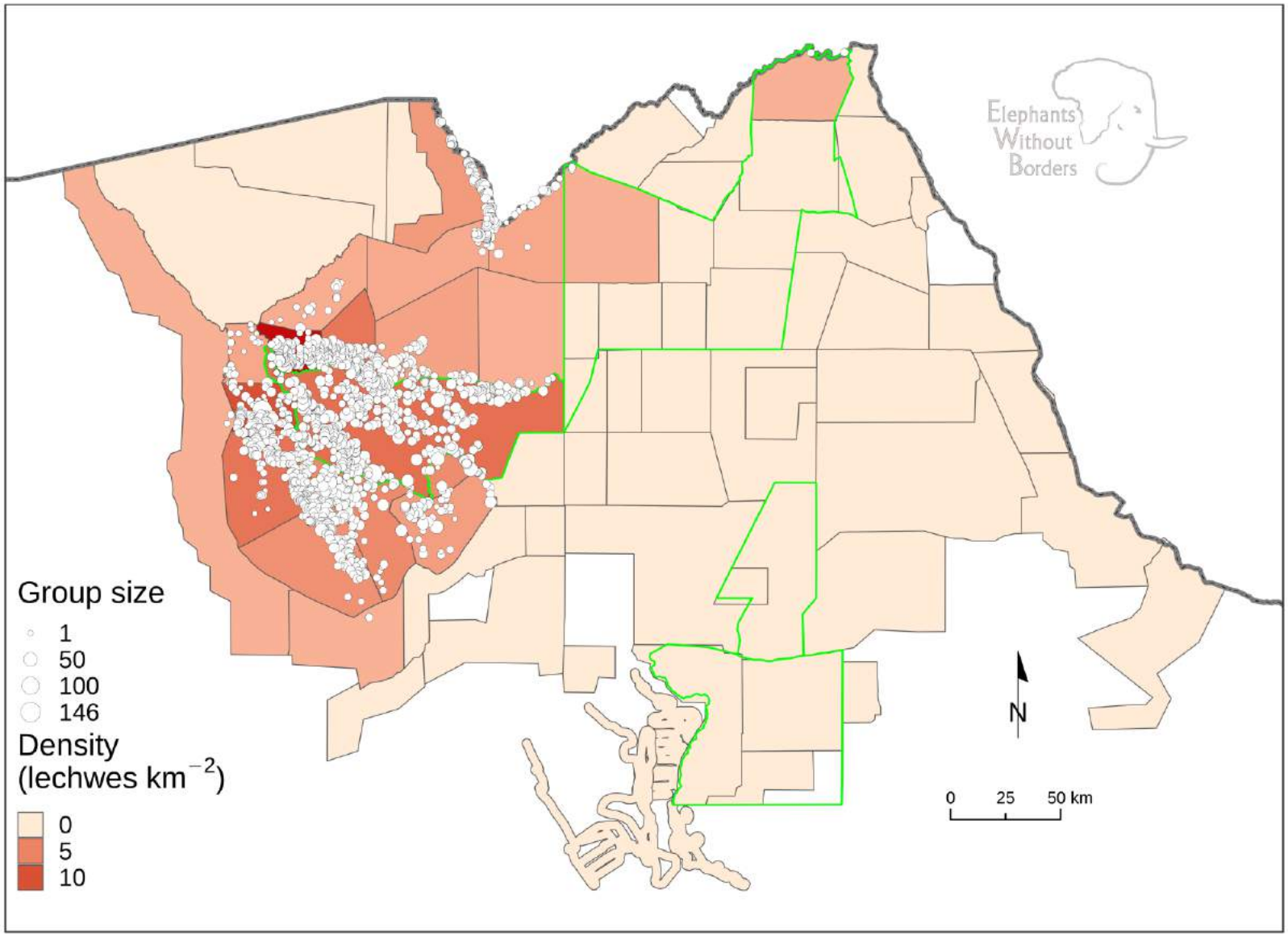


Table 32. Dry season population estimates for reedbuck

Stratum	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density (animals km^{-2})
Chobe (CH) district								
CH 1 Chobe Enclave	0	0	0	0	0	0	0	0.00
CH 2 Chobe FR (high density)	0	0	0	0	0	0	0	0.00
CH 2 Chobe FR (low density)	0	0	0	0	0	0	0	0.00
CH 4 Kasane FR	0	0	0	0	0	0	0	0.00
CH 5 N Plains	0	0	0	0	0	0	0	0.00
CH 7 & 8	0	0	0	0	0	0	0	0.00
CH 11	0	0	0	0	0	0	0	0.00
CH 12	0	0	0	0	0	0	0	0.00
Nogatsaa C	0	0	0	0	0	0	0	0.00
Chinamba (low density)	0	0	0	0	0	0	0	0.00
Chinamba (high density)	0	0	0	0	0	0	0	0.00
Chobe Mababe	0	0	0	0	0	0	0	0.00
Chobe River	16	3	14	30	185	0	46	0.01
Kazuma FR (total count)	0	0	0	0	0	0	0	0.00
Nogatsaa A and B	0	0	0	0	0	0	0	0.00
Savute East	0	0	0	0	0	0	0	0.00
Savute North	0	0	0	0	0	0	0	0.00
Savute South (high density)	0	0	0	0	0	0	0	0.00
Savute South (low density)	0	0	0	0	0	0	0	0.00
Sibuyu FR	0	0	0	0	0	0	0	0.00
CH District Subtotal	**16**	**3**	**14**	**181**	**1,133**	**3**	**197**	**0.00**
Central (CT) district								
CT 1 & 2 (high density)	0	0	0	0	0	0	0	0.00
CT 1 & 2 (low density)	0	0	0	0	0	0	0	0.00
CT 3	0	0	0	0	0	0	0	0.00
Ngwasha & Sepako	0	0	0	0	0	0	0	0.00
Mak. NP East	0	0	0	0	0	0	0	0.00
Mak. NP East (salt pans)	0	0	0	0	0	0	0	0.00
Mak. NP West	0	0	0	0	0	0	0	0.00
CT 4 & 7 (recce count)	0	0	0	0	0	0	0	0.00
Boteti River (recce count)	0	0	0	0	0	0	0	0.00
Gweta (total count)	0	0	0	0	0	0	0	0.00
Hainaveld (recce count)	0	0	0	0	0	0	0	0.00
Nata (recce count)	0	0	0	0	0	0	0	0.00
Rakops (recce count)	0	0	0	0	0	0	0	0.00
CT District Subtotal	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0.00**
Ngamiland (NG) district								
Moremi GR NG 28	755	136	139	277	37	478	1,032	0.15
NG 7 & 8 West Okavango	46	4	31	62	135	0	108	0.01
NG 10 & 11	0	0	0	0	0	0	0	0.00
NG 12	38	7	22	45	119	0	82	0.04
NG 13	0	0	0	0	0	0	0	0.00
NG 14 Kwando (high density)	12	2	11	22	185	0	34	0.01
NG 14 Kwando (low density)	0	0	0	0	0	0	0	0.00
NG 15 Linyanti	5	1	5	10	186	0	15	0.00
NG 16 Selinda	10	2	9	19	182	0	29	0.01
NG 18 & 19 Khwai	36	7	20	42	118	0	77	0.02
NG 20 & 21 Splash	243	47	69	143	59	100	386	0.13
NG 22 Vumbra	40	8	19	41	100	0	81	0.06
NG 23 Duba Plains	68	13	28	60	88	8	128	0.14

Stratum	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density (animals km^{-2})
NG 24 Jedibe	0	0	0	0	0	0	0	0.00
NG 25 Jao	146	25	55	124	85	23	270	0.24
NG 26 Abu / EBS	260	46	57	118	45	142	377	0.15
NG 27 A & B & NG 30	450	63	79	163	36	288	613	0.33
NG 29	164	29	77	158	96	6	322	0.09
NG 31 & 17 Chitabe	30	6	14	32	105	0	62	0.11
NG 32 Stanleys	297	52	76	156	53	140	453	0.24
NG 33 & 34	0	0	0	0	0	0	0	0.00
NG 41 Mababe (high density)	0	0	0	0	0	0	0	0.00
NG 41 Mababe (low density)	0	0	0	0	0	0	0	0.00
NG 42 (high density)	0	0	0	0	0	0	0	0.00
NG 42 (low density)	0	0	0	0	0	0	0	0.00
NG 43 (high density)	0	0	0	0	0	0	0	0.00
NG 43 (low density)	0	0	0	0	0	0	0	0.00
NG 47 & 49	0	0	0	0	0	0	0	0.00
Nxai Pan NP (high density)	0	0	0	0	0	0	0	0.00
Nxai Pan NP (low density)	0	0	0	0	0	0	0	0.00
Maun East	0	0	0	0	0	0	0	0.00
Kwebe	0	0	0	0	0	0	0	0.00
Maun	5	1	5	10	184	0	15	0.00
Shorobe	0	0	0	0	0	0	0	0.00
Maun Southeast	0	0	0	0	0	0	0	0.00
Maun West	0	0	0	0	0	0	0	0.00
NG District Subtotal	**2,604**	**449**	**227**	**452**	**17**	**2,152**	**3,056**	**0.04**
TOTAL	**2,620**	**452**	**227**	**452**	**17**	**2,168**	**3,072**	**0.03**

Figure 32. Estimated density and observations for reedbuck on the 2018 dry-season aerial survey of northern Botswana.

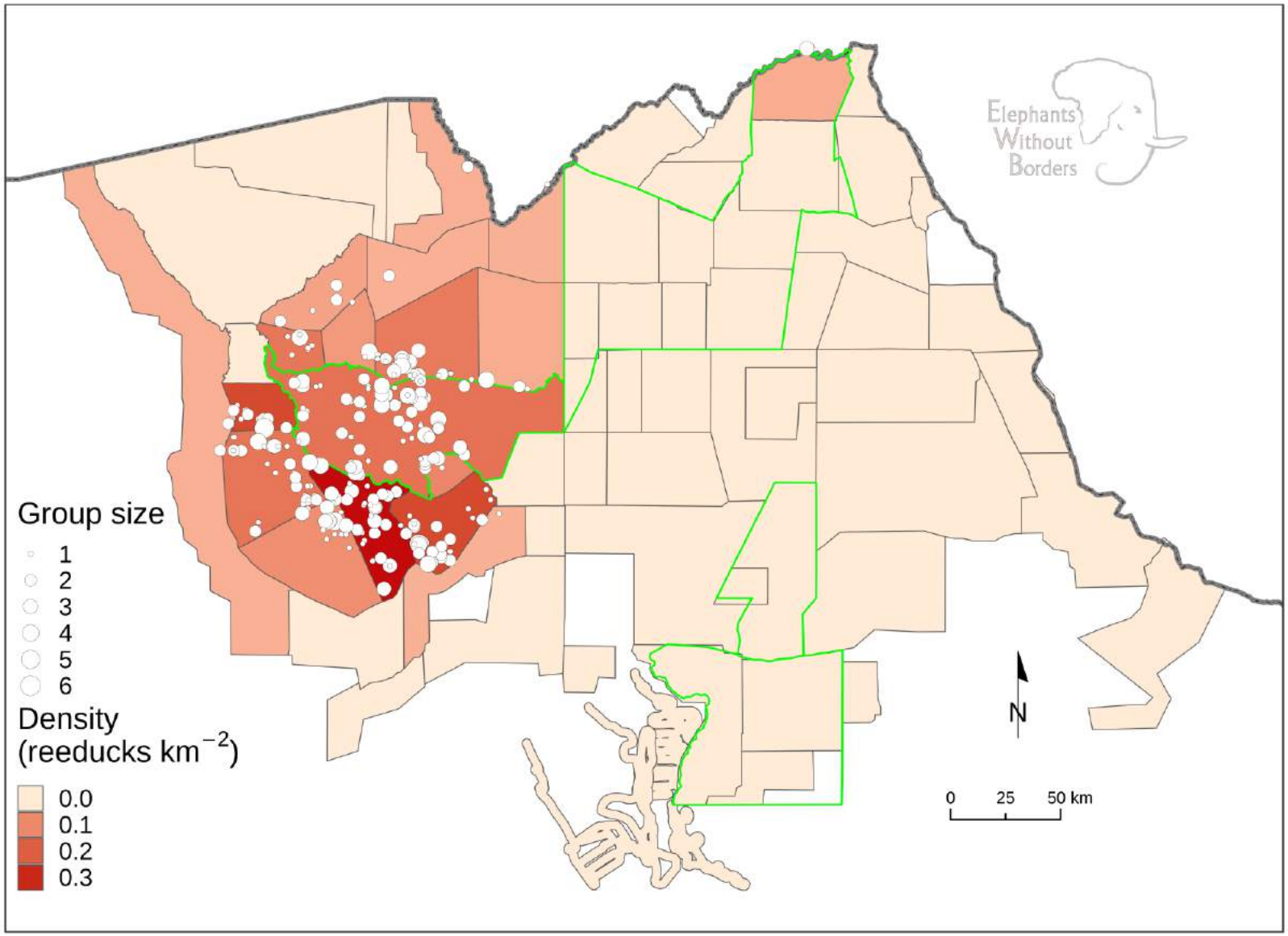


Table 33. Dry season population estimates for roan

Stratum	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density (animals km^{-2})
Chobe (CH) district								
CH 1 Chobe Enclave	23	4	10	21	89	3	44	0.02
CH 2 Chobe FR (high density)	0	0	0	0	0	0	0	0.00
CH 2 Chobe FR (low density)	0	0	0	0	0	0	0	0.00
CH 4 Kasane FR	0	0	0	0	0	0	0	0.00
CH 5 N Plains	24	2	15	34	142	0	58	0.01
CH 7 & 8	13	1	13	29	216	0	42	0.01
CH 11	0	0	0	0	0	0	0	0.00
CH 12	0	0	0	0	0	0	0	0.00
Nogatsaa C	92	9	69	154	167	0	245	0.09
Chinamba (low density)	0	0	0	0	0	0	0	0.00
Chinamba (high density)	0	0	0	0	0	0	0	0.00
Chobe Mababe	21	4	19	44	205	0	65	0.03
Chobe River	69	13	46	96	139	0	165	0.06
Kazuma FR (total count)	0	0	0	0	0	0	0	0.00
Nogatsaa A and B	0	0	0	0	0	0	0	0.00
Savute East	43	5	24	56	131	0	98	0.05
Savute North	16	3	8	16	102	0	33	0.01
Savute South (high density)	27	5	24	58	213	0	85	0.05
Savute South (low density)	0	0	0	0	0	0	0	0.00
Sibuyu FR	16	3	14	29	184	0	45	0.01
CH District Subtotal	**345**	**49**	**96**	**197**	**57**	**148**	**541**	**0.02**
Central (CT) district								
CT 1 & 2 (high density)	0	0	0	0	0	0	0	0.00
CT 1 & 2 (low density)	0	0	0	0	0	0	0	0.00
CT 3	0	0	0	0	0	0	0	0.00
Ngwasha & Sepako	0	0	0	0	0	0	0	0.00
Mak. NP East	0	0	0	0	0	0	0	0.00
Mak. NP East (salt pans)	0	0	0	0	0	0	0	0.00
Mak. NP West	0	0	0	0	0	0	0	0.00
CT 4 & 7 (recce count)	0	0	0	0	0	0	0	0.00
Boteti River (recce count)	0	0	0	0	0	0	0	0.00
Gweta (total count)	0	0	0	0	0	0	0	0.00
Hainaveld (recce count)	0	0	0	0	0	0	0	0.00
Nata (recce count)	0	0	0	0	0	0	0	0.00
Rakops (recce count)	0	0	0	0	0	0	0	0.00
CT District Subtotal	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0.00**
Ngamiland (NG) district								
Moremi GR NG 28	33	6	21	43	129	0	76	0.01
NG 7 & 8 West Okavango	0	0	0	0	0	0	0	0.00
NG 10 & 11	20	4	9	18	87	3	38	0.00
NG 12	0	0	0	0	0	0	0	0.00
NG 13	0	0	0	0	0	0	0	0.00
NG 14 Kwando (high density)	124	21	56	115	93	9	239	0.09
NG 14 Kwando (low density)	11	1	10	26	232	0	37	0.01
NG 15 Linyanti	5	1	5	10	187	0	15	0.00
NG 16 Selinda	41	8	23	48	117	0	89	0.03
NG 18 & 19 Khwai	46	9	26	54	118	0	100	0.02
NG 20 & 21 Splash	5	1	5	9	183	0	15	0.00
NG 22 Vumbra	40	8	18	40	99	0	80	0.06
NG 23 Duba Plains	0	0	0	0	0	0	0	0.00

Stratum	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density (animals km^{-2})
NG 24 Jedibe	0	0	0	0	0	0	0	0.00
NG 25 Jao	0	0	0	0	0	0	0	0.00
NG 26 Abu / EBS	0	0	0	0	0	0	0	0.00
NG 27 A & B & NG 30	0	0	0	0	0	0	0	0.00
NG 29	17	3	15	32	187	0	49	0.01
NG 31 & 17 Chitabe	0	0	0	0	0	0	0	0.00
NG 32 Stanleys	29	5	26	55	192	0	83	0.02
NG 33 & 34	40	7	25	54	137	0	94	0.04
NG 41 Mababe (high density)	50	7	47	120	238	0	171	0.09
NG 41 Mababe (low density)	0	0	0	0	0	0	0	0.00
NG 42 (high density)	0	0	0	0	0	0	0	0.00
NG 42 (low density)	0	0	0	0	0	0	0	0.00
NG 43 (high density)	27	2	26	82	306	0	109	0.04
NG 43 (low density)	0	0	0	0	0	0	0	0.00
NG 47 & 49	0	0	0	0	0	0	0	0.00
Nxai Pan NP (high density)	0	0	0	0	0	0	0	0.00
Nxai Pan NP (low density)	0	0	0	0	0	0	0	0.00
Maun East	0	0	0	0	0	0	0	0.00
Kwebe	0	0	0	0	0	0	0	0.00
Maun	0	0	0	0	0	0	0	0.00
Shorobe	0	0	0	0	0	0	0	0.00
Maun Southeast	0	0	0	0	0	0	0	0.00
Maun West	0	0	0	0	0	0	0	0.00
NG District Subtotal	**489**	**83**	**99**	**198**	**40**	**291**	**686**	**0.01**
TOTAL	**833**	**132**	**138**	**272**	**33**	**561**	**1,106**	**0.01**

Figure 33. Estimated density and observations for roan on the 2018 dry-season aerial survey of northern Botswana.

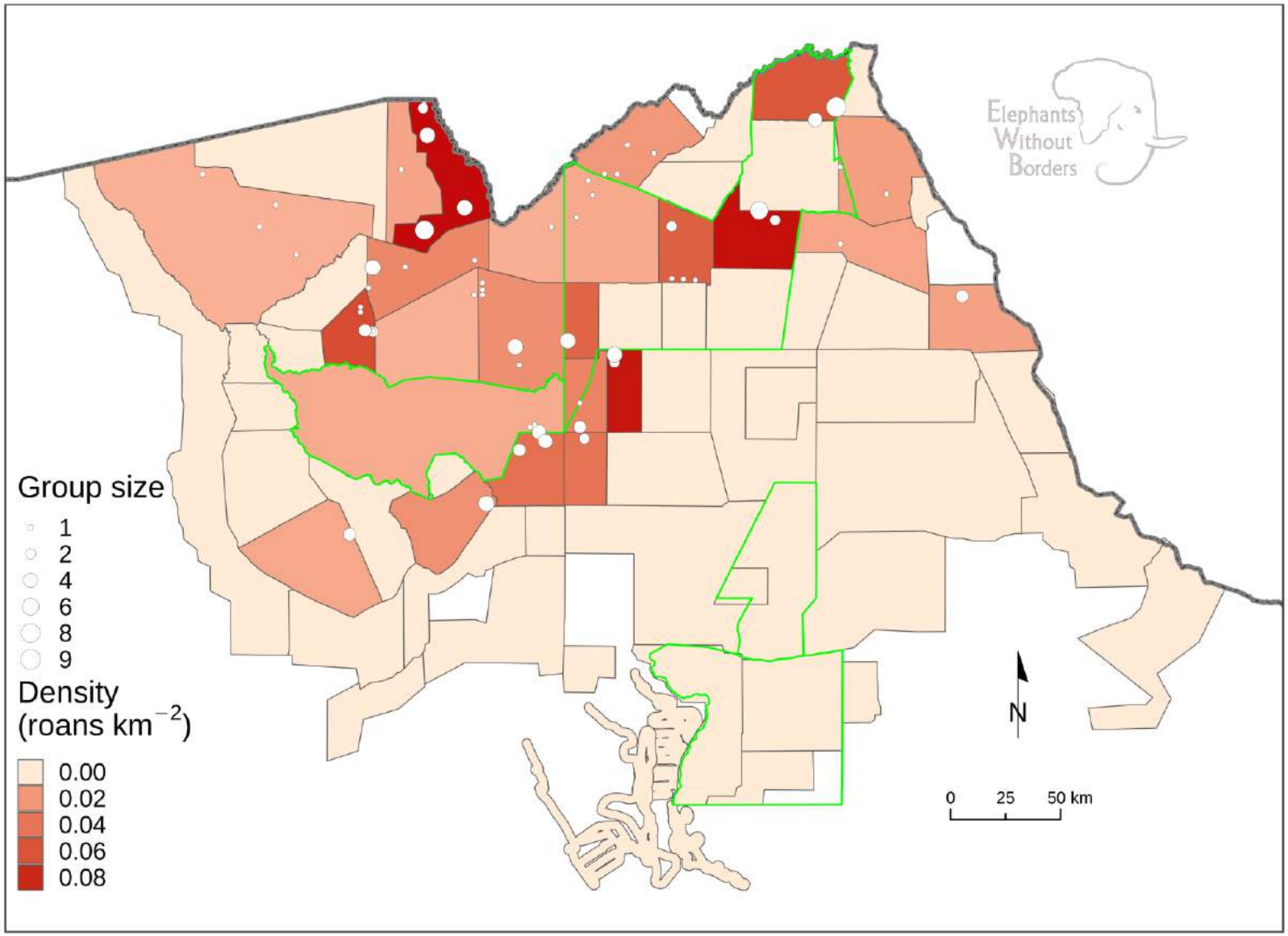


Table 34. Dry season population estimates for sable

Stratum	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density (animals km^{-2})
Chobe (CH) district								
CH 1 Chobe Enclave	52	9	28	59	112	0	111	0.04
CH 2 Chobe FR (high density)	6	1	5	11	181	0	17	0.01
CH 2 Chobe FR (low density)	0	0	0	0	0	0	0	0.00
CH 4 Kasane FR	6	1	6	12	200	0	18	0.01
CH 5 N Plains	36	3	19	41	116	0	77	0.02
CH 7 & 8	751	56	708	1,559	208	0	2,310	0.57
CH 11	0	0	0	0	0	0	0	0.00
CH 12	0	0	0	0	0	0	0	0.00
Nogatsaa C	0	0	0	0	0	0	0	0.00
Chinamba (low density)	0	0	0	0	0	0	0	0.00
Chinamba (high density)	0	0	0	0	0	0	0	0.00
Chobe Mababe	0	0	0	0	0	0	0	0.00
Chobe River	218	41	173	359	165	0	578	0.18
Kazuma FR (total count)	76	76	0	0	0	76	76	0.30
Nogatsaa A and B	0	0	0	0	0	0	0	0.00
Savute East	0	0	0	0	0	0	0	0.00
Savute North	27	5	20	41	152	0	68	0.01
Savute South (high density)	0	0	0	0	0	0	0	0.00
Savute South (low density)	0	0	0	0	0	0	0	0.00
Sibuyu FR	69	13	44	90	130	0	158	0.06
CH District Subtotal	**1,241**	**205**	**732**	**1,690**	**136**	**205**	**2,931**	**0.06**
Central (CT) district								
CT 1 & 2 (high density)	0	0	0	0	0	0	0	0.00
CT 1 & 2 (low density)	0	0	0	0	0	0	0	0.00
CT 3	0	0	0	0	0	0	0	0.00
Ngwasha & Sepako	0	0	0	0	0	0	0	0.00
Mak. NP East	0	0	0	0	0	0	0	0.00
Mak. NP East (salt pans)	0	0	0	0	0	0	0	0.00
Mak. NP West	0	0	0	0	0	0	0	0.00
CT 4 & 7 (recce count)	0	0	0	0	0	0	0	0.00
Boteti River (recce count)	0	0	0	0	0	0	0	0.00
Gweta (total count)	0	0	0	0	0	0	0	0.00
Hainaveld (recce count)	0	0	0	0	0	0	0	0.00
Nata (recce count)	0	0	0	0	0	0	0	0.00
Rakops (recce count)	0	0	0	0	0	0	0	0.00
CT District Subtotal	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0.00**
Ngamiland (NG) district								
Moremi GR NG 28	17	3	11	22	133	0	39	0.00
NG 7 & 8 West Okavango	0	0	0	0	0	0	0	0.00
NG 10 & 11	208	41	145	289	139	0	497	0.04
NG 12	27	5	15	32	120	0	59	0.03
NG 13	158	12	101	214	136	0	371	0.05
NG 14 Kwando (high density)	225	38	89	182	81	43	407	0.16
NG 14 Kwando (low density)	122	11	34	88	73	33	210	0.12
NG 15 Linyanti	266	50	211	444	167	0	711	0.23
NG 16 Selinda	389	76	114	232	60	157	621	0.28
NG 18 & 19 Khwai	107	21	46	96	90	11	203	0.06
NG 20 & 21 Splash	98	19	51	104	106	0	202	0.05
NG 22 Vumbra	10	2	6	14	134	0	24	0.02
NG 23 Duba Plains	0	0	0	0	0	0	0	0.00

Stratum	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density (animals km^{-2})
NG 24 Jedibe	0	0	0	0	0	0	0	0.00
NG 25 Jao	0	0	0	0	0	0	0	0.00
NG 26 Abu / EBS	0	0	0	0	0	0	0	0.00
NG 27 A & B & NG 30	0	0	0	0	0	0	0	0.00
NG 29	0	0	0	0	0	0	0	0.00
NG 31 & 17 Chitabe	0	0	0	0	0	0	0	0.00
NG 32 Stanleys	0	0	0	0	0	0	0	0.00
NG 33 & 34	6	1	5	11	196	0	17	0.01
NG 41 Mababe (high density)	0	0	0	0	0	0	0	0.00
NG 41 Mababe (low density)	0	0	0	0	0	0	0	0.00
NG 42 (high density)	0	0	0	0	0	0	0	0.00
NG 42 (low density)	0	0	0	0	0	0	0	0.00
NG 43 (high density)	0	0	0	0	0	0	0	0.00
NG 43 (low density)	0	0	0	0	0	0	0	0.00
NG 47 & 49	0	0	0	0	0	0	0	0.00
Nxai Pan NP (high density)	0	0	0	0	0	0	0	0.00
Nxai Pan NP (low density)	0	0	0	0	0	0	0	0.00
Maun East	0	0	0	0	0	0	0	0.00
Kwebe	0	0	0	0	0	0	0	0.00
Maun	0	0	0	0	0	0	0	0.00
Shorobe	0	0	0	0	0	0	0	0.00
Maun Southeast	0	0	0	0	0	0	0	0.00
Maun West	0	0	0	0	0	0	0	0.00
NG District Subtotal	**1,631**	**279**	**320**	**647**	**40**	**985**	**2,278**	**0.03**
TOTAL	**2,872**	**484**	**799**	**1,631**	**57**	**1,242**	**4,503**	**0.03**

Figure 34. Estimated density and observations for sable on the 2018 dry-season aerial survey of northern Botswana.

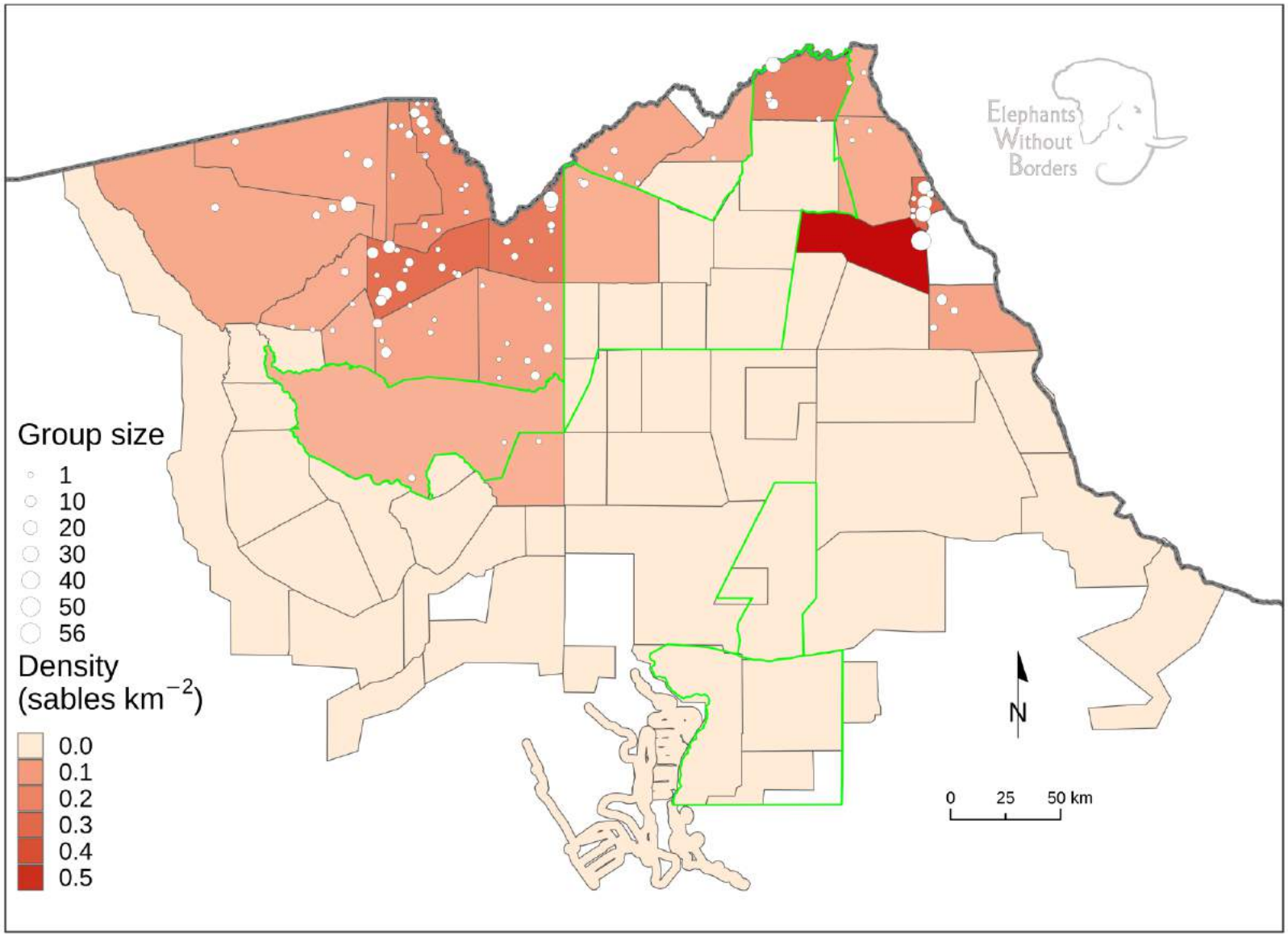


Table 35. Dry season population estimates for sitatunga

Stratum	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density (animals km^{-2})
Chobe (CH) district								
CH 1 Chobe Enclave	0	0	0	0	0	0	0	0.00
CH 2 Chobe FR (high density)	0	0	0	0	0	0	0	0.00
CH 2 Chobe FR (low density)	0	0	0	0	0	0	0	0.00
CH 4 Kasane FR	0	0	0	0	0	0	0	0.00
CH 5 N Plains	0	0	0	0	0	0	0	0.00
CH 7 & 8	0	0	0	0	0	0	0	0.00
CH 11	0	0	0	0	0	0	0	0.00
CH 12	0	0	0	0	0	0	0	0.00
Nogatsaa C	0	0	0	0	0	0	0	0.00
Chinamba (low density)	0	0	0	0	0	0	0	0.00
Chinamba (high density)	0	0	0	0	0	0	0	0.00
Chobe Mababe	0	0	0	0	0	0	0	0.00
Chobe River	0	0	0	0	0	0	0	0.00
Kazuma FR (total count)	0	0	0	0	0	0	0	0.00
Nogatsaa A and B	0	0	0	0	0	0	0	0.00
Savute East	0	0	0	0	0	0	0	0.00
Savute North	0	0	0	0	0	0	0	0.00
Savute South (high density)	0	0	0	0	0	0	0	0.00
Savute South (low density)	0	0	0	0	0	0	0	0.00
Sibuyu FR	0	0	0	0	0	0	0	0.00
CH District Subtotal	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0.00**
Central (CT) district								
CT 1 & 2 (high density)	0	0	0	0	0	0	0	0.00
CT 1 & 2 (low density)	0	0	0	0	0	0	0	0.00
CT 3	0	0	0	0	0	0	0	0.00
Ngwasha & Sepako	0	0	0	0	0	0	0	0.00
Mak. NP East	0	0	0	0	0	0	0	0.00
Mak. NP East (salt pans)	0	0	0	0	0	0	0	0.00
Mak. NP West	0	0	0	0	0	0	0	0.00
CT 4 & 7 (recce count)	0	0	0	0	0	0	0	0.00
Boteti River (recce count)	0	0	0	0	0	0	0	0.00
Gweta (total count)	0	0	0	0	0	0	0	0.00
Hainaveld (recce count)	0	0	0	0	0	0	0	0.00
Nata (recce count)	0	0	0	0	0	0	0	0.00
Rakops (recce count)	0	0	0	0	0	0	0	0.00
CT District Subtotal	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0.00**
Ngamiland (NG) district								
Moremi GR NG 28	283	51	51	101	36	182	384	0.06
NG 7 & 8 West Okavango	34	3	24	49	142	0	83	0.01
NG 10 & 11	178	35	31	63	35	115	240	0.03
NG 12	0	0	0	0	0	0	0	0.00
NG 13	0	0	0	0	0	0	0	0.00
NG 14 Kwando (high density)	0	0	0	0	0	0	0	0.00
NG 14 Kwando (low density)	0	0	0	0	0	0	0	0.00
NG 15 Linyanti	5	1	5	10	187	0	15	0.00
NG 16 Selinda	5	1	5	9	184	0	15	0.00
NG 18 & 19 Khwai	0	0	0	0	0	0	0	0.00
NG 20 & 21 Splash	21	4	9	18	89	2	39	0.01
NG 22 Vumbra	40	8	14	30	73	11	70	0.06
NG 23 Duba Plains	78	15	20	42	53	37	120	0.16

Stratum	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density (animals km^{-2})
NG 24 Jedibe	111	21	34	73	66	38	184	0.24
NG 25 Jao	94	16	32	72	77	22	166	0.16
NG 26 Abu / EBS	11	2	7	15	131	0	26	0.01
NG 27 A & B & NG 30	14	2	10	20	138	0	34	0.01
NG 29	0	0	0	0	0	0	0	0.00
NG 31 & 17 Chitabe	0	0	0	0	0	0	0	0.00
NG 32 Stanleys	0	0	0	0	0	0	0	0.00
NG 33 & 34	0	0	0	0	0	0	0	0.00
NG 41 Mababe (high density)	0	0	0	0	0	0	0	0.00
NG 41 Mababe (low density)	0	0	0	0	0	0	0	0.00
NG 42 (high density)	0	0	0	0	0	0	0	0.00
NG 42 (low density)	0	0	0	0	0	0	0	0.00
NG 43 (high density)	0	0	0	0	0	0	0	0.00
NG 43 (low density)	0	0	0	0	0	0	0	0.00
NG 47 & 49	0	0	0	0	0	0	0	0.00
Nxai Pan NP (high density)	0	0	0	0	0	0	0	0.00
Nxai Pan NP (low density)	0	0	0	0	0	0	0	0.00
Maun East	0	0	0	0	0	0	0	0.00
Kwebe	0	0	0	0	0	0	0	0.00
Maun	0	0	0	0	0	0	0	0.00
Shorobe	0	0	0	0	0	0	0	0.00
Maun Southeast	0	0	0	0	0	0	0	0.00
Maun West	0	0	0	0	0	0	0	0.00
NG District Subtotal	**875**	**159**	**85**	**169**	**19**	**706**	**1,045**	**0.02**
TOTAL	**875**	**159**	**85**	**169**	**19**	**706**	**1,045**	**0.01**

Figure 35. Estimated density and observations for sitatunga on the 2018 dry-season aerial survey of northern Botswana.

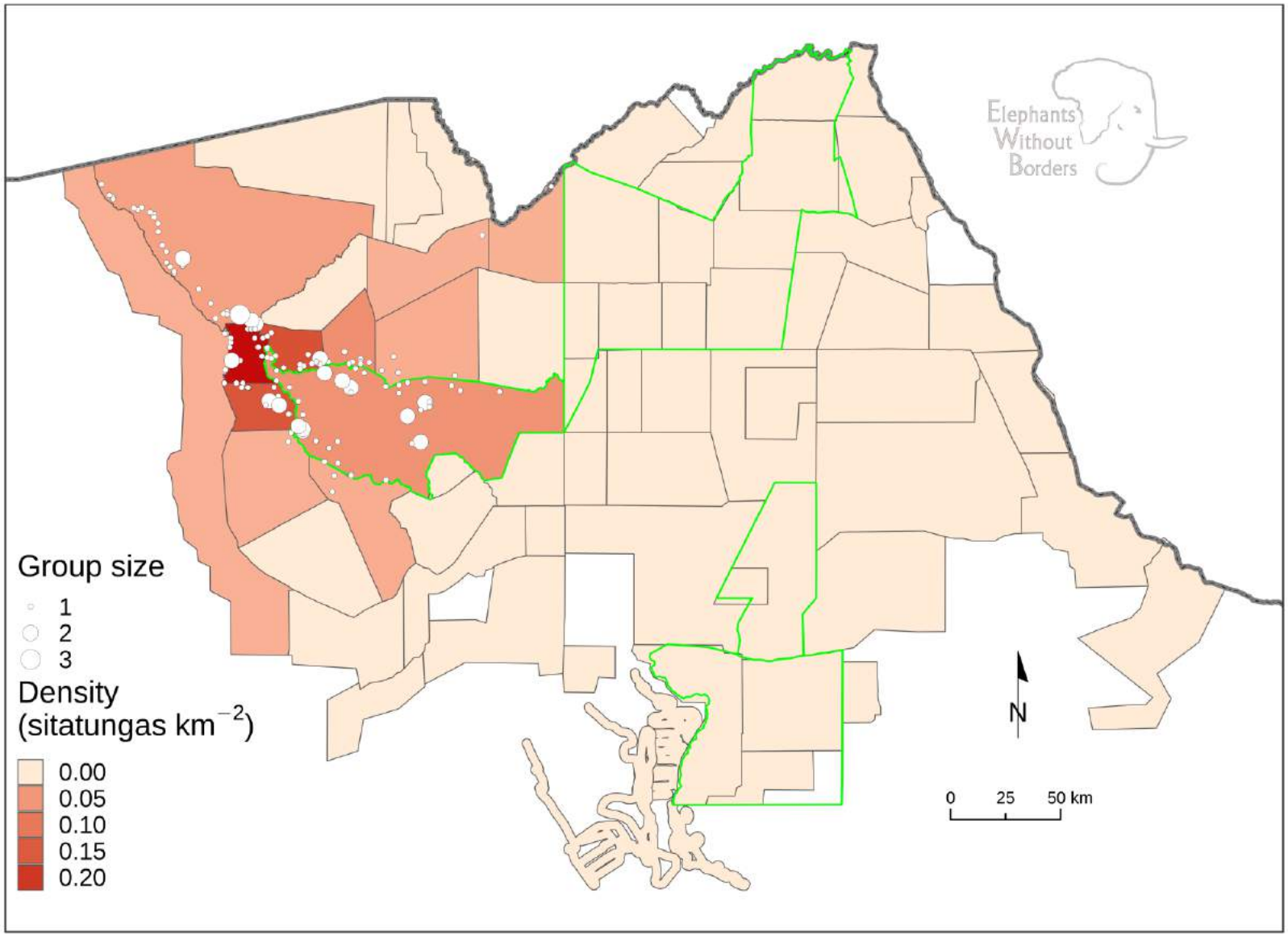


Table 36. Dry season population estimates for springbok

Stratum	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density (animals km^{-2})
Chobe (CH) district								
CH 1 Chobe Enclave	0	0	0	0	0	0	0	0.00
CH 2 Chobe FR (high density)	0	0	0	0	0	0	0	0.00
CH 2 Chobe FR (low density)	0	0	0	0	0	0	0	0.00
CH 4 Kasane FR	0	0	0	0	0	0	0	0.00
CH 5 N Plains	0	0	0	0	0	0	0	0.00
CH 7 & 8	0	0	0	0	0	0	0	0.00
CH 11	0	0	0	0	0	0	0	0.00
CH 12	0	0	0	0	0	0	0	0.00
Nogatsaa C	0	0	0	0	0	0	0	0.00
Chinamba (low density)	0	0	0	0	0	0	0	0.00
Chinamba (high density)	0	0	0	0	0	0	0	0.00
Chobe Mababe	0	0	0	0	0	0	0	0.00
Chobe River	0	0	0	0	0	0	0	0.00
Kazuma FR (total count)	0	0	0	0	0	0	0	0.00
Nogatsaa A and B	0	0	0	0	0	0	0	0.00
Savute East	0	0	0	0	0	0	0	0.00
Savute North	0	0	0	0	0	0	0	0.00
Savute South (high density)	0	0	0	0	0	0	0	0.00
Savute South (low density)	0	0	0	0	0	0	0	0.00
Sibuyu FR	0	0	0	0	0	0	0	0.00
CH District Subtotal	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0.00**
Central (CT) district								
CT 1 & 2 (high density)	0	0	0	0	0	0	0	0.00
CT 1 & 2 (low density)	0	0	0	0	0	0	0	0.00
CT 3	0	0	0	0	0	0	0	0.00
Ngwasha & Sepako	0	0	0	0	0	0	0	0.00
Mak. NP East	0	0	0	0	0	0	0	0.00
Mak. NP East (salt pans)	0	0	0	0	0	0	0	0.00
Mak. NP West	0	0	0	0	0	0	0	0.00
CT 4 & 7 (recce count)	0	0	0	0	0	0	0	0.00
Boteti River (recce count)	0	0	0	0	0	0	0	0.00
Gweta (total count)	58	58	0	0	0	58	58	0.13
Hainaveld (recce count)	0	0	0	0	0	0	0	0.00
Nata (recce count)	0	0	0	0	0	0	0	0.00
Rakops (recce count)	0	0	0	0	0	0	0	0.00
CT District Subtotal	**58**	**58**	**0**	**0**	**0**	**58**	**58**	**0.00**
Ngamiland (NG) district								
Moremi GR NG 28	0	0	0	0	0	0	0	0.00
NG 7 & 8 West Okavango	0	0	0	0	0	0	0	0.00
NG 10 & 11	0	0	0	0	0	0	0	0.00
NG 12	0	0	0	0	0	0	0	0.00
NG 13	0	0	0	0	0	0	0	0.00
NG 14 Kwando (high density)	0	0	0	0	0	0	0	0.00
NG 14 Kwando (low density)	0	0	0	0	0	0	0	0.00
NG 15 Linyanti	0	0	0	0	0	0	0	0.00
NG 16 Selinda	0	0	0	0	0	0	0	0.00
NG 18 & 19 Khwai	0	0	0	0	0	0	0	0.00
NG 20 & 21 Splash	0	0	0	0	0	0	0	0.00
NG 22 Vumbra	0	0	0	0	0	0	0	0.00
NG 23 Duba Plains	0	0	0	0	0	0	0	0.00

Stratum	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density (animals km^{-2})
NG 24 Jedibe	0	0	0	0	0	0	0	0.00
NG 25 Jao	0	0	0	0	0	0	0	0.00
NG 26 Abu / EBS	0	0	0	0	0	0	0	0.00
NG 27 A & B & NG 30	0	0	0	0	0	0	0	0.00
NG 29	0	0	0	0	0	0	0	0.00
NG 31 & 17 Chitabe	0	0	0	0	0	0	0	0.00
NG 32 Stanleys	0	0	0	0	0	0	0	0.00
NG 33 & 34	0	0	0	0	0	0	0	0.00
NG 41 Mababe (high density)	0	0	0	0	0	0	0	0.00
NG 41 Mababe (low density)	0	0	0	0	0	0	0	0.00
NG 42 (high density)	0	0	0	0	0	0	0	0.00
NG 42 (low density)	0	0	0	0	0	0	0	0.00
NG 43 (high density)	0	0	0	0	0	0	0	0.00
NG 43 (low density)	0	0	0	0	0	0	0	0.00
NG 47 & 49	0	0	0	0	0	0	0	0.00
Nxai Pan NP (high density)	62	11	52	122	197	0	184	0.18
Nxai Pan NP (low density)	0	0	0	0	0	0	0	0.00
Maun East	0	0	0	0	0	0	0	0.00
Kwebe	0	0	0	0	0	0	0	0.00
Maun	0	0	0	0	0	0	0	0.00
Shorobe	0	0	0	0	0	0	0	0.00
Maun Southeast	0	0	0	0	0	0	0	0.00
Maun West	0	0	0	0	0	0	0	0.00
NG District Subtotal	**62**	**11**	**52**	**655**	**1,060**	**11**	**716**	**0.00**
TOTAL	**120**	**69**	**52**	**655**	**547**	**69**	**774**	**0.00**

Figure 36. Estimated density and observations for springbok on the 2018 dry-season aerial survey of northern Botswana.

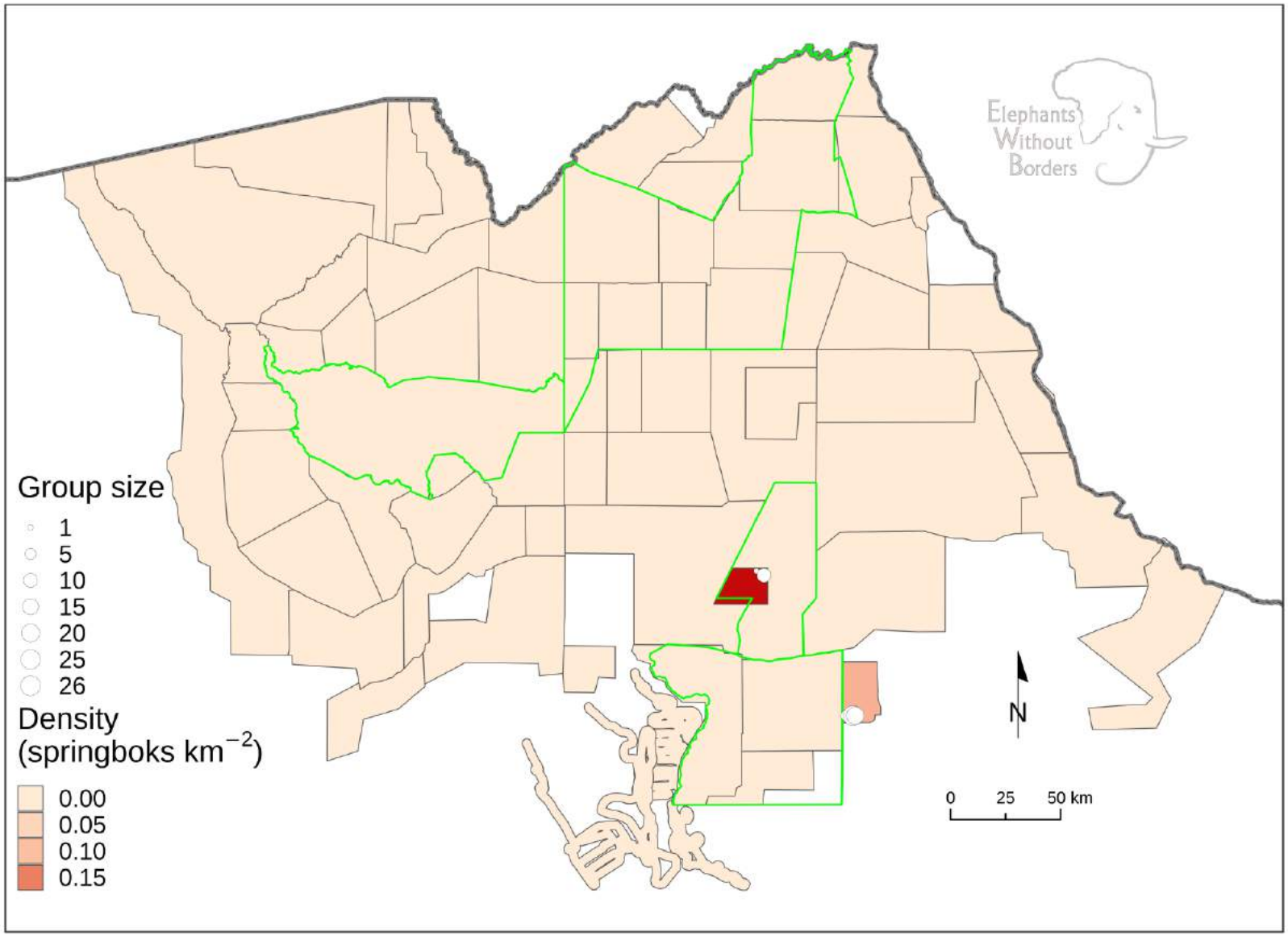


Table 37. Dry season population estimates for steenbuck

Stratum	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density (animals km^{-2})
Chobe (CH) district								
CH 1 Chobe Enclave	12	2	8	16	134	0	27	0.01
CH 2 Chobe FR (high density)	0	0	0	0	0	0	0	0.00
CH 2 Chobe FR (low density)	0	0	0	0	0	0	0	0.00
CH 4 Kasane FR	6	1	6	12	198	0	18	0.01
CH 5 N Plains	0	0	0	0	0	0	0	0.00
CH 7 & 8	0	0	0	0	0	0	0	0.00
CH 11	0	0	0	0	0	0	0	0.00
CH 12	24	2	23	50	207	0	73	0.02
Nogatsaa C	10	1	10	21	209	0	32	0.01
Chinamba (low density)	17	1	17	44	251	0	61	0.01
Chinamba (high density)	22	2	13	36	162	0	59	0.04
Chobe Mababe	48	9	14	31	64	17	79	0.07
Chobe River	27	5	14	29	107	0	55	0.02
Kazuma FR (total count)	0	0	0	0	0	0	0	0.00
Nogatsaa A and B	21	2	14	29	137	0	50	0.01
Savute East	0	0	0	0	0	0	0	0.00
Savute North	54	10	17	35	66	19	89	0.03
Savute South (high density)	38	7	14	32	85	6	70	0.07
Savute South (low density)	0	0	0	0	0	0	0	0.00
Sibuyu FR	5	1	5	10	184	0	15	0.00
CH District Subtotal	**284**	**43**	**47**	**94**	**33**	**191**	**378**	**0.01**
Central (CT) district								
CT 1 & 2 (high density)	0	0	0	0	0	0	0	0.00
CT 1 & 2 (low density)	0	0	0	0	0	0	0	0.00
CT 3	0	0	0	0	0	0	0	0.00
Ngwasha & Sepako	11	2	7	15	130	0	26	0.01
Mak. NP East	50	4	47	107	216	0	157	0.03
Mak. NP East (salt pans)	0	0	0	0	0	0	0	0.00
Mak. NP West	39	7	14	27	70	12	67	0.02
CT 4 & 7 (recce count)	0	0	0	0	0	0	0	0.00
Boteti River (recce count)	0	0	0	0	0	0	0	0.00
Gweta (total count)	0	0	0	0	0	0	0	0.00
Hainaveld (recce count)	0	0	0	0	0	0	0	0.00
Nata (recce count)	0	0	0	0	0	0	0	0.00
Rakops (recce count)	0	0	0	0	0	0	0	0.00
CT District Subtotal	**100**	**13**	**50**	**182**	**181**	**13**	**282**	**0.00**
Ngamiland (NG) district								
Moremi GR NG 28	100	18	85	171	171	0	270	0.02
NG 7 & 8 West Okavango	80	7	27	55	68	26	135	0.02
NG 10 & 11	25	5	10	20	78	6	45	0.00
NG 12	11	2	10	20	184	0	30	0.01
NG 13	144	11	48	101	70	43	245	0.05
NG 14 Kwando (high density)	6	1	5	11	182	0	17	0.00
NG 14 Kwando (low density)	22	2	20	51	232	0	73	0.02
NG 15 Linyanti	37	7	15	32	85	6	69	0.03
NG 16 Selinda	5	1	5	9	184	0	15	0.00
NG 18 & 19 Khwai	0	0	0	0	0	0	0	0.00
NG 20 & 21 Splash	26	5	12	24	92	2	50	0.01
NG 22 Vumbra	15	3	10	21	137	0	36	0.02
NG 23 Duba Plains	0	0	0	0	0	0	0	0.00

Stratum	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density (animals km^{-2})
NG 24 Jedibe	0	0	0	0	0	0	0	0.00
NG 25 Jao	0	0	0	0	0	0	0	0.00
NG 26 Abu / EBS	6	1	5	10	184	0	16	0.00
NG 27 A & B & NG 30	7	1	6	13	186	0	20	0.01
NG 29	0	0	0	0	0	0	0	0.00
NG 31 & 17 Chitabe	0	0	0	0	0	0	0	0.00
NG 32 Stanleys	0	0	0	0	0	0	0	0.00
NG 33 & 34	6	1	5	11	190	0	16	0.01
NG 41 Mababe (high density)	29	4	13	34	119	0	63	0.05
NG 41 Mababe (low density)	0	0	0	0	0	0	0	0.00
NG 42 (high density)	6	1	5	11	193	0	17	0.01
NG 42 (low density)	55	3	55	122	222	0	177	0.03
NG 43 (high density)	40	3	24	78	195	0	118	0.06
NG 43 (low density)	16	1	15	35	223	0	51	0.01
NG 47 & 49	195	9	106	251	129	0	446	0.05
Nxai Pan NP (high density)	11	2	7	15	137	0	27	0.03
Nxai Pan NP (low density)	23	2	22	46	198	0	69	0.01
Maun East	118	7	57	122	104	0	241	0.05
Kwebe	100	4	103	286	287	0	386	0.11
Maun	21	4	11	22	105	0	43	0.02
Shorobe	30	3	19	52	175	0	82	0.07
Maun Southeast	11	1	10	26	236	0	36	0.02
Maun West	31	3	21	44	144	0	75	0.02
NG District Subtotal	**1,176**	**112**	**206**	**406**	**35**	**770**	**1,582**	**0.02**
TOTAL	**1,561**	**168**	**217**	**427**	**27**	**1,134**	**1,988**	**0.02**

Figure 37. Estimated density and observations for steenbuck on the 2018 dry-season aerial survey of northern Botswana.

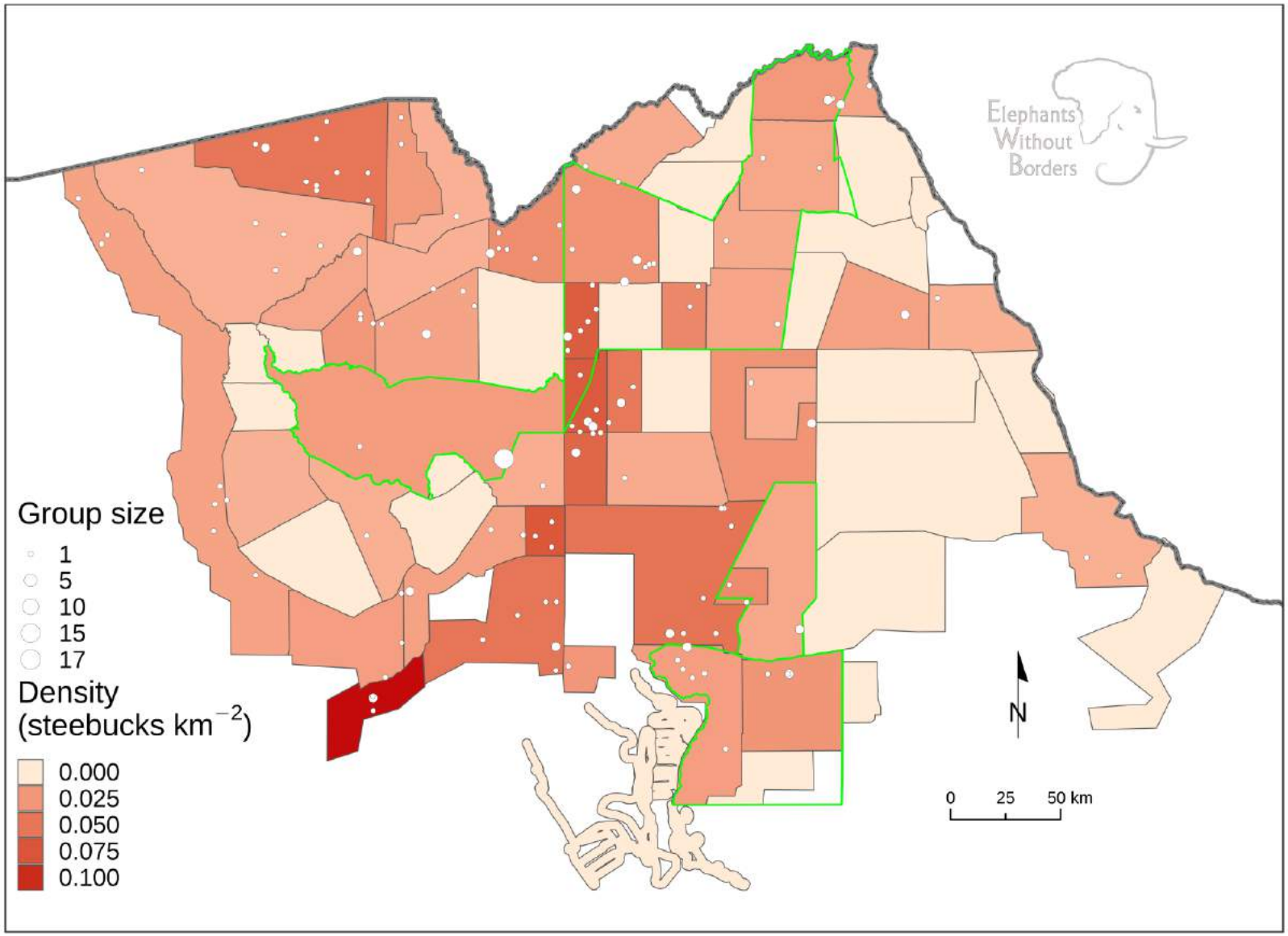


Table 38. Dry season population estimates for tsessebe

Stratum	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density (animals km^{-2})
Chobe (CH) district								
CH 1 Chobe Enclave	0	0	0	0	0	0	0	0.00
CH 2 Chobe FR (high density)	0	0	0	0	0	0	0	0.00
CH 2 Chobe FR (low density)	0	0	0	0	0	0	0	0.00
CH 4 Kasane FR	0	0	0	0	0	0	0	0.00
CH 5 N Plains	0	0	0	0	0	0	0	0.00
CH 7 & 8	0	0	0	0	0	0	0	0.00
CH 11	0	0	0	0	0	0	0	0.00
CH 12	0	0	0	0	0	0	0	0.00
Nogatsaa C	0	0	0	0	0	0	0	0.00
Chinamba (low density)	0	0	0	0	0	0	0	0.00
Chinamba (high density)	0	0	0	0	0	0	0	0.00
Chobe Mababe	64	12	36	82	128	0	146	0.10
Chobe River	21	4	19	40	189	0	62	0.02
Kazuma FR (total count)	1	1	0	0	0	1	1	0.00
Nogatsaa A and B	0	0	0	0	0	0	0	0.00
Savute East	0	0	0	0	0	0	0	0.00
Savute North	65	12	43	89	137	0	154	0.03
Savute South (high density)	16	3	15	35	213	0	51	0.03
Savute South (low density)	89	9	44	103	116	0	192	0.10
Sibuyu FR	0	0	0	0	0	0	0	0.00
CH District Subtotal	**256**	**41**	**75**	**161**	**63**	**96**	**417**	**0.01**
Central (CT) district								
CT 1 & 2 (high density)	0	0	0	0	0	0	0	0.00
CT 1 & 2 (low density)	0	0	0	0	0	0	0	0.00
CT 3	0	0	0	0	0	0	0	0.00
Ngwasha & Sepako	0	0	0	0	0	0	0	0.00
Mak. NP East	0	0	0	0	0	0	0	0.00
Mak. NP East (salt pans)	0	0	0	0	0	0	0	0.00
Mak. NP West	0	0	0	0	0	0	0	0.00
CT 4 & 7 (recce count)	0	0	0	0	0	0	0	0.00
Boteti River (recce count)	0	0	0	0	0	0	0	0.00
Gweta (total count)	0	0	0	0	0	0	0	0.00
Hainaveld (recce count)	0	0	0	0	0	0	0	0.00
Nata (recce count)	0	0	0	0	0	0	0	0.00
Rakops (recce count)	0	0	0	0	0	0	0	0.00
CT District Subtotal	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0.00**
Ngamiland (NG) district								
Moremi GR NG 28	583	105	138	275	47	307	858	0.12
NG 7 & 8 West Okavango	0	0	0	0	0	0	0	0.00
NG 10 & 11	0	0	0	0	0	0	0	0.00
NG 12	107	20	55	114	107	0	222	0.11
NG 13	0	0	0	0	0	0	0	0.00
NG 14 Kwando (high density)	172	29	100	204	119	0	375	0.12
NG 14 Kwando (low density)	44	4	40	103	233	0	147	0.04
NG 15 Linyanti	0	0	0	0	0	0	0	0.00
NG 16 Selinda	108	21	48	98	92	9	206	0.08
NG 18 & 19 Khwai	46	9	28	59	129	0	105	0.02
NG 20 & 21 Splash	139	27	53	109	78	30	248	0.08
NG 22 Vumbra	61	12	32	69	114	0	130	0.10
NG 23 Duba Plains	110	21	71	150	137	0	260	0.23

Stratum	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density (animals km^{-2})
NG 24 Jedibe	0	0	0	0	0	0	0	0.00
NG 25 Jao	6	1	5	12	206	0	18	0.01
NG 26 Abu / EBS	621	110	122	251	40	370	871	0.36
NG 27 A & B & NG 30	522	73	186	384	74	138	906	0.38
NG 29	514	91	137	282	55	232	795	0.28
NG 31 & 17 Chitabe	15	3	13	29	195	0	44	0.05
NG 32 Stanleys	342	60	168	347	101	0	689	0.28
NG 33 & 34	6	1	5	11	190	0	16	0.01
NG 41 Mababe (high density)	0	0	0	0	0	0	0	0.00
NG 41 Mababe (low density)	0	0	0	0	0	0	0	0.00
NG 42 (high density)	0	0	0	0	0	0	0	0.00
NG 42 (low density)	0	0	0	0	0	0	0	0.00
NG 43 (high density)	0	0	0	0	0	0	0	0.00
NG 43 (low density)	0	0	0	0	0	0	0	0.00
NG 47 & 49	0	0	0	0	0	0	0	0.00
Nxai Pan NP (high density)	0	0	0	0	0	0	0	0.00
Nxai Pan NP (low density)	0	0	0	0	0	0	0	0.00
Maun East	0	0	0	0	0	0	0	0.00
Kwebe	0	0	0	0	0	0	0	0.00
Maun	0	0	0	0	0	0	0	0.00
Shorobe	0	0	0	0	0	0	0	0.00
Maun Southeast	0	0	0	0	0	0	0	0.00
Maun West	0	0	0	0	0	0	0	0.00
NG District Subtotal	**3,394**	**587**	**377**	**748**	**22**	**2,646**	**4,142**	**0.06**
TOTAL	**3,650**	**628**	**384**	**760**	**21**	**2,891**	**4,410**	**0.04**

Figure 38. Estimated density and observations for tsessebe on the 2018 dry-season aerial survey of northern Botswana.

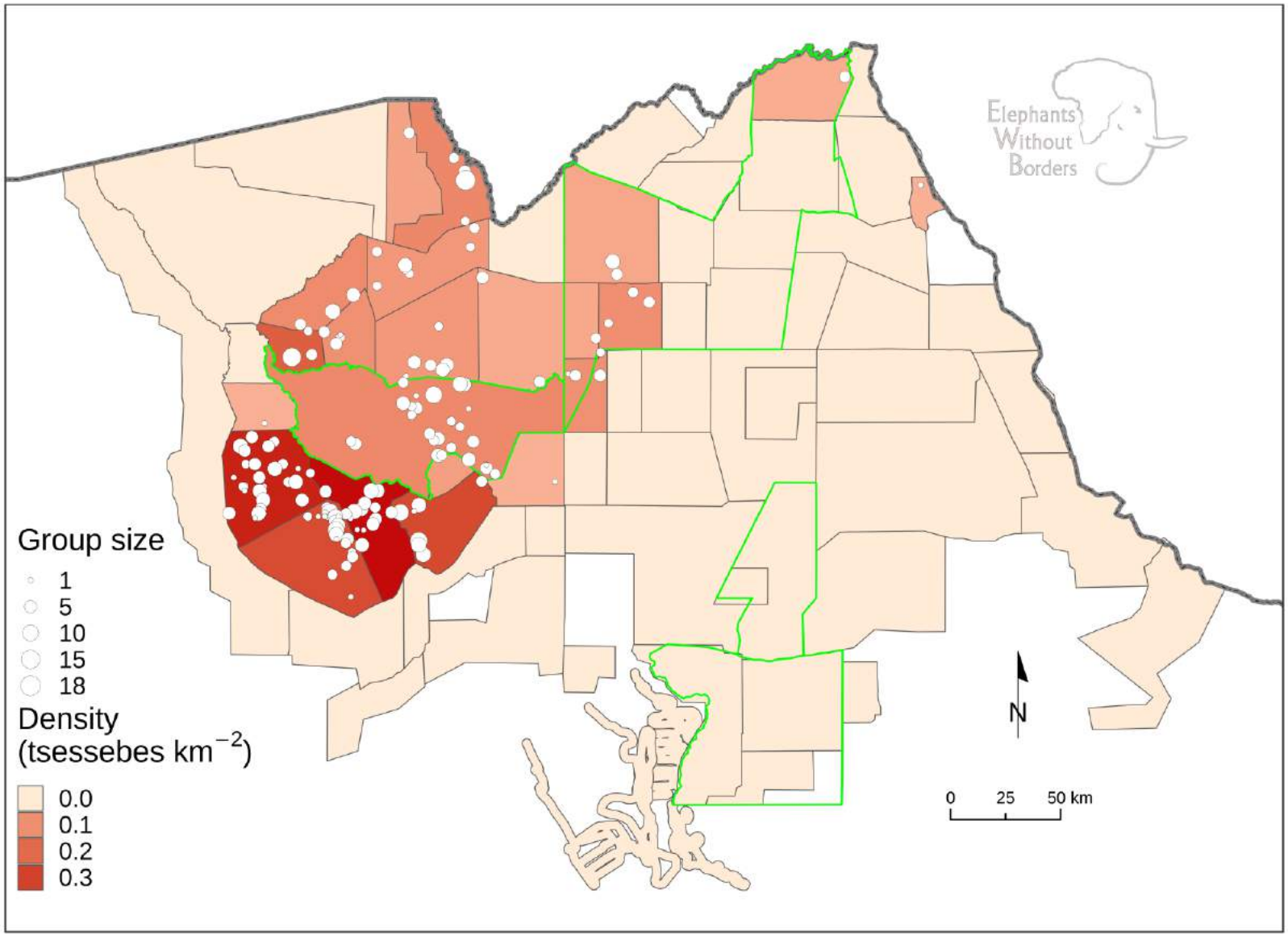


Table 39. Dry season population estimates for warthog

Stratum	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density (animals km^{-2})
Chobe (CH) district								
CH 1 Chobe Enclave	81	14	27	55	68	26	136	0.06
CH 2 Chobe FR (high density)	0	0	0	0	0	0	0	0.00
CH 2 Chobe FR (low density)	0	0	0	0	0	0	0	0.00
CH 4 Kasane FR	0	0	0	0	0	0	0	0.00
CH 5 N Plains	12	1	12	26	216	0	38	0.01
CH 7 & 8	40	3	28	61	151	0	101	0.03
CH 11	35	2	35	86	241	0	121	0.04
CH 12	24	2	23	50	207	0	73	0.02
Nogatsaa C	10	1	10	22	212	0	32	0.01
Chinamba (low density)	0	0	0	0	0	0	0	0.00
Chinamba (high density)	22	2	21	59	266	0	82	0.04
Chobe Mababe	107	20	65	148	138	0	255	0.16
Chobe River	59	11	52	109	186	0	167	0.05
Kazuma FR (total count)	0	0	0	0	0	0	0	0.00
Nogatsaa A and B	42	4	40	83	197	0	126	0.02
Savute East	43	5	26	62	146	0	105	0.05
Savute North	5	1	5	10	188	0	16	0.00
Savute South (high density)	22	4	15	35	161	0	56	0.04
Savute South (low density)	69	7	46	108	157	0	177	0.08
Sibuyu FR	21	4	19	39	184	0	60	0.02
CH District Subtotal	**593**	**81**	**126**	**250**	**42**	**343**	**844**	**0.03**
Central (CT) district								
CT 1 & 2 (high density)	0	0	0	0	0	0	0	0.00
CT 1 & 2 (low density)	0	0	0	0	0	0	0	0.00
CT 3	0	0	0	0	0	0	0	0.00
Ngwasha & Sepako	0	0	0	0	0	0	0	0.00
Mak. NP East	0	0	0	0	0	0	0	0.00
Mak. NP East (salt pans)	0	0	0	0	0	0	0	0.00
Mak. NP West	0	0	0	0	0	0	0	0.00
CT 4 & 7 (recce count)	0	0	0	0	0	0	0	0.00
Boteti River (recce count)	0	0	0	0	0	0	0	0.00
Gweta (total count)	0	0	0	0	0	0	0	0.00
Hainaveld (recce count)	0	0	0	0	0	0	0	0.00
Nata (recce count)	1	1	0	0	0	1	1	0.00
Rakops (recce count)	0	0	0	0	0	0	0	0.00
CT District Subtotal	**1**	**1**	**0**	**0**	**0**	**1**	**1**	**0.00**
Ngamiland (NG) district								
Moremi GR NG 28	1,060	191	186	372	35	688	1,432	0.22
NG 7 & 8 West Okavango	172	15	79	158	92	14	331	0.03
NG 10 & 11	142	28	43	87	61	55	229	0.03
NG 12	97	18	44	91	94	6	187	0.10
NG 13	13	1	13	27	208	0	40	0.00
NG 14 Kwando (high density)	320	54	66	135	42	185	454	0.23
NG 14 Kwando (low density)	44	4	14	35	78	10	79	0.04
NG 15 Linyanti	170	32	54	113	67	57	284	0.14
NG 16 Selinda	159	31	56	114	72	45	273	0.11
NG 18 & 19 Khwai	91	18	32	67	74	24	159	0.05
NG 20 & 21 Splash	31	6	16	32	103	0	63	0.02
NG 22 Vumbra	76	15	52	113	149	0	189	0.12
NG 23 Duba Plains	821	157	212	453	55	369	1,274	1.72

Stratum	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density (animals km^{-2})
NG 24 Jedibe	0	0	0	0	0	0	0	0.00
NG 25 Jao	105	18	46	104	99	1	210	0.18
NG 26 Abu / EBS	288	51	66	136	47	151	424	0.17
NG 27 A & B & NG 30	436	61	98	202	46	234	638	0.32
NG 29	395	70	98	203	51	192	598	0.21
NG 31 & 17 Chitabe	35	7	28	62	176	0	97	0.12
NG 32 Stanleys	496	87	113	233	47	263	729	0.41
NG 33 & 34	79	14	26	56	71	23	135	0.09
NG 41 Mababe (high density)	0	0	0	0	0	0	0	0.00
NG 41 Mababe (low density)	0	0	0	0	0	0	0	0.00
NG 42 (high density)	0	0	0	0	0	0	0	0.00
NG 42 (low density)	0	0	0	0	0	0	0	0.00
NG 43 (high density)	0	0	0	0	0	0	0	0.00
NG 43 (low density)	0	0	0	0	0	0	0	0.00
NG 47 & 49	0	0	0	0	0	0	0	0.00
Nxai Pan NP (high density)	0	0	0	0	0	0	0	0.00
Nxai Pan NP (low density)	0	0	0	0	0	0	0	0.00
Maun East	0	0	0	0	0	0	0	0.00
Kwebe	0	0	0	0	0	0	0	0.00
Maun	5	1	5	10	184	0	15	0.00
Shorobe	0	0	0	0	0	0	0	0.00
Maun Southeast	0	0	0	0	0	0	0	0.00
Maun West	93	9	45	98	106	0	191	0.06
NG District Subtotal	**5,129**	**888**	**383**	**758**	**15**	**4,371**	**5,887**	**0.09**
TOTAL	**5,723**	**970**	**403**	**794**	**14**	**4,930**	**6,517**	**0.06**

Figure 39. Estimated density and observations for warthog on the 2018 dry-season aerial survey of northern Botswana.

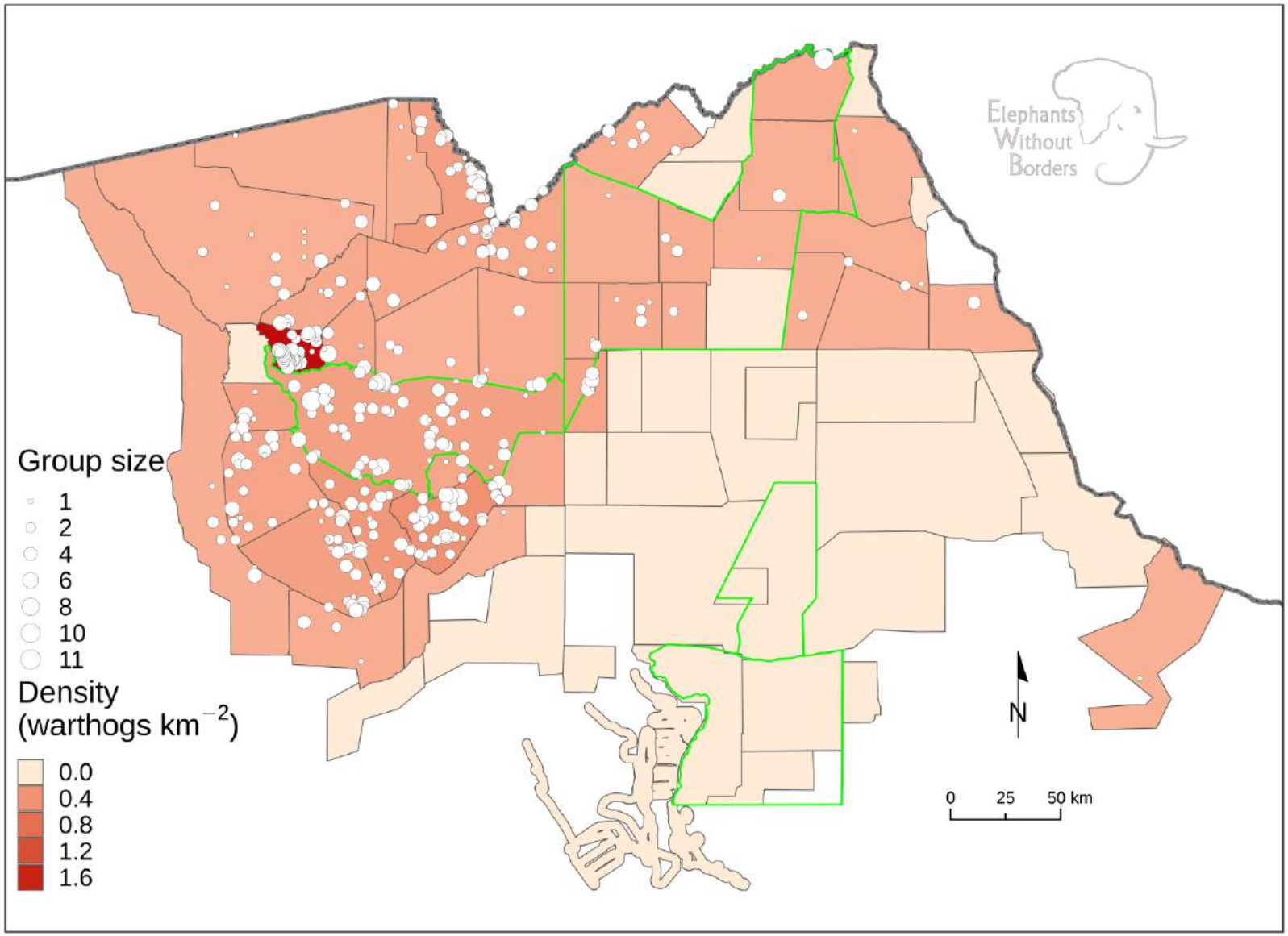


Table 40. Dry season population estimates for waterbuck

Stratum	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density (animals km^{-2})
Chobe (CH) district								
CH 1 Chobe Enclave	99	17	65	135	137	0	234	0.08
CH 2 Chobe FR (high density)	6	1	6	12	200	0	18	0.01
CH 2 Chobe FR (low density)	0	0	0	0	0	0	0	0.00
CH 4 Kasane FR	0	0	0	0	0	0	0	0.00
CH 5 N Plains	0	0	0	0	0	0	0	0.00
CH 7 & 8	0	0	0	0	0	0	0	0.00
CH 11	0	0	0	0	0	0	0	0.00
CH 12	0	0	0	0	0	0	0	0.00
Nogatsaa C	0	0	0	0	0	0	0	0.00
Chinamba (low density)	0	0	0	0	0	0	0	0.00
Chinamba (high density)	0	0	0	0	0	0	0	0.00
Chobe Mababe	5	1	5	11	205	0	16	0.01
Chobe River	117	22	107	221	189	0	338	0.10
Kazuma FR (total count)	0	0	0	0	0	0	0	0.00
Nogatsaa A and B	0	0	0	0	0	0	0	0.00
Savute East	0	0	0	0	0	0	0	0.00
Savute North	0	0	0	0	0	0	0	0.00
Savute South (high density)	0	0	0	0	0	0	0	0.00
Savute South (low density)	0	0	0	0	0	0	0	0.00
Sibuyu FR	0	0	0	0	0	0	0	0.00
CH District Subtotal	**227**	**41**	**125**	**322**	**142**	**41**	**549**	**0.01**
Central (CT) district								
CT 1 & 2 (high density)	0	0	0	0	0	0	0	0.00
CT 1 & 2 (low density)	0	0	0	0	0	0	0	0.00
CT 3	0	0	0	0	0	0	0	0.00
Ngwasha & Sepako	0	0	0	0	0	0	0	0.00
Mak. NP East	0	0	0	0	0	0	0	0.00
Mak. NP East (salt pans)	0	0	0	0	0	0	0	0.00
Mak. NP West	0	0	0	0	0	0	0	0.00
CT 4 & 7 (recce count)	0	0	0	0	0	0	0	0.00
Boteti River (recce count)	0	0	0	0	0	0	0	0.00
Gweta (total count)	0	0	0	0	0	0	0	0.00
Hainaveld (recce count)	0	0	0	0	0	0	0	0.00
Nata (recce count)	0	0	0	0	0	0	0	0.00
Rakops (recce count)	0	0	0	0	0	0	0	0.00
CT District Subtotal	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0.00**
Ngamiland (NG) district								
Moremi GR NG 28	283	51	80	160	56	123	443	0.06
NG 7 & 8 West Okavango	0	0	0	0	0	0	0	0.00
NG 10 & 11	0	0	0	0	0	0	0	0.00
NG 12	0	0	0	0	0	0	0	0.00
NG 13	0	0	0	0	0	0	0	0.00
NG 14 Kwando (high density)	0	0	0	0	0	0	0	0.00
NG 14 Kwando (low density)	0	0	0	0	0	0	0	0.00
NG 15 Linyanti	59	11	27	58	99	1	116	0.05
NG 16 Selinda	0	0	0	0	0	0	0	0.00
NG 18 & 19 Khwai	152	30	72	151	99	1	303	0.08
NG 20 & 21 Splash	52	10	26	54	106	0	106	0.03
NG 22 Vumbra	45	9	32	70	154	0	115	0.07
NG 23 Duba Plains	42	8	27	58	139	0	100	0.09

Stratum	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density (animals km^{-2})
NG 24 Jedibe	0	0	0	0	0	0	0	0.00
NG 25 Jao	0	0	0	0	0	0	0	0.00
NG 26 Abu / EBS	0	0	0	0	0	0	0	0.00
NG 27 A & B & NG 30	0	0	0	0	0	0	0	0.00
NG 29	0	0	0	0	0	0	0	0.00
NG 31 & 17 Chitabe	100	20	48	107	106	0	207	0.36
NG 32 Stanleys	11	2	10	21	186	0	33	0.01
NG 33 & 34	0	0	0	0	0	0	0	0.00
NG 41 Mababe (high density)	0	0	0	0	0	0	0	0.00
NG 41 Mababe (low density)	0	0	0	0	0	0	0	0.00
NG 42 (high density)	0	0	0	0	0	0	0	0.00
NG 42 (low density)	0	0	0	0	0	0	0	0.00
NG 43 (high density)	0	0	0	0	0	0	0	0.00
NG 43 (low density)	0	0	0	0	0	0	0	0.00
NG 47 & 49	0	0	0	0	0	0	0	0.00
Nxai Pan NP (high density)	0	0	0	0	0	0	0	0.00
Nxai Pan NP (low density)	0	0	0	0	0	0	0	0.00
Maun East	0	0	0	0	0	0	0	0.00
Kwebe	0	0	0	0	0	0	0	0.00
Maun	21	4	19	38	184	0	59	0.02
Shorobe	0	0	0	0	0	0	0	0.00
Maun Southeast	0	0	0	0	0	0	0	0.00
Maun West	0	0	0	0	0	0	0	0.00
NG District Subtotal	**765**	**145**	**133**	**270**	**35**	**495**	**1,036**	**0.01**
TOTAL	**993**	**186**	**182**	**365**	**37**	**628**	**1,358**	**0.01**

Figure 40. Estimated density and observations for waterbuck on the 2018 dry-season aerial survey of northern Botswana.

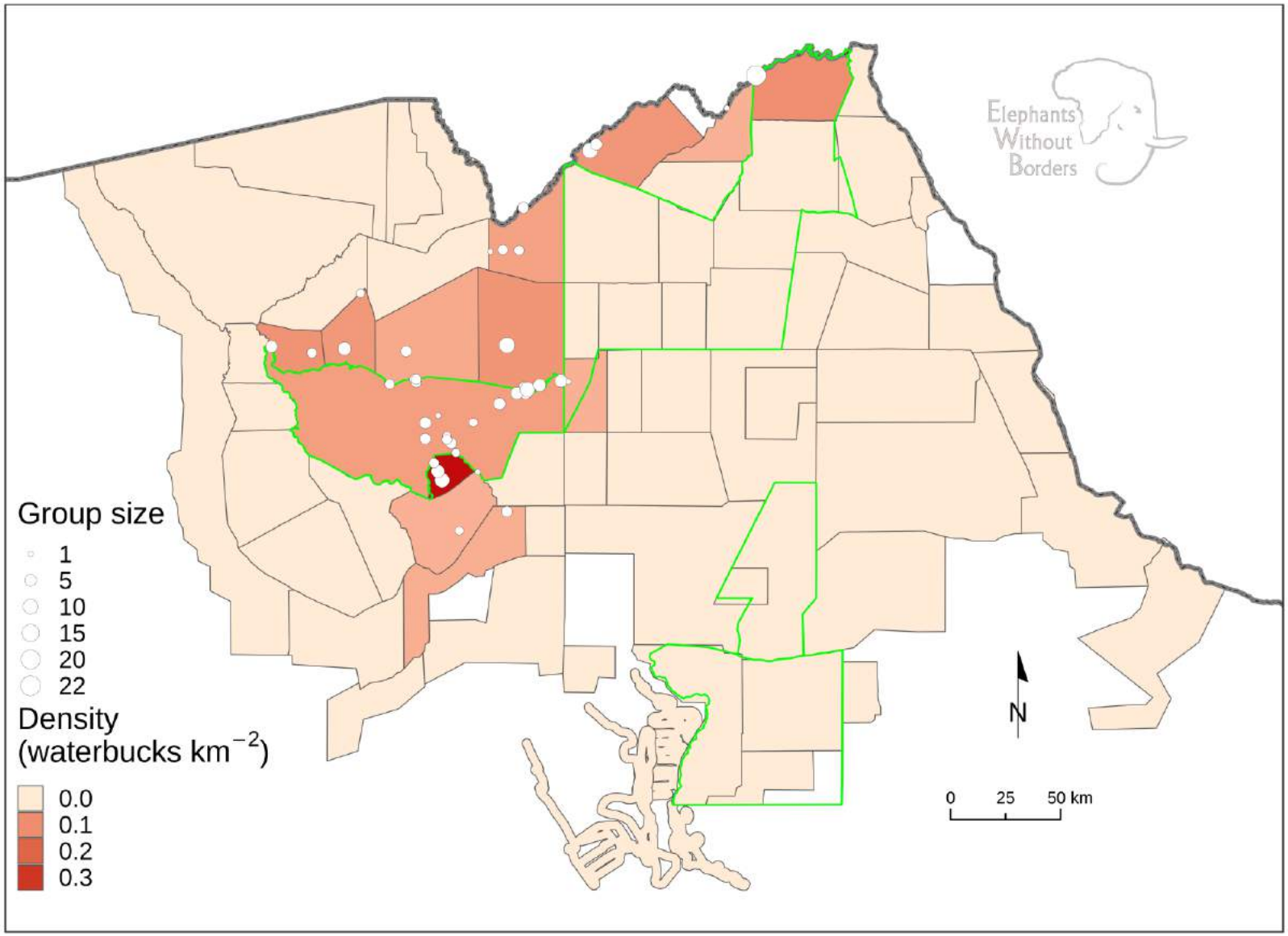


Table 41. Dry season population estimates for wildebeest

Stratum	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density (animals km^{-2})
Chobe (CH) district								
CH 1 Chobe Enclave	29	5	21	44	152	0	73	0.02
CH 2 Chobe FR (high density)	0	0	0	0	0	0	0	0.00
CH 2 Chobe FR (low density)	0	0	0	0	0	0	0	0.00
CH 4 Kasane FR	0	0	0	0	0	0	0	0.00
CH 5 N Plains	0	0	0	0	0	0	0	0.00
CH 7 & 8	0	0	0	0	0	0	0	0.00
CH 11	0	0	0	0	0	0	0	0.00
CH 12	0	0	0	0	0	0	0	0.00
Nogatsaa C	0	0	0	0	0	0	0	0.00
Chinamba (low density)	0	0	0	0	0	0	0	0.00
Chinamba (high density)	0	0	0	0	0	0	0	0.00
Chobe Mababe	364	68	290	655	180	0	1,019	0.54
Chobe River	0	0	0	0	0	0	0	0.00
Kazuma FR (total count)	3	3	0	0	0	3	3	0.01
Nogatsaa A and B	0	0	0	0	0	0	0	0.00
Savute East	0	0	0	0	0	0	0	0.00
Savute North	184	34	85	176	96	8	359	0.09
Savute South (high density)	0	0	0	0	0	0	0	0.00
Savute South (low density)	0	0	0	0	0	0	0	0.00
Sibuyu FR	0	0	0	0	0	0	0	0.00
CH District Subtotal	**580**	**110**	**302**	**1,127**	**194**	**110**	**1,707**	**0.03**
Central (CT) district								
CT 1 & 2 (high density)	0	0	0	0	0	0	0	0.00
CT 1 & 2 (low density)	0	0	0	0	0	0	0	0.00
CT 3	0	0	0	0	0	0	0	0.00
Ngwasha & Sepako	0	0	0	0	0	0	0	0.00
Mak. NP East	8,119	655	3,691	8,350	103	0	16,469	4.14
Mak. NP East (salt pans)	0	0	0	0	0	0	0	0.00
Mak. NP West	361	64	238	483	134	0	844	0.17
CT 4 & 7 (recce count)	0	0	0	0	0	0	0	0.00
Boteti River (recce count)	0	0	0	0	0	0	0	0.00
Gweta (total count)	2,518	2,518	0	0	0	2,518	2,518	5.70
Hainaveld (recce count)	0	0	0	0	0	0	0	0.00
Nata (recce count)	0	0	0	0	0	0	0	0.00
Rakops (recce count)	0	0	0	0	0	0	0	0.00
CT District Subtotal	**10,998**	**3,237**	**3,699**	**46,090**	**419**	**3,237**	**57,087**	**0.45**
Ngamiland (NG) district								
Moremi GR NG 28	644	116	277	553	86	91	1,196	0.13
NG 7 & 8 West Okavango	0	0	0	0	0	0	0	0.00
NG 10 & 11	0	0	0	0	0	0	0	0.00
NG 12	177	33	159	328	186	0	505	0.18
NG 13	236	18	143	302	128	0	539	0.08
NG 14 Kwando (high density)	568	96	236	480	84	89	1,048	0.40
NG 14 Kwando (low density)	77	7	70	180	232	0	257	0.08
NG 15 Linyanti	69	13	36	75	108	0	144	0.06
NG 16 Selinda	164	32	85	174	106	0	337	0.12
NG 18 & 19 Khwai	81	16	48	101	124	0	182	0.04
NG 20 & 21 Splash	464	90	203	419	90	46	883	0.25
NG 22 Vumbra	51	10	33	71	141	0	122	0.08
NG 23 Duba Plains	58	11	35	75	130	0	132	0.12

Stratum	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density (animals km^{-2})
NG 24 Jedibe	0	0	0	0	0	0	0	0.00
NG 25 Jao	18	3	16	36	207	0	54	0.03
NG 26 Abu / EBS	356	63	147	303	85	52	659	0.20
NG 27 A & B & NG 30	729	102	430	888	122	0	1,617	0.54
NG 29	581	103	191	394	68	187	975	0.31
NG 31 & 17 Chitabe	15	3	13	29	195	0	44	0.05
NG 32 Stanleys	969	170	302	625	64	345	1,594	0.80
NG 33 & 34	107	19	54	116	108	0	223	0.12
NG 41 Mababe (high density)	0	0	0	0	0	0	0	0.00
NG 41 Mababe (low density)	0	0	0	0	0	0	0	0.00
NG 42 (high density)	0	0	0	0	0	0	0	0.00
NG 42 (low density)	0	0	0	0	0	0	0	0.00
NG 43 (high density)	0	0	0	0	0	0	0	0.00
NG 43 (low density)	0	0	0	0	0	0	0	0.00
NG 47 & 49	0	0	0	0	0	0	0	0.00
Nxai Pan NP (high density)	17	3	16	37	218	0	54	0.05
Nxai Pan NP (low density)	58	5	54	113	195	0	171	0.03
Maun East	0	0	0	0	0	0	0	0.00
Kwebe	0	0	0	0	0	0	0	0.00
Maun	0	0	0	0	0	0	0	0.00
Shorobe	0	0	0	0	0	0	0	0.00
Maun Southeast	0	0	0	0	0	0	0	0.00
Maun West	0	0	0	0	0	0	0	0.00
NG District Subtotal	**5,440**	**913**	**760**	**1,506**	**28**	**3,933**	**6,946**	**0.09**
TOTAL	**17,017**	**4,260**	**3,788**	**7,778**	**46**	**9,240**	**24,795**	**0.16**

Figure 41. Estimated density and observations for wildebeest on the 2018 dry-season aerial survey of northern Botswana.

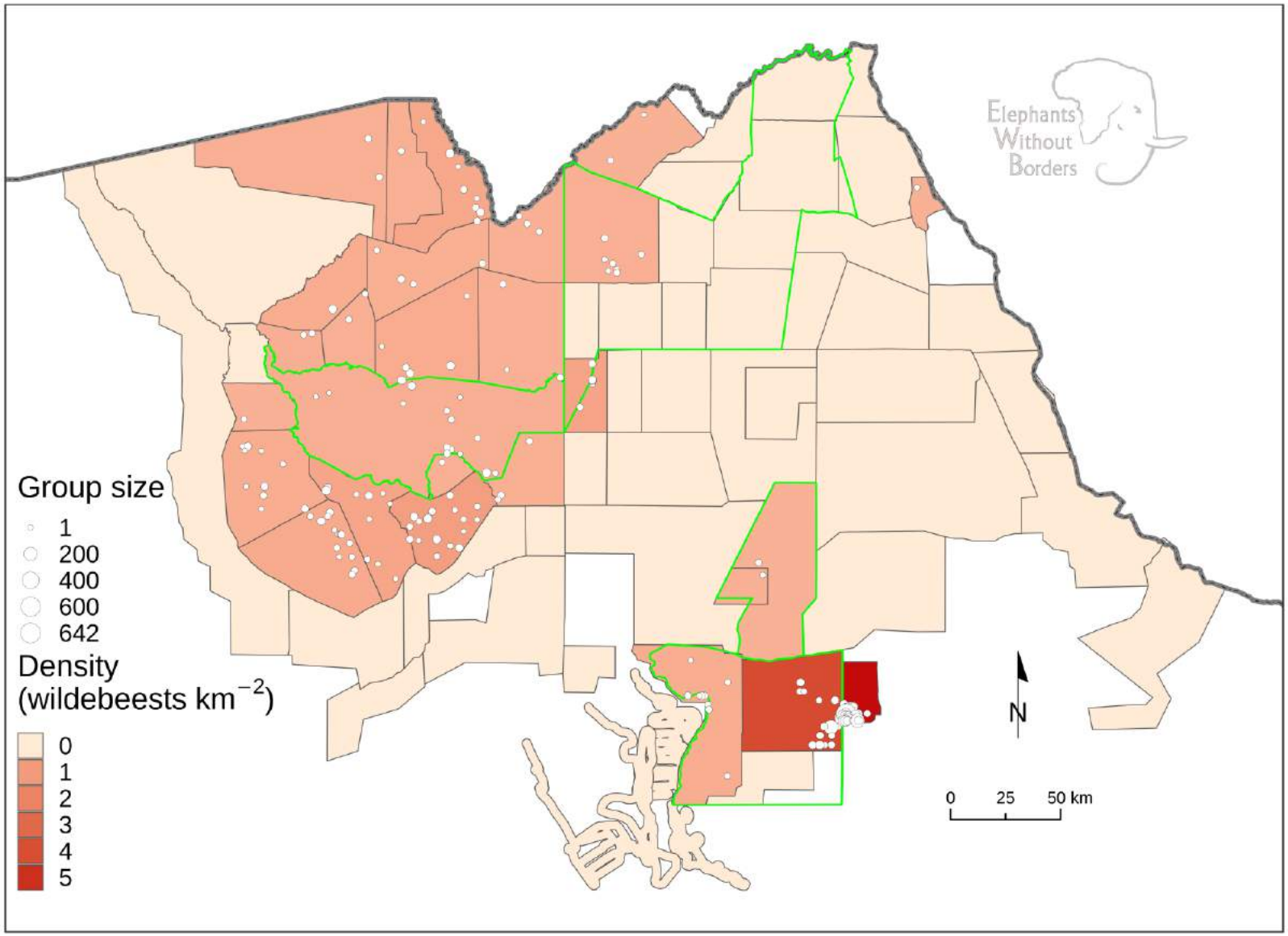


Table 42. Dry season population estimates for zebra

Stratum	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density (animals km^{-2})
Chobe (CH) district								
CH 1 Chobe Enclave	4,658	803	1,919	3,970	85	688	8,628	3.69
CH 2 Chobe FR (high density)	458	77	252	535	117	0	993	0.69
CH 2 Chobe FR (low density)	0	0	0	0	0	0	0	0.00
CH 4 Kasane FR	24	4	21	45	189	0	69	0.06
CH 5 N Plains	0	0	0	0	0	0	0	0.00
CH 7 & 8	241	18	124	273	113	0	514	0.18
CH 11	35	2	35	85	238	0	120	0.04
CH 12	0	0	0	0	0	0	0	0.00
Nogatsaa C	0	0	0	0	0	0	0	0.00
Chinamba (low density)	0	0	0	0	0	0	0	0.00
Chinamba (high density)	0	0	0	0	0	0	0	0.00
Chobe Mababe	402	75	119	269	67	132	671	0.60
Chobe River	1,715	322	673	1,395	81	320	3,110	1.43
Kazuma FR (total count)	35	35	0	0	0	35	35	0.14
Nogatsaa A and B	0	0	0	0	0	0	0	0.00
Savute East	119	14	113	266	224	0	386	0.15
Savute North	243	45	84	174	72	69	417	0.12
Savute South (high density)	0	0	0	0	0	0	0	0.00
Savute South (low density)	0	0	0	0	0	0	0	0.00
Sibuyu FR	90	17	67	138	153	0	228	0.07
CH District Subtotal	**8,020**	**1,412**	**2,063**	**4,501**	**56**	**3,519**	**12,522**	**0.38**
Central (CT) district								
CT 1 & 2 (high density)	0	0	0	0	0	0	0	0.00
CT 1 & 2 (low density)	0	0	0	0	0	0	0	0.00
CT 3	0	0	0	0	0	0	0	0.00
Ngwasha & Sepako	290	51	124	253	88	36	543	0.13
Mak. NP East	1,958	158	1,009	2,283	117	0	4,242	1.00
Mak. NP East (salt pans)	0	0	0	0	0	0	0	0.00
Mak. NP West	19,446	3,450	5,573	11,315	58	8,132	30,761	9.31
CT 4 & 7 (recce count)	0	0	0	0	0	0	0	0.00
Boteti River (recce count)	0	0	0	0	0	0	0	0.00
Gweta (total count)	2,331	2,331	0	0	0	2,331	2,331	5.28
Hainaveld (recce count)	0	0	0	0	0	0	0	0.00
Nata (recce count)	0	0	0	0	0	0	0	0.00
Rakops (recce count)	0	0	0	0	0	0	0	0.00
CT District Subtotal	**24,025**	**5,990**	**5,665**	**22,975**	**96**	**5,990**	**47,001**	**0.98**
Ngamiland (NG) district								
Moremi GR NG 28	2,914	525	442	882	30	2,031	3,796	0.59
NG 7 & 8 West Okavango	1,746	152	797	1,598	91	149	3,344	0.34
NG 10 & 11	289	57	96	191	66	98	480	0.05
NG 12	2,477	462	539	1,115	45	1,363	3,592	2.52
NG 13	1,799	137	510	1,075	60	723	2,874	0.62
NG 14 Kwando (high density)	995	168	232	472	47	523	1,467	0.70
NG 14 Kwando (low density)	155	14	64	165	107	0	320	0.15
NG 15 Linyanti	335	63	111	235	70	100	570	0.28
NG 16 Selinda	630	123	170	347	55	283	977	0.45
NG 18 & 19 Khwai	432	85	155	323	75	109	755	0.23
NG 20 & 21 Splash	294	57	96	199	68	96	493	0.16
NG 22 Vumbra	470	93	202	440	94	30	910	0.74
NG 23 Duba Plains	282	54	140	297	105	0	580	0.59

Stratum	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density (animals km^{-2})
NG 24 Jedibe	0	0	0	0	0	0	0	0.00
NG 25 Jao	293	50	163	369	126	0	662	0.49
NG 26 Abu / EBS	2,901	514	514	1,058	36	1,842	3,959	1.67
NG 27 A & B & NG 30	851	119	236	488	57	363	1,338	0.62
NG 29	1,174	208	279	574	49	599	1,748	0.63
NG 31 & 17 Chitabe	156	31	61	136	88	19	292	0.55
NG 32 Stanleys	2,960	519	668	1,382	47	1,578	4,342	2.44
NG 33 & 34	198	35	83	177	89	21	374	0.22
NG 41 Mababe (high density)	0	0	0	0	0	0	0	0.00
NG 41 Mababe (low density)	0	0	0	0	0	0	0	0.00
NG 42 (high density)	12	2	11	23	196	0	34	0.01
NG 42 (low density)	0	0	0	0	0	0	0	0.00
NG 43 (high density)	13	1	13	41	306	0	54	0.02
NG 43 (low density)	0	0	0	0	0	0	0	0.00
NG 47 & 49	6,751	311	6,834	16,159	239	0	22,910	1.79
Nxai Pan NP (high density)	0	0	0	0	0	0	0	0.00
Nxai Pan NP (low density)	0	0	0	0	0	0	0	0.00
Maun East	0	0	0	0	0	0	0	0.00
Kwebe	0	0	0	0	0	0	0	0.00
Maun	0	0	0	0	0	0	0	0.00
Shorobe	0	0	0	0	0	0	0	0.00
Maun Southeast	0	0	0	0	0	0	0	0.00
Maun West	0	0	0	0	0	0	0	0.00
NG District Subtotal	**28,125**	**3,780**	**7,012**	**14,459**	**51**	**13,665**	**42,584**	**0.48**
TOTAL	**60,170**	**11,182**	**9,247**	**18,399**	**31**	**41,771**	**78,569**	**0.58**

Figure 42. Estimated density and observations for zebra on the 2018 dry-season aerial survey of northern Botswana.

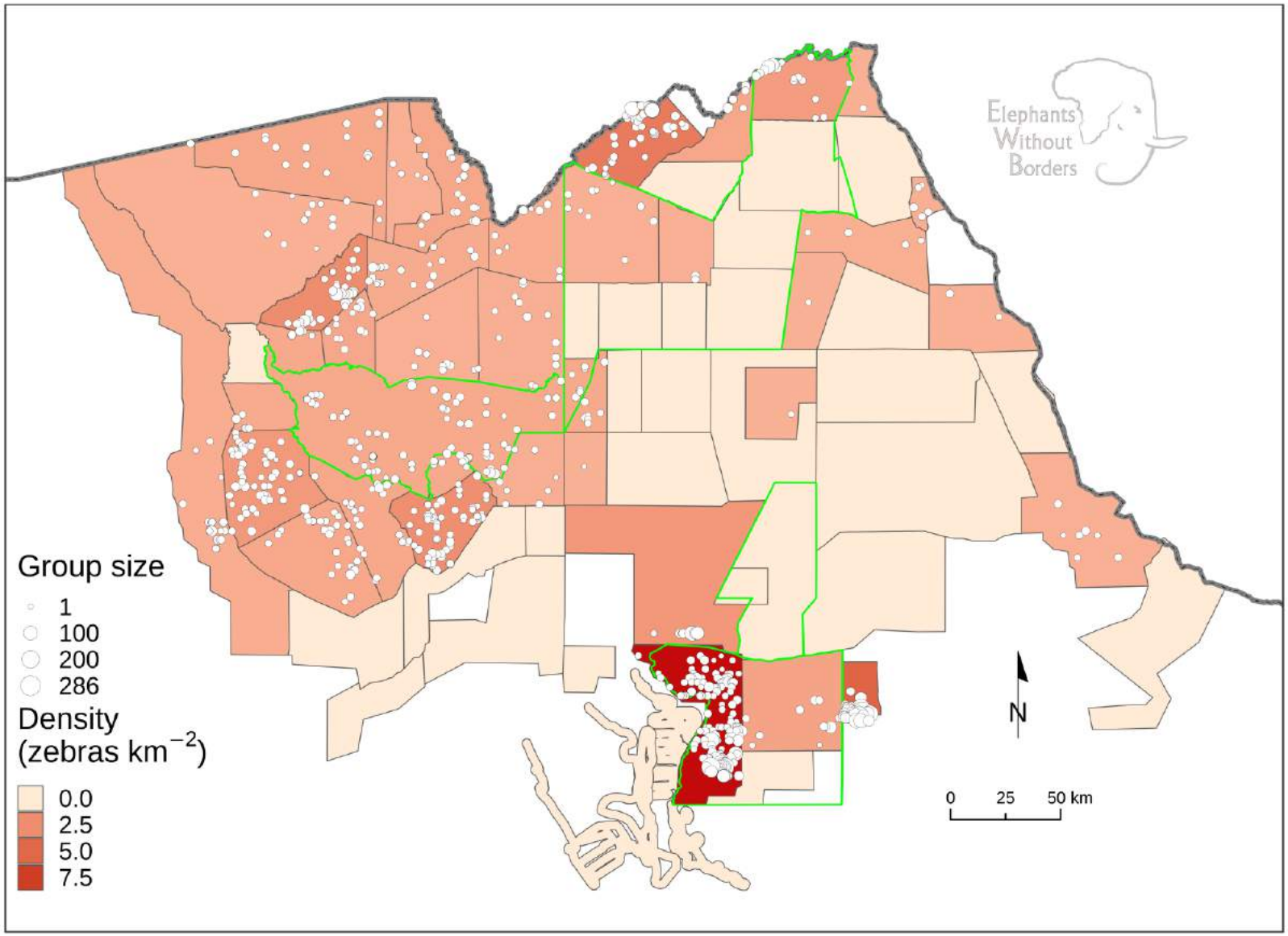


Table 43. Dry season population estimates for hyena

Stratum	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density (animals km^{-2})
Chobe (CH) district								
CH 1 Chobe Enclave	0	0	0	0	0	0	0	0.00
CH 2 Chobe FR (high density)	0	0	0	0	0	0	0	0.00
CH 2 Chobe FR (low density)	0	0	0	0	0	0	0	0.00
CH 4 Kasane FR	0	0	0	0	0	0	0	0.00
CH 5 N Plains	0	0	0	0	0	0	0	0.00
CH 7 & 8	0	0	0	0	0	0	0	0.00
CH 11	0	0	0	0	0	0	0	0.00
CH 12	0	0	0	0	0	0	0	0.00
Nogatsaa C	0	0	0	0	0	0	0	0.00
Chinamba (low density)	0	0	0	0	0	0	0	0.00
Chinamba (high density)	0	0	0	0	0	0	0	0.00
Chobe Mababe	11	2	10	22	205	0	33	0.02
Chobe River	0	0	0	0	0	0	0	0.00
Kazuma FR (total count)	0	0	0	0	0	0	0	0.00
Nogatsaa A and B	0	0	0	0	0	0	0	0.00
Savute East	0	0	0	0	0	0	0	0.00
Savute North	16	3	11	22	136	0	38	0.01
Savute South (high density)	0	0	0	0	0	0	0	0.00
Savute South (low density)	0	0	0	0	0	0	0	0.00
Sibuyu FR	0	0	0	0	0	0	0	0.00
CH District Subtotal	**27**	**5**	**14**	**62**	**231**	**5**	**89**	**0.00**
Central (CT) district								
CT 1 & 2 (high density)	0	0	0	0	0	0	0	0.00
CT 1 & 2 (low density)	0	0	0	0	0	0	0	0.00
CT 3	0	0	0	0	0	0	0	0.00
Ngwasha & Sepako	6	1	5	11	187	0	16	0.00
Mak. NP East	0	0	0	0	0	0	0	0.00
Mak. NP East (salt pans)	0	0	0	0	0	0	0	0.00
Mak. NP West	0	0	0	0	0	0	0	0.00
CT 4 & 7 (recce count)	0	0	0	0	0	0	0	0.00
Boteti River (recce count)	0	0	0	0	0	0	0	0.00
Gweta (total count)	0	0	0	0	0	0	0	0.00
Hainaveld (recce count)	0	0	0	0	0	0	0	0.00
Nata (recce count)	0	0	0	0	0	0	0	0.00
Rakops (recce count)	0	0	0	0	0	0	0	0.00
CT District Subtotal	**6**	**1**	**5**	**66**	**1,160**	**1**	**72**	**0.00**
Ngamiland (NG) district								
Moremi GR NG 28	28	5	18	36	129	0	64	0.01
NG 7 & 8 West Okavango	0	0	0	0	0	0	0	0.00
NG 10 & 11	0	0	0	0	0	0	0	0.00
NG 12	0	0	0	0	0	0	0	0.00
NG 13	0	0	0	0	0	0	0	0.00
NG 14 Kwando (high density)	0	0	0	0	0	0	0	0.00
NG 14 Kwando (low density)	0	0	0	0	0	0	0	0.00
NG 15 Linyanti	0	0	0	0	0	0	0	0.00
NG 16 Selinda	0	0	0	0	0	0	0	0.00
NG 18 & 19 Khwai	30	6	27	57	186	0	87	0.02
NG 20 & 21 Splash	0	0	0	0	0	0	0	0.00
NG 22 Vumbra	0	0	0	0	0	0	0	0.00
NG 23 Duba Plains	0	0	0	0	0	0	0	0.00

Stratum	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density (animals km^{-2})
NG 24 Jedibe	0	0	0	0	0	0	0	0.00
NG 25 Jao	0	0	0	0	0	0	0	0.00
NG 26 Abu / EBS	0	0	0	0	0	0	0	0.00
NG 27 A & B & NG 30	0	0	0	0	0	0	0	0.00
NG 29	0	0	0	0	0	0	0	0.00
NG 31 & 17 Chitabe	0	0	0	0	0	0	0	0.00
NG 32 Stanleys	0	0	0	0	0	0	0	0.00
NG 33 & 34	0	0	0	0	0	0	0	0.00
NG 41 Mababe (high density)	0	0	0	0	0	0	0	0.00
NG 41 Mababe (low density)	0	0	0	0	0	0	0	0.00
NG 42 (high density)	0	0	0	0	0	0	0	0.00
NG 42 (low density)	0	0	0	0	0	0	0	0.00
NG 43 (high density)	0	0	0	0	0	0	0	0.00
NG 43 (low density)	0	0	0	0	0	0	0	0.00
NG 47 & 49	0	0	0	0	0	0	0	0.00
Nxai Pan NP (high density)	0	0	0	0	0	0	0	0.00
Nxai Pan NP (low density)	0	0	0	0	0	0	0	0.00
Maun East	0	0	0	0	0	0	0	0.00
Kwebe	0	0	0	0	0	0	0	0.00
Maun	0	0	0	0	0	0	0	0.00
Shorobe	0	0	0	0	0	0	0	0.00
Maun Southeast	0	0	0	0	0	0	0	0.00
Maun West	0	0	0	0	0	0	0	0.00
NG District Subtotal	**58**	**11**	**33**	**163**	**281**	**11**	**222**	**0.00**
TOTAL	**91**	**17**	**36**	**80**	**88**	**17**	**171**	**0.00**

Figure 43. Estimated density and observations for hyena on the 2018 dry-season aerial survey of northern Botswana.

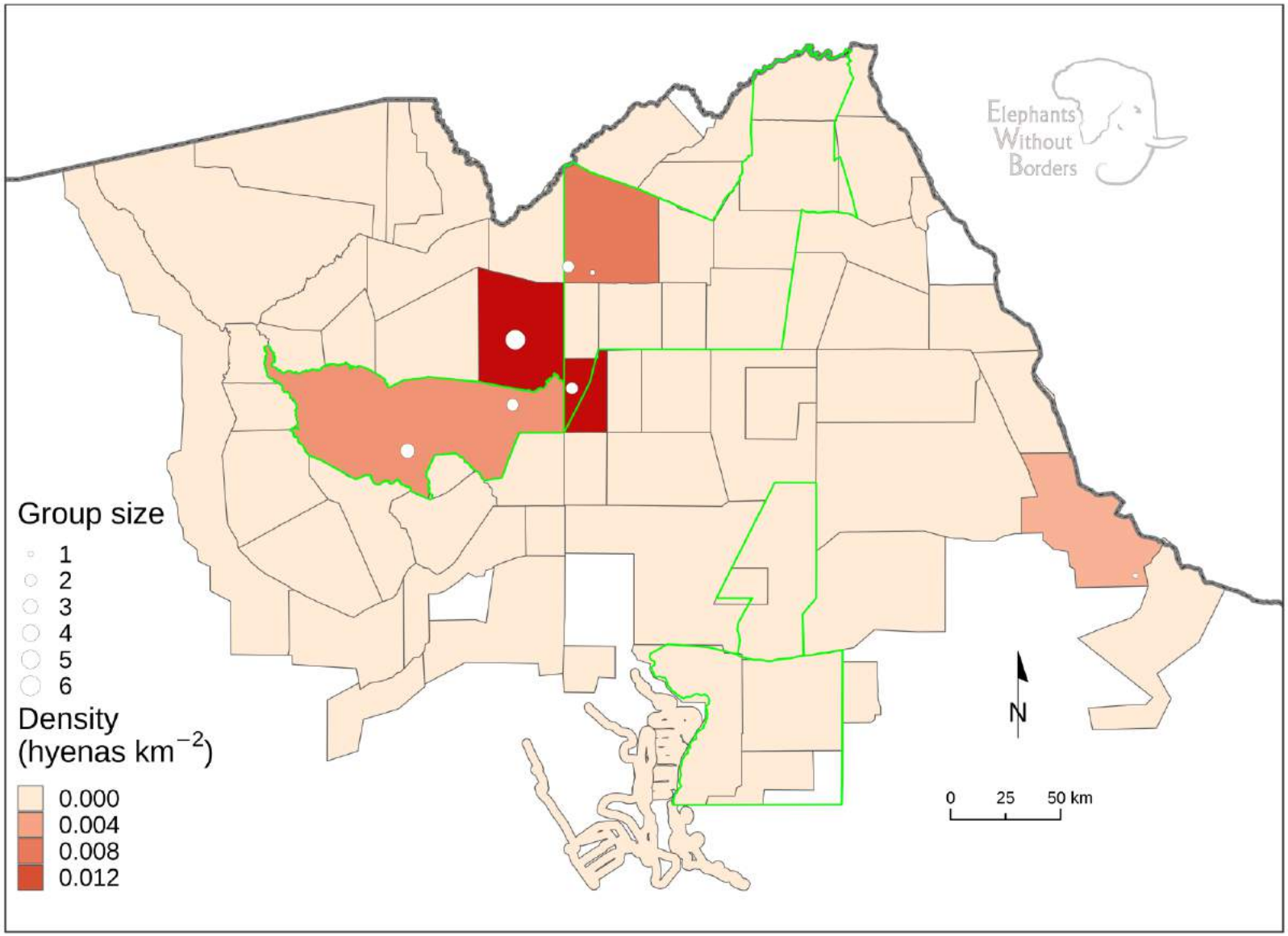


Table 44. Dry season population estimates for bateleur

Stratum	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density (animals km^{-2})
Chobe (CH) district								
CH 1 Chobe Enclave	0	0	0	0	0	0	0	0.00
CH 2 Chobe FR (high density)	0	0	0	0	0	0	0	0.00
CH 2 Chobe FR (low density)	35	3	21	53	152	0	87	0.04
CH 4 Kasane FR	0	0	0	0	0	0	0	0.00
CH 5 N Plains	95	8	57	126	132	0	222	0.06
CH 7 & 8	27	2	26	58	216	0	85	0.02
CH 11	18	1	17	41	232	0	59	0.02
CH 12	24	2	23	50	210	0	74	0.02
Nogatsaa C	0	0	0	0	0	0	0	0.00
Chinamba (low density)	69	4	34	86	124	0	156	0.05
Chinamba (high density)	0	0	0	0	0	0	0	0.00
Chobe Mababe	16	3	10	23	142	0	39	0.02
Chobe River	5	1	5	10	188	0	15	0.00
Kazuma FR (total count)	0	0	0	0	0	0	0	0.00
Nogatsaa A and B	11	1	10	21	197	0	31	0.01
Savute East	0	0	0	0	0	0	0	0.00
Savute North	16	3	8	17	103	0	33	0.01
Savute South (high density)	0	0	0	0	0	0	0	0.00
Savute South (low density)	40	4	28	67	169	0	106	0.05
Sibuyu FR	11	2	7	14	131	0	24	0.01
CH District Subtotal	**366**	**34**	**86**	**173**	**47**	**193**	**539**	**0.02**
Central (CT) district								
CT 1 & 2 (high density)	34	3	23	53	157	0	87	0.01
CT 1 & 2 (low density)	23	1	23	52	229	0	75	0.00
CT 3	12	1	12	26	214	0	39	0.01
Ngwasha & Sepako	40	7	14	28	70	12	68	0.02
Mak. NP East	12	1	12	27	215	0	39	0.01
Mak. NP East (salt pans)	0	0	0	0	0	0	0	0.00
Mak. NP West	17	3	11	23	133	0	39	0.01
CT 4 & 7 (recce count)	0	0	0	0	0	0	0	0.00
Boteti River (recce count)	0	0	0	0	0	0	0	0.00
Gweta (total count)	0	0	0	0	0	0	0	0.00
Hainaveld (recce count)	0	0	0	0	0	0	0	0.00
Nata (recce count)	0	0	0	0	0	0	0	0.00
Rakops (recce count)	0	0	0	0	0	0	0	0.00
CT District Subtotal	**138**	**16**	**40**	**83**	**60**	**55**	**221**	**0.01**
Ngamiland (NG) district								
Moremi GR NG 28	100	18	24	48	48	52	147	0.02
NG 7 & 8 West Okavango	23	2	15	31	134	0	54	0.00
NG 10 & 11	30	6	11	23	74	8	53	0.01
NG 12	16	3	8	16	102	0	32	0.02
NG 13	53	4	30	62	119	0	115	0.02
NG 14 Kwando (high density)	0	0	0	0	0	0	0	0.00
NG 14 Kwando (low density)	0	0	0	0	0	0	0	0.00
NG 15 Linyanti	27	5	15	32	121	0	59	0.02
NG 16 Selinda	31	6	14	29	93	2	59	0.02
NG 18 & 19 Khwai	25	5	9	19	75	6	45	0.01
NG 20 & 21 Splash	31	6	17	34	110	0	65	0.02
NG 22 Vumbra	15	3	8	17	112	0	32	0.02
NG 23 Duba Plains	5	1	5	10	191	0	15	0.01

Stratum	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density (animals km^{-2})
NG 24 Jedibe	5	1	5	10	195	0	16	0.01
NG 25 Jao	18	3	8	19	106	0	36	0.03
NG 26 Abu / EBS	0	0	0	0	0	0	0	0.00
NG 27 A & B & NG 30	14	2	9	18	128	0	33	0.01
NG 29	34	6	11	22	65	12	56	0.02
NG 31 & 17 Chitabe	5	1	4	10	199	0	15	0.02
NG 32 Stanleys	6	1	5	11	192	0	17	0.00
NG 33 & 34	28	5	10	21	73	8	49	0.03
NG 41 Mababe (high density)	0	0	0	0	0	0	0	0.00
NG 41 Mababe (low density)	14	1	14	35	248	0	50	0.01
NG 42 (high density)	6	1	5	11	196	0	17	0.01
NG 42 (low density)	0	0	0	0	0	0	0	0.00
NG 43 (high density)	13	1	13	41	306	0	54	0.02
NG 43 (low density)	0	0	0	0	0	0	0	0.00
NG 47 & 49	43	2	28	66	153	0	110	0.01
Nxai Pan NP (high density)	11	2	6	15	136	0	27	0.03
Nxai Pan NP (low density)	0	0	0	0	0	0	0	0.00
Maun East	0	0	0	0	0	0	0	0.00
Kwebe	0	0	0	0	0	0	0	0.00
Maun	0	0	0	0	0	0	0	0.00
Shorobe	0	0	0	0	0	0	0	0.00
Maun Southeast	0	0	0	0	0	0	0	0.00
Maun West	21	2	20	42	206	0	63	0.01
NG District Subtotal	**575**	**87**	**69**	**136**	**24**	**439**	**711**	**0.01**
TOTAL	**1,079**	**137**	**117**	**231**	**21**	**848**	**1,309**	**0.01**

Figure 44. Estimated density and observations for bateleur on the 2018 dry-season aerial survey of northern Botswana.

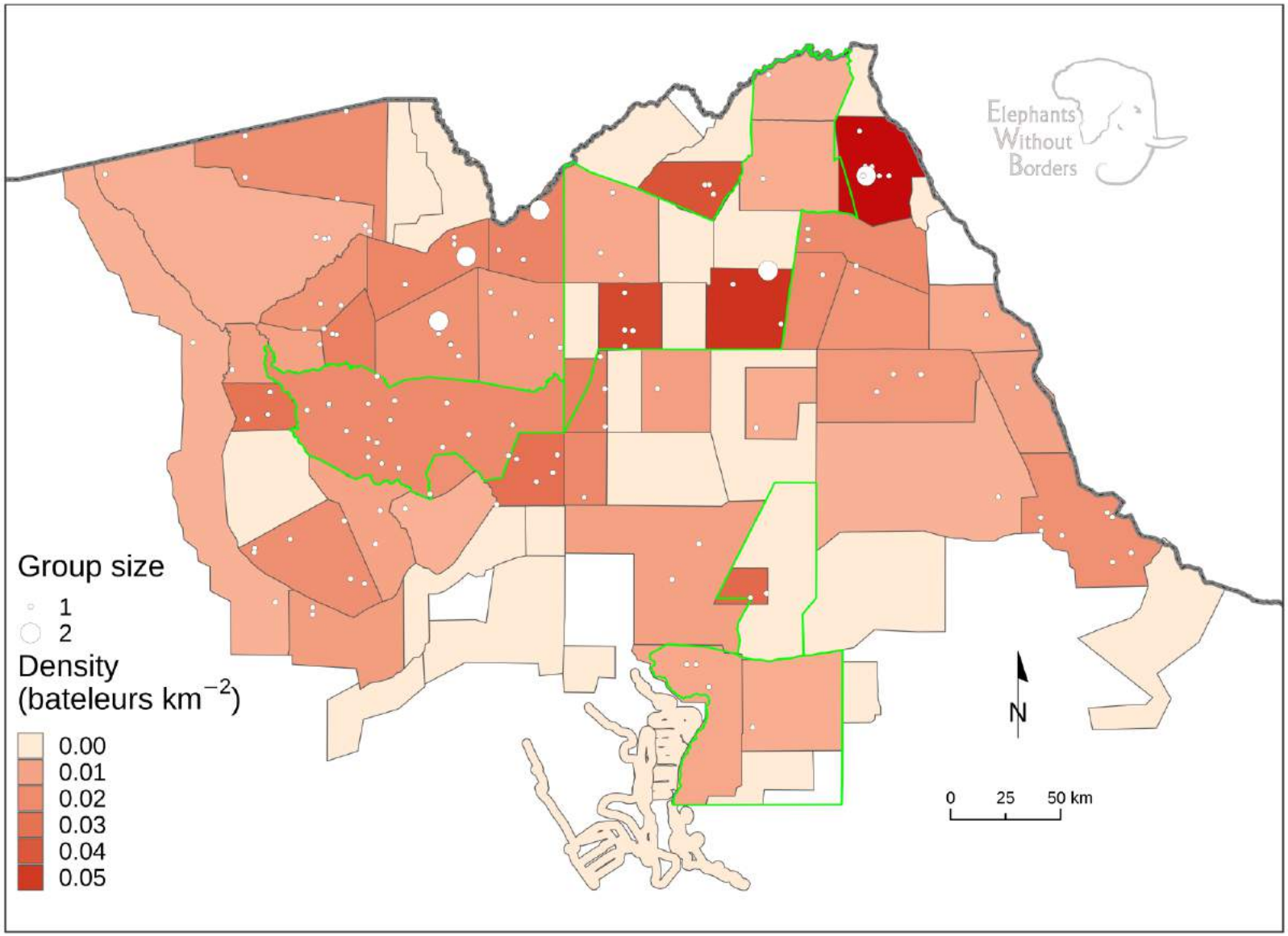


Table 45. Dry season population estimates for fish eagle

Stratum	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density (animals km^{-2})
Chobe (CH) district								
CH 1 Chobe Enclave	12	2	7	15	131	0	27	0.01
CH 2 Chobe FR (high density)	0	0	0	0	0	0	0	0.00
CH 2 Chobe FR (low density)	0	0	0	0	0	0	0	0.00
CH 4 Kasane FR	0	0	0	0	0	0	0	0.00
CH 5 N Plains	0	0	0	0	0	0	0	0.00
CH 7 & 8	0	0	0	0	0	0	0	0.00
CH 11	0	0	0	0	0	0	0	0.00
CH 12	0	0	0	0	0	0	0	0.00
Nogatsaa C	0	0	0	0	0	0	0	0.00
Chinamba (low density)	0	0	0	0	0	0	0	0.00
Chinamba (high density)	0	0	0	0	0	0	0	0.00
Chobe Mababe	5	1	5	11	205	0	16	0.01
Chobe River	0	0	0	0	0	0	0	0.00
Kazuma FR (total count)	0	0	0	0	0	0	0	0.00
Nogatsaa A and B	0	0	0	0	0	0	0	0.00
Savute East	0	0	0	0	0	0	0	0.00
Savute North	0	0	0	0	0	0	0	0.00
Savute South (high density)	0	0	0	0	0	0	0	0.00
Savute South (low density)	0	0	0	0	0	0	0	0.00
Sibuyu FR	0	0	0	0	0	0	0	0.00
CH District Subtotal	**17**	**3**	**9**	**44**	**259**	**3**	**61**	**0.00**
Central (CT) district								
CT 1 & 2 (high density)	0	0	0	0	0	0	0	0.00
CT 1 & 2 (low density)	0	0	0	0	0	0	0	0.00
CT 3	0	0	0	0	0	0	0	0.00
Ngwasha & Sepako	0	0	0	0	0	0	0	0.00
Mak. NP East	0	0	0	0	0	0	0	0.00
Mak. NP East (salt pans)	0	0	0	0	0	0	0	0.00
Mak. NP West	6	1	5	10	183	0	16	0.00
CT 4 & 7 (recce count)	0	0	0	0	0	0	0	0.00
Boteti River (recce count)	0	0	0	0	0	0	0	0.00
Gweta (total count)	0	0	0	0	0	0	0	0.00
Hainaveld (recce count)	0	0	0	0	0	0	0	0.00
Nata (recce count)	0	0	0	0	0	0	0	0.00
Rakops (recce count)	0	0	0	0	0	0	0	0.00
CT District Subtotal	**6**	**1**	**5**	**65**	**1,147**	**1**	**70**	**0.00**
Ngamiland (NG) district								
Moremi GR NG 28	366	66	50	100	27	266	467	0.07
NG 7 & 8 West Okavango	46	4	27	53	116	0	99	0.01
NG 10 & 11	254	50	40	81	32	173	335	0.05
NG 12	91	17	25	52	57	39	143	0.09
NG 13	0	0	0	0	0	0	0	0.00
NG 14 Kwando (high density)	18	3	12	24	133	0	41	0.01
NG 14 Kwando (low density)	0	0	0	0	0	0	0	0.00
NG 15 Linyanti	21	4	11	24	111	0	45	0.02
NG 16 Selinda	0	0	0	0	0	0	0	0.00
NG 18 & 19 Khwai	15	3	7	15	102	0	31	0.01
NG 20 & 21 Splash	52	10	33	68	133	0	120	0.03
NG 22 Vumbra	10	2	9	19	192	0	29	0.02
NG 23 Duba Plains	21	4	9	19	89	2	40	0.04

Stratum	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density (animals km^{-2})
NG 24 Jedibe	232	44	33	72	31	160	304	0.50
NG 25 Jao	316	54	54	122	39	194	438	0.53
NG 26 Abu / EBS	158	28	40	82	52	76	240	0.09
NG 27 A & B & NG 30	207	29	41	84	41	123	292	0.15
NG 29	152	27	30	61	40	92	213	0.08
NG 31 & 17 Chitabe	15	3	7	16	108	0	31	0.05
NG 32 Stanleys	165	29	33	68	41	97	234	0.14
NG 33 & 34	11	2	10	22	192	0	33	0.01
NG 41 Mababe (high density)	0	0	0	0	0	0	0	0.00
NG 41 Mababe (low density)	0	0	0	0	0	0	0	0.00
NG 42 (high density)	0	0	0	0	0	0	0	0.00
NG 42 (low density)	0	0	0	0	0	0	0	0.00
NG 43 (high density)	0	0	0	0	0	0	0	0.00
NG 43 (low density)	0	0	0	0	0	0	0	0.00
NG 47 & 49	0	0	0	0	0	0	0	0.00
Nxai Pan NP (high density)	0	0	0	0	0	0	0	0.00
Nxai Pan NP (low density)	0	0	0	0	0	0	0	0.00
Maun East	0	0	0	0	0	0	0	0.00
Kwebe	0	0	0	0	0	0	0	0.00
Maun	26	5	12	24	93	2	50	0.02
Shorobe	0	0	0	0	0	0	0	0.00
Maun Southeast	0	0	0	0	0	0	0	0.00
Maun West	41	4	22	47	113	0	88	0.03
NG District Subtotal	**2,219**	**388**	**131**	**258**	**12**	**1,961**	**2,477**	**0.04**
TOTAL	**2,242**	**392**	**131**	**258**	**12**	**1,983**	**2,500**	**0.02**

Figure 45. Estimated density and observations for fish eagle on the 2018 dry-season aerial survey of northern Botswana.

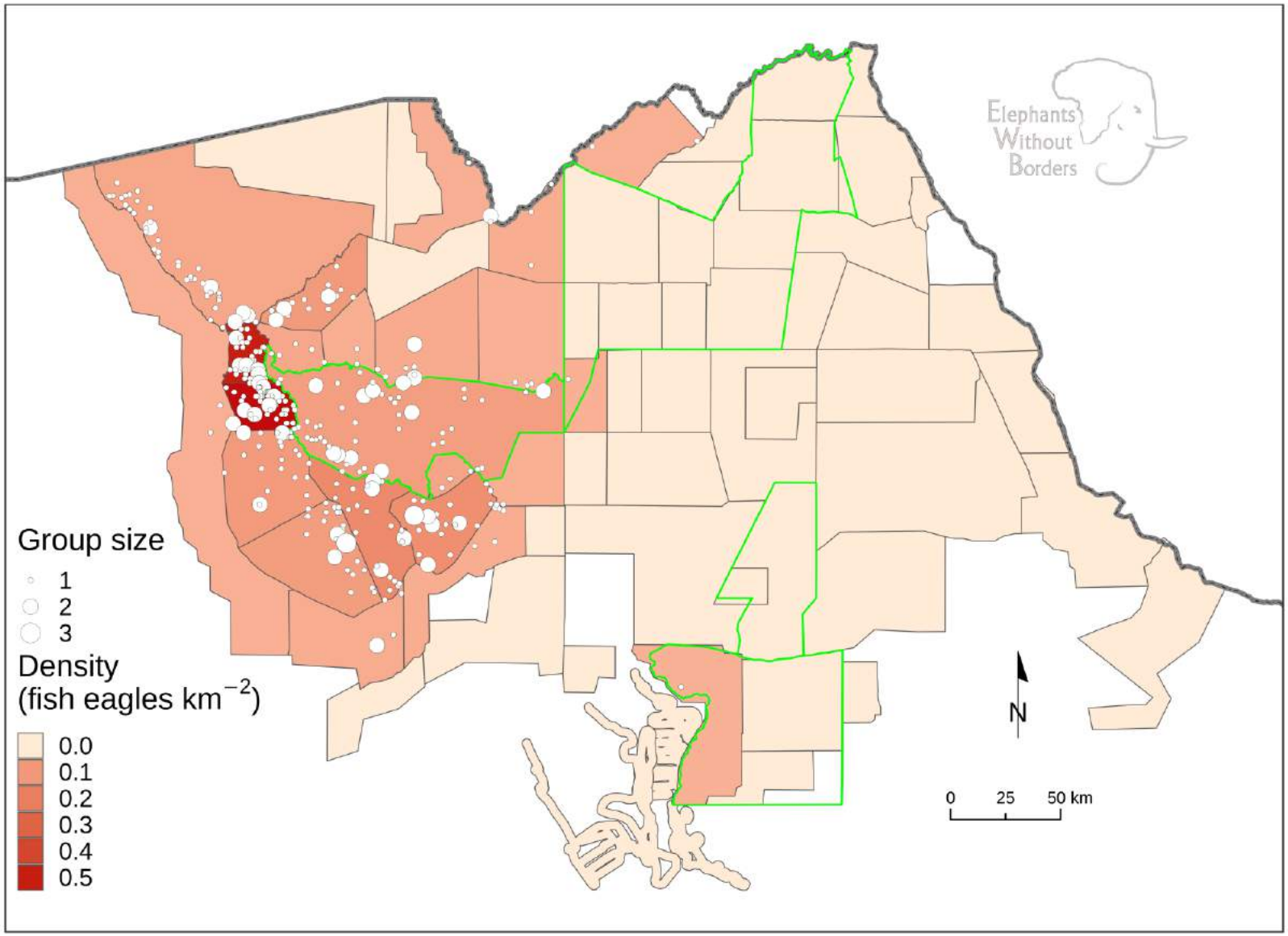


Table 46. Dry season population estimates for ground hornbill

Stratum	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density (animals km^{-2})
Chobe (CH) district								
CH 1 Chobe Enclave	0	0	0	0	0	0	0	0.00
CH 2 Chobe FR (high density)	0	0	0	0	0	0	0	0.00
CH 2 Chobe FR (low density)	0	0	0	0	0	0	0	0.00
CH 4 Kasane FR	24	4	22	48	199	0	72	0.06
CH 5 N Plains	24	2	23	52	216	0	75	0.01
CH 7 & 8	0	0	0	0	0	0	0	0.00
CH 11	0	0	0	0	0	0	0	0.00
CH 12	0	0	0	0	0	0	0	0.00
Nogatsaa C	0	0	0	0	0	0	0	0.00
Chinamba (low density)	0	0	0	0	0	0	0	0.00
Chinamba (high density)	0	0	0	0	0	0	0	0.00
Chobe Mababe	0	0	0	0	0	0	0	0.00
Chobe River	0	0	0	0	0	0	0	0.00
Kazuma FR (total count)	0	0	0	0	0	0	0	0.00
Nogatsaa A and B	0	0	0	0	0	0	0	0.00
Savute East	17	2	16	38	223	0	55	0.02
Savute North	22	4	20	41	188	0	62	0.01
Savute South (high density)	0	0	0	0	0	0	0	0.00
Savute South (low density)	0	0	0	0	0	0	0	0.00
Sibuyu FR	0	0	0	0	0	0	0	0.00
CH District Subtotal	**87**	**12**	**41**	**90**	**104**	**12**	**176**	**0.00**
Central (CT) district								
CT 1 & 2 (high density)	0	0	0	0	0	0	0	0.00
CT 1 & 2 (low density)	0	0	0	0	0	0	0	0.00
CT 3	0	0	0	0	0	0	0	0.00
Ngwasha & Sepako	23	4	20	42	185	0	65	0.01
Mak. NP East	0	0	0	0	0	0	0	0.00
Mak. NP East (salt pans)	0	0	0	0	0	0	0	0.00
Mak. NP West	0	0	0	0	0	0	0	0.00
CT 4 & 7 (recce count)	3	3	0	0	0	3	3	0.00
Boteti River (recce count)	0	0	0	0	0	0	0	0.00
Gweta (total count)	0	0	0	0	0	0	0	0.00
Hainaveld (recce count)	0	0	0	0	0	0	0	0.00
Nata (recce count)	0	0	0	0	0	0	0	0.00
Rakops (recce count)	0	0	0	0	0	0	0	0.00
CT District Subtotal	**26**	**7**	**20**	**260**	**1,013**	**7**	**286**	**0.00**
Ngamiland (NG) district								
Moremi GR NG 28	61	11	27	55	90	6	116	0.01
NG 7 & 8 West Okavango	0	0	0	0	0	0	0	0.00
NG 10 & 11	25	5	16	32	128	0	58	0.00
NG 12	0	0	0	0	0	0	0	0.00
NG 13	0	0	0	0	0	0	0	0.00
NG 14 Kwando (high density)	24	4	22	44	188	0	68	0.02
NG 14 Kwando (low density)	0	0	0	0	0	0	0	0.00
NG 15 Linyanti	0	0	0	0	0	0	0	0.00
NG 16 Selinda	0	0	0	0	0	0	0	0.00
NG 18 & 19 Khwai	0	0	0	0	0	0	0	0.00
NG 20 & 21 Splash	26	5	23	48	186	0	74	0.01
NG 22 Vumbra	5	1	4	10	191	0	15	0.01
NG 23 Duba Plains	0	0	0	0	0	0	0	0.00

Stratum	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density (animals km^{-2})
NG 24 Jedibe	0	0	0	0	0	0	0	0.00
NG 25 Jao	0	0	0	0	0	0	0	0.00
NG 26 Abu / EBS	23	4	20	42	185	0	64	0.01
NG 27 A & B & NG 30	43	6	28	58	134	0	100	0.03
NG 29	17	3	16	32	189	0	49	0.01
NG 31 & 17 Chitabe	40	8	25	55	138	0	96	0.14
NG 32 Stanleys	40	7	27	56	140	0	96	0.03
NG 33 & 34	23	4	21	44	194	0	66	0.02
NG 41 Mababe (high density)	0	0	0	0	0	0	0	0.00
NG 41 Mababe (low density)	0	0	0	0	0	0	0	0.00
NG 42 (high density)	0	0	0	0	0	0	0	0.00
NG 42 (low density)	0	0	0	0	0	0	0	0.00
NG 43 (high density)	0	0	0	0	0	0	0	0.00
NG 43 (low density)	0	0	0	0	0	0	0	0.00
NG 47 & 49	0	0	0	0	0	0	0	0.00
Nxai Pan NP (high density)	0	0	0	0	0	0	0	0.00
Nxai Pan NP (low density)	0	0	0	0	0	0	0	0.00
Maun East	0	0	0	0	0	0	0	0.00
Kwebe	0	0	0	0	0	0	0	0.00
Maun	0	0	0	0	0	0	0	0.00
Shorobe	0	0	0	0	0	0	0	0.00
Maun Southeast	0	0	0	0	0	0	0	0.00
Maun West	0	0	0	0	0	0	0	0.00
NG District Subtotal	**326**	**58**	**72**	**144**	**44**	**182**	**470**	**0.01**
TOTAL	**438**	**77**	**86**	**169**	**39**	**269**	**607**	**0.00**

Figure 46. Estimated density and observations for ground hornbill on the 2018 dry-season aerial survey of northern Botswana.

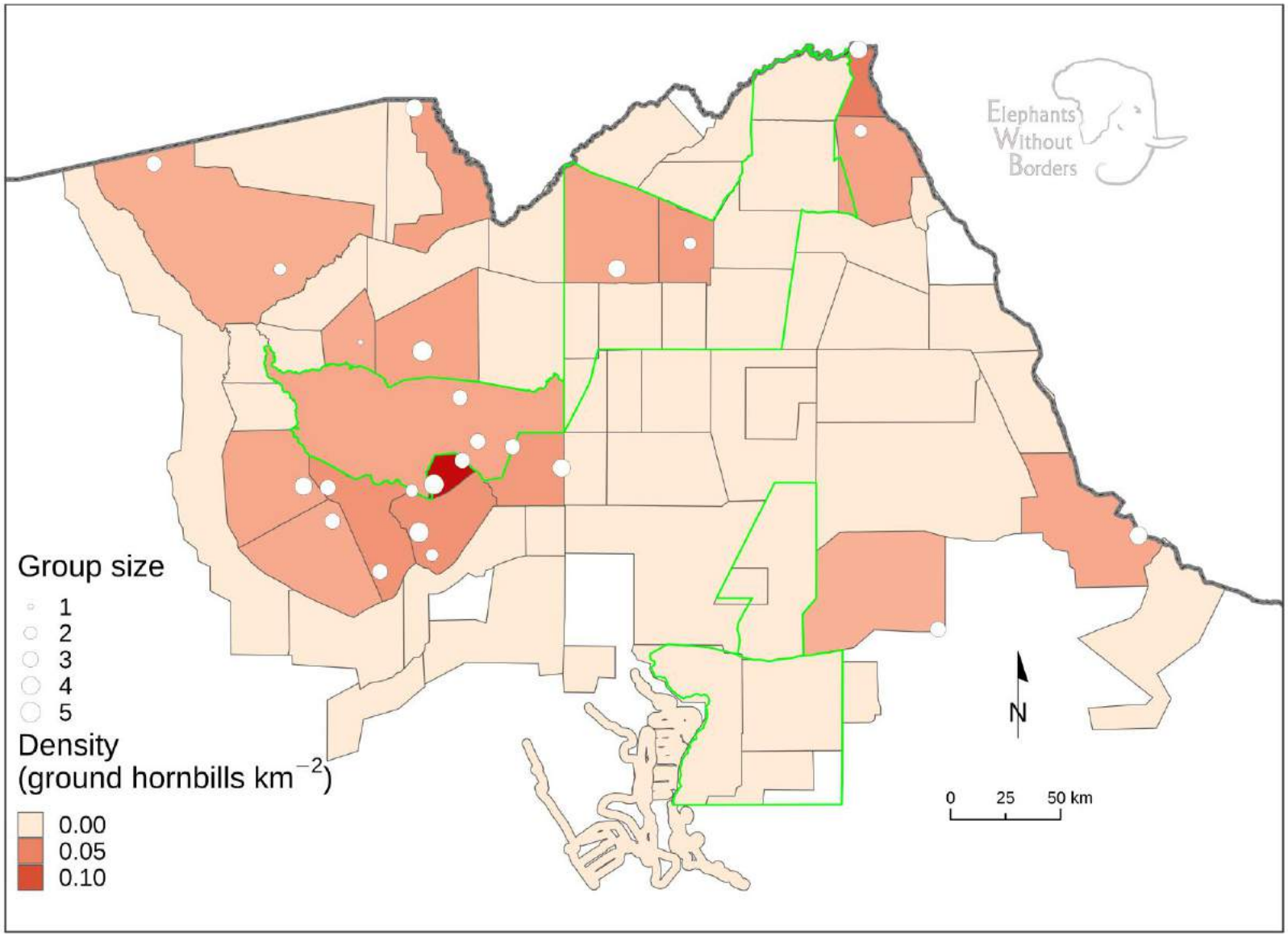


Table 47. Dry season population estimates for ostrich

Stratum	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density (animals km^{-2})
Chobe (CH) district								
CH 1 Chobe Enclave	75	13	30	62	82	14	137	0.06
CH 2 Chobe FR (high density)	0	0	0	0	0	0	0	0.00
CH 2 Chobe FR (low density)	0	0	0	0	0	0	0	0.00
CH 4 Kasane FR	0	0	0	0	0	0	0	0.00
CH 5 N Plains	12	1	11	26	214	0	37	0.01
CH 7 & 8	0	0	0	0	0	0	0	0.00
CH 11	0	0	0	0	0	0	0	0.00
CH 12	0	0	0	0	0	0	0	0.00
Nogatsaa C	0	0	0	0	0	0	0	0.00
Chinamba (low density)	0	0	0	0	0	0	0	0.00
Chinamba (high density)	0	0	0	0	0	0	0	0.00
Chobe Mababe	5	1	5	11	202	0	16	0.01
Chobe River	16	3	11	22	139	0	38	0.01
Kazuma FR (total count)	2	2	0	0	0	2	2	0.01
Nogatsaa A and B	11	1	10	21	197	0	31	0.01
Savute East	0	0	0	0	0	0	0	0.00
Savute North	5	1	5	10	188	0	16	0.00
Savute South (high density)	32	6	21	48	150	0	81	0.06
Savute South (low density)	49	5	47	111	224	0	160	0.06
Sibuyu FR	5	1	5	10	184	0	15	0.00
CH District Subtotal	**214**	**34**	**63**	**130**	**61**	**83**	**344**	**0.01**
Central (CT) district								
CT 1 & 2 (high density)	0	0	0	0	0	0	0	0.00
CT 1 & 2 (low density)	0	0	0	0	0	0	0	0.00
CT 3	0	0	0	0	0	0	0	0.00
Ngwasha & Sepako	74	13	41	84	113	0	158	0.03
Mak. NP East	459	37	200	452	98	7	910	0.23
Mak. NP East (salt pans)	0	0	0	0	0	0	0	0.00
Mak. NP West	592	105	191	387	65	204	979	0.28
CT 4 & 7 (recce count)	0	0	0	0	0	0	0	0.00
Boteti River (recce count)	6	6	0	0	0	6	6	0.01
Gweta (total count)	45	45	0	0	0	45	45	0.10
Hainaveld (recce count)	0	0	0	0	0	0	0	0.00
Nata (recce count)	7	7	0	0	0	7	7	0.00
Rakops (recce count)	0	0	0	0	0	0	0	0.00
CT District Subtotal	**1,182**	**213**	**279**	**763**	**65**	**419**	**1,946**	**0.05**
Ngamiland (NG) district								
Moremi GR NG 28	61	11	32	65	106	0	126	0.01
NG 7 & 8 West Okavango	574	50	184	370	64	204	944	0.11
NG 10 & 11	10	2	6	13	126	0	23	0.00
NG 12	43	8	20	42	98	1	85	0.04
NG 13	79	6	63	133	168	0	211	0.03
NG 14 Kwando (high density)	6	1	5	11	187	0	17	0.00
NG 14 Kwando (low density)	11	1	9	24	220	0	35	0.01
NG 15 Linyanti	0	0	0	0	0	0	0	0.00
NG 16 Selinda	0	0	0	0	0	0	0	0.00
NG 18 & 19 Khwai	5	1	5	10	188	0	15	0.00
NG 20 & 21 Splash	36	7	13	26	72	10	62	0.02
NG 22 Vumbra	5	1	5	10	197	0	15	0.01
NG 23 Duba Plains	5	1	5	10	190	0	15	0.01

Stratum	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density (animals km^{-2})
NG 24 Jedibe	0	0	0	0	0	0	0	0.00
NG 25 Jao	6	1	5	12	206	0	18	0.01
NG 26 Abu / EBS	51	9	21	44	86	7	95	0.03
NG 27 A & B & NG 30	14	2	9	19	130	0	33	0.01
NG 29	17	3	11	23	133	0	39	0.01
NG 31 & 17 Chitabe	35	7	27	59	169	0	94	0.12
NG 32 Stanleys	91	16	28	57	62	34	148	0.08
NG 33 & 34	17	3	11	24	141	0	41	0.02
NG 41 Mababe (high density)	0	0	0	0	0	0	0	0.00
NG 41 Mababe (low density)	0	0	0	0	0	0	0	0.00
NG 42 (high density)	0	0	0	0	0	0	0	0.00
NG 42 (low density)	0	0	0	0	0	0	0	0.00
NG 43 (high density)	0	0	0	0	0	0	0	0.00
NG 43 (low density)	0	0	0	0	0	0	0	0.00
NG 47 & 49	65	3	66	155	238	0	220	0.02
Nxai Pan NP (high density)	34	6	20	48	142	0	81	0.10
Nxai Pan NP (low density)	58	5	28	58	100	0	116	0.03
Maun East	304	18	200	426	140	0	730	0.13
Kwebe	0	0	0	0	0	0	0	0.00
Maun	52	10	20	42	80	10	93	0.04
Shorobe	0	0	0	0	0	0	0	0.00
Maun Southeast	11	1	11	28	257	0	39	0.02
Maun West	443	43	110	238	54	205	681	0.27
NG District Subtotal	**2,034**	**216**	**317**	**630**	**31**	**1,404**	**2,663**	**0.03**
TOTAL	**3,429**	**463**	**427**	**841**	**25**	**2,588**	**4,271**	**0.03**

Figure 47. Estimated density and observations for ostrich on the 2018 dry-season aerial survey of northern Botswana.

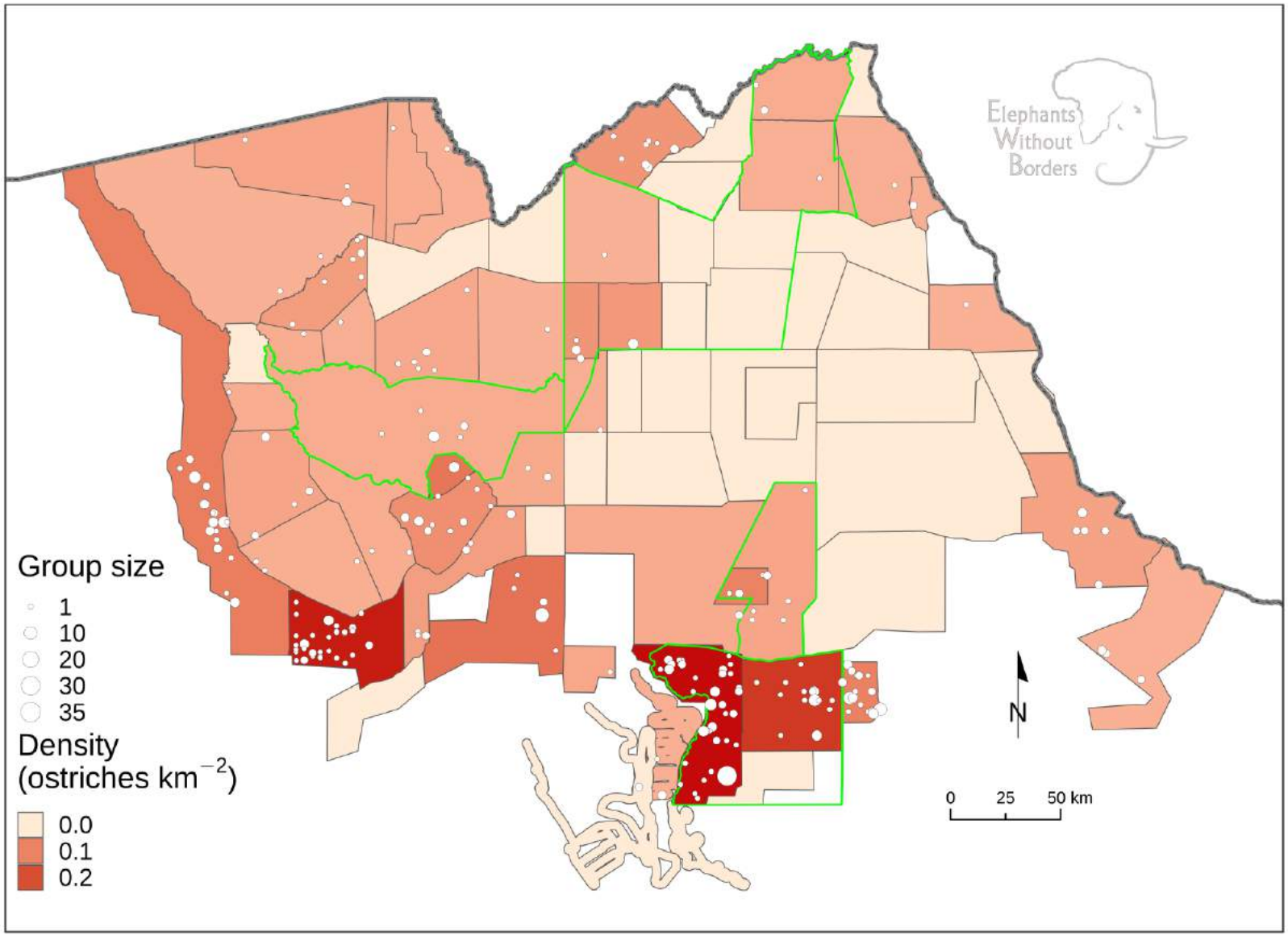


Table 48. Dry season population estimates for pelicans

Stratum	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density (animals km^{-2})
Chobe (CH) district								
CH 1 Chobe Enclave	615	106	560	1,159	189	0	1,774	0.49
CH 2 Chobe FR (high density)	244	41	231	489	201	0	733	0.36
CH 2 Chobe FR (low density)	0	0	0	0	0	0	0	0.00
CH 4 Kasane FR	0	0	0	0	0	0	0	0.00
CH 5 N Plains	0	0	0	0	0	0	0	0.00
CH 7 & 8	0	0	0	0	0	0	0	0.00
CH 11	0	0	0	0	0	0	0	0.00
CH 12	0	0	0	0	0	0	0	0.00
Nogatsaa C	0	0	0	0	0	0	0	0.00
Chinamba (low density)	0	0	0	0	0	0	0	0.00
Chinamba (high density)	0	0	0	0	0	0	0	0.00
Chobe Mababe	0	0	0	0	0	0	0	0.00
Chobe River	2,141	402	1,948	4,040	189	0	6,181	1.78
Kazuma FR (total count)	0	0	0	0	0	0	0	0.00
Nogatsaa A and B	0	0	0	0	0	0	0	0.00
Savute East	0	0	0	0	0	0	0	0.00
Savute North	0	0	0	0	0	0	0	0.00
Savute South (high density)	0	0	0	0	0	0	0	0.00
Savute South (low density)	0	0	0	0	0	0	0	0.00
Sibuyu FR	0	0	0	0	0	0	0	0.00
CH District Subtotal	**3,000**	**549**	**2,040**	**7,540**	**251**	**549**	**10,540**	**0.14**
Central (CT) district								
CT 1 & 2 (high density)	0	0	0	0	0	0	0	0.00
CT 1 & 2 (low density)	0	0	0	0	0	0	0	0.00
CT 3	0	0	0	0	0	0	0	0.00
Ngwasha & Sepako	0	0	0	0	0	0	0	0.00
Mak. NP East	0	0	0	0	0	0	0	0.00
Mak. NP East (salt pans)	0	0	0	0	0	0	0	0.00
Mak. NP West	0	0	0	0	0	0	0	0.00
CT 4 & 7 (recce count)	0	0	0	0	0	0	0	0.00
Boteti River (recce count)	0	0	0	0	0	0	0	0.00
Gweta (total count)	0	0	0	0	0	0	0	0.00
Hainaveld (recce count)	0	0	0	0	0	0	0	0.00
Nata (recce count)	47	47	0	0	0	47	47	0.02
Rakops (recce count)	0	0	0	0	0	0	0	0.00
CT District Subtotal	**47**	**47**	**0**	**0**	**0**	**47**	**47**	**0.00**
Ngamiland (NG) district								
Moremi GR NG 28	94	17	62	124	131	0	218	0.02
NG 7 & 8 West Okavango	333	29	319	639	192	0	972	0.06
NG 10 & 11	0	0	0	0	0	0	0	0.00
NG 12	0	0	0	0	0	0	0	0.00
NG 13	0	0	0	0	0	0	0	0.00
NG 14 Kwando (high density)	0	0	0	0	0	0	0	0.00
NG 14 Kwando (low density)	0	0	0	0	0	0	0	0.00
NG 15 Linyanti	0	0	0	0	0	0	0	0.00
NG 16 Selinda	0	0	0	0	0	0	0	0.00
NG 18 & 19 Khwai	0	0	0	0	0	0	0	0.00
NG 20 & 21 Splash	0	0	0	0	0	0	0	0.00
NG 22 Vumbra	0	0	0	0	0	0	0	0.00
NG 23 Duba Plains	0	0	0	0	0	0	0	0.00

Stratum	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density (animals km^{-2})
NG 24 Jedibe	0	0	0	0	0	0	0	0.00
NG 25 Jao	0	0	0	0	0	0	0	0.00
NG 26 Abu / EBS	169	30	152	314	185	0	483	0.10
NG 27 A & B & NG 30	0	0	0	0	0	0	0	0.00
NG 29	0	0	0	0	0	0	0	0.00
NG 31 & 17 Chitabe	0	0	0	0	0	0	0	0.00
NG 32 Stanleys	80	14	72	148	186	0	228	0.07
NG 33 & 34	0	0	0	0	0	0	0	0.00
NG 41 Mababe (high density)	0	0	0	0	0	0	0	0.00
NG 41 Mababe (low density)	0	0	0	0	0	0	0	0.00
NG 42 (high density)	0	0	0	0	0	0	0	0.00
NG 42 (low density)	0	0	0	0	0	0	0	0.00
NG 43 (high density)	0	0	0	0	0	0	0	0.00
NG 43 (low density)	0	0	0	0	0	0	0	0.00
NG 47 & 49	0	0	0	0	0	0	0	0.00
Nxai Pan NP (high density)	0	0	0	0	0	0	0	0.00
Nxai Pan NP (low density)	0	0	0	0	0	0	0	0.00
Maun East	0	0	0	0	0	0	0	0.00
Kwebe	0	0	0	0	0	0	0	0.00
Maun	2,700	520	1,779	3,639	135	0	6,339	2.13
Shorobe	0	0	0	0	0	0	0	0.00
Maun Southeast	0	0	0	0	0	0	0	0.00
Maun West	0	0	0	0	0	0	0	0.00
NG District Subtotal	**3,377**	**610**	**1,816**	**4,891**	**145**	**610**	**8,268**	**0.06**
TOTAL	**6,423**	**1,206**	**2,731**	**5,794**	**90**	**1,206**	**12,217**	**0.06**

Figure 48. Estimated density and observations for pelicans on the 2018 dry-season aerial survey of northern Botswana.

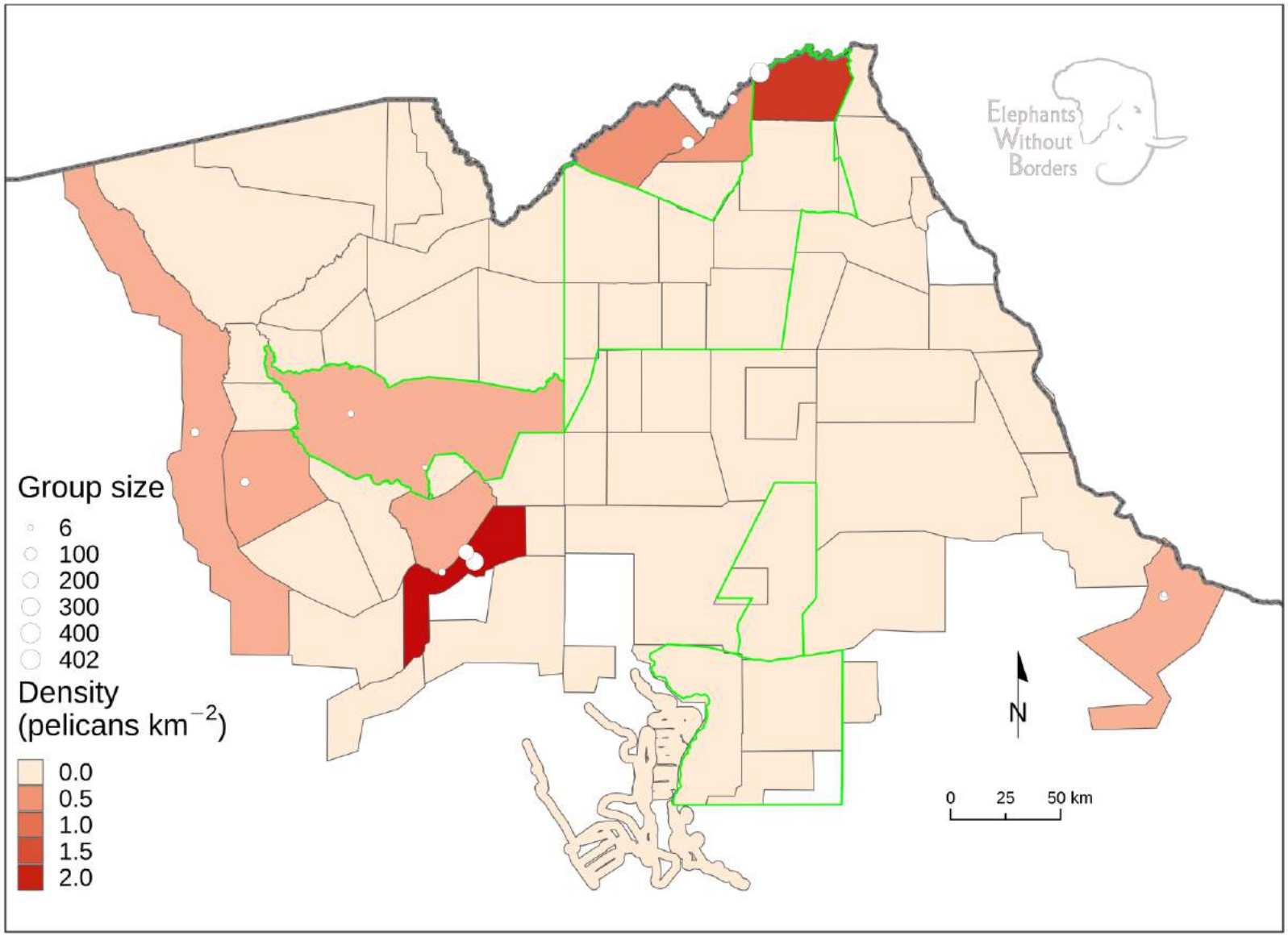


Table 49. Dry season population estimates for saddle-billed stork

Stratum	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density (animals km^{-2})
Chobe (CH) district								
CH 1 Chobe Enclave	0	0	0	0	0	0	0	0.00
CH 2 Chobe FR (high density)	0	0	0	0	0	0	0	0.00
CH 2 Chobe FR (low density)	0	0	0	0	0	0	0	0.00
CH 4 Kasane FR	0	0	0	0	0	0	0	0.00
CH 5 N Plains	0	0	0	0	0	0	0	0.00
CH 7 & 8	0	0	0	0	0	0	0	0.00
CH 11	0	0	0	0	0	0	0	0.00
CH 12	0	0	0	0	0	0	0	0.00
Nogatsaa C	0	0	0	0	0	0	0	0.00
Chinamba (low density)	0	0	0	0	0	0	0	0.00
Chinamba (high density)	0	0	0	0	0	0	0	0.00
Chobe Mababe	0	0	0	0	0	0	0	0.00
Chobe River	0	0	0	0	0	0	0	0.00
Kazuma FR (total count)	0	0	0	0	0	0	0	0.00
Nogatsaa A and B	0	0	0	0	0	0	0	0.00
Savute East	0	0	0	0	0	0	0	0.00
Savute North	0	0	0	0	0	0	0	0.00
Savute South (high density)	0	0	0	0	0	0	0	0.00
Savute South (low density)	0	0	0	0	0	0	0	0.00
Sibuyu FR	0	0	0	0	0	0	0	0.00
CH District Subtotal	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0.00**
Central (CT) district								
CT 1 & 2 (high density)	0	0	0	0	0	0	0	0.00
CT 1 & 2 (low density)	0	0	0	0	0	0	0	0.00
CT 3	0	0	0	0	0	0	0	0.00
Ngwasha & Sepako	0	0	0	0	0	0	0	0.00
Mak. NP East	0	0	0	0	0	0	0	0.00
Mak. NP East (salt pans)	0	0	0	0	0	0	0	0.00
Mak. NP West	0	0	0	0	0	0	0	0.00
CT 4 & 7 (recce count)	0	0	0	0	0	0	0	0.00
Boteti River (recce count)	0	0	0	0	0	0	0	0.00
Gweta (total count)	0	0	0	0	0	0	0	0.00
Hainaveld (recce count)	0	0	0	0	0	0	0	0.00
Nata (recce count)	0	0	0	0	0	0	0	0.00
Rakops (recce count)	0	0	0	0	0	0	0	0.00
CT District Subtotal	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0.00**
Ngamiland (NG) district								
Moremi GR NG 28	122	22	31	61	50	61	183	0.02
NG 7 & 8 West Okavango	11	1	11	22	191	0	33	0.00
NG 10 & 11	25	5	13	26	104	0	52	0.00
NG 12	11	2	7	14	127	0	24	0.01
NG 13	0	0	0	0	0	0	0	0.00
NG 14 Kwando (high density)	0	0	0	0	0	0	0	0.00
NG 14 Kwando (low density)	0	0	0	0	0	0	0	0.00
NG 15 Linyanti	0	0	0	0	0	0	0	0.00
NG 16 Selinda	5	1	5	9	184	0	15	0.00
NG 18 & 19 Khwai	0	0	0	0	0	0	0	0.00
NG 20 & 21 Splash	10	2	7	14	131	0	24	0.01
NG 22 Vumbra	0	0	0	0	0	0	0	0.00
NG 23 Duba Plains	37	7	15	32	88	4	69	0.08

Stratum	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density (animals km^{-2})
NG 24 Jedibe	21	4	10	23	107	0	44	0.05
NG 25 Jao	70	12	27	62	88	9	132	0.12
NG 26 Abu / EBS	40	7	18	36	92	3	76	0.02
NG 27 A & B & NG 30	64	9	18	36	56	28	101	0.05
NG 29	62	11	15	31	51	31	93	0.03
NG 31 & 17 Chitabe	5	1	4	10	198	0	15	0.02
NG 32 Stanleys	68	12	24	49	72	19	117	0.06
NG 33 & 34	0	0	0	0	0	0	0	0.00
NG 41 Mababe (high density)	0	0	0	0	0	0	0	0.00
NG 41 Mababe (low density)	0	0	0	0	0	0	0	0.00
NG 42 (high density)	0	0	0	0	0	0	0	0.00
NG 42 (low density)	0	0	0	0	0	0	0	0.00
NG 43 (high density)	0	0	0	0	0	0	0	0.00
NG 43 (low density)	0	0	0	0	0	0	0	0.00
NG 47 & 49	0	0	0	0	0	0	0	0.00
Nxai Pan NP (high density)	0	0	0	0	0	0	0	0.00
Nxai Pan NP (low density)	0	0	0	0	0	0	0	0.00
Maun East	0	0	0	0	0	0	0	0.00
Kwebe	0	0	0	0	0	0	0	0.00
Maun	0	0	0	0	0	0	0	0.00
Shorobe	0	0	0	0	0	0	0	0.00
Maun Southeast	0	0	0	0	0	0	0	0.00
Maun West	0	0	0	0	0	0	0	0.00
NG District Subtotal	**552**	**96**	**62**	**123**	**22**	**429**	**676**	**0.01**
TOTAL	**552**	**96**	**62**	**123**	**22**	**429**	**676**	**0.01**

Figure 49. Estimated density and observations for saddle-billed stork on the 2018 dry-season aerial survey of northern Botswana.

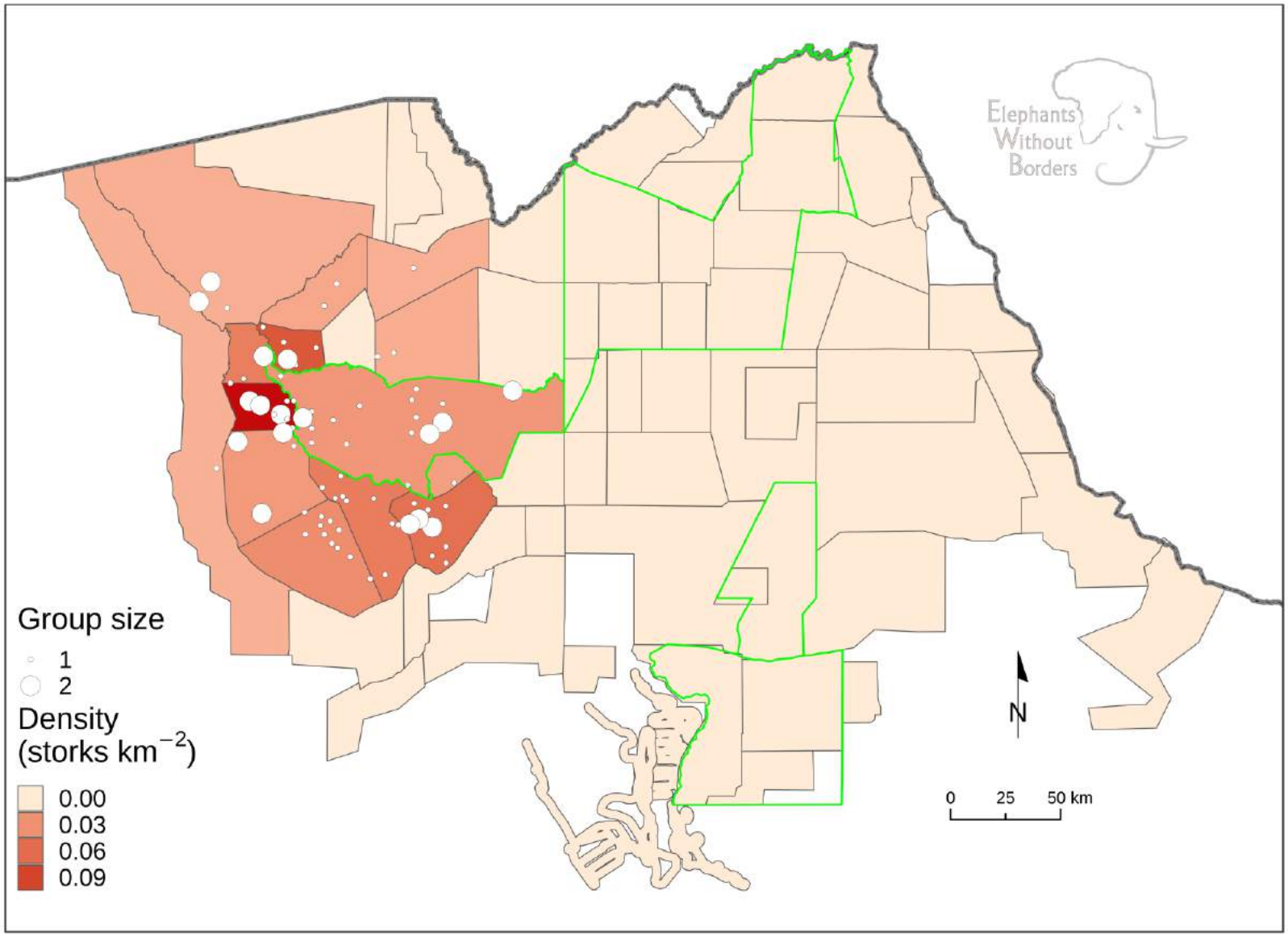


Table 50. Dry season population estimates for vulture

Stratum	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density (animals km^{-2})
Chobe (CH) district								
CH 1 Chobe Enclave	481	83	233	481	100	0	963	0.38
CH 2 Chobe FR (high density)	0	0	0	0	0	0	0	0.00
CH 2 Chobe FR (low density)	0	0	0	0	0	0	0	0.00
CH 4 Kasane FR	0	0	0	0	0	0	0	0.00
CH 5 N Plains	143	12	50	111	77	32	254	0.09
CH 7 & 8	0	0	0	0	0	0	0	0.00
CH 11	0	0	0	0	0	0	0	0.00
CH 12	36	3	34	73	204	0	109	0.02
Nogatsaa C	61	6	58	130	211	0	191	0.06
Chinamba (low density)	0	0	0	0	0	0	0	0.00
Chinamba (high density)	0	0	0	0	0	0	0	0.00
Chobe Mababe	0	0	0	0	0	0	0	0.00
Chobe River	437	82	212	439	100	0	875	0.36
Kazuma FR (total count)	0	0	0	0	0	0	0	0.00
Nogatsaa A and B	32	3	30	63	197	0	94	0.02
Savute East	34	4	32	76	223	0	110	0.04
Savute North	151	28	116	241	159	0	392	0.07
Savute South (high density)	0	0	0	0	0	0	0	0.00
Savute South (low density)	0	0	0	0	0	0	0	0.00
Sibuyu FR	16	3	14	29	184	0	45	0.01
CH District Subtotal	**1,391**	**224**	**348**	**721**	**52**	**670**	**2,112**	**0.07**
Central (CT) district								
CT 1 & 2 (high density)	0	0	0	0	0	0	0	0.00
CT 1 & 2 (low density)	0	0	0	0	0	0	0	0.00
CT 3	0	0	0	0	0	0	0	0.00
Ngwasha & Sepako	221	39	131	268	121	0	490	0.10
Mak. NP East	112	9	43	97	87	15	208	0.06
Mak. NP East (salt pans)	0	0	0	0	0	0	0	0.00
Mak. NP West	338	60	97	197	58	141	535	0.16
CT 4 & 7 (recce count)	0	0	0	0	0	0	0	0.00
Boteti River (recce count)	0	0	0	0	0	0	0	0.00
Gweta (total count)	13	13	0	0	0	13	13	0.03
Hainaveld (recce count)	33	33	0	0	0	33	33	0.02
Nata (recce count)	47	47	0	0	0	47	47	0.02
Rakops (recce count)	0	0	0	0	0	0	0	0.00
CT District Subtotal	**764**	**201**	**168**	**460**	**60**	**304**	**1,224**	**0.03**
Ngamiland (NG) district								
Moremi GR NG 28	261	47	77	153	59	108	414	0.05
NG 7 & 8 West Okavango	11	1	11	22	190	0	33	0.00
NG 10 & 11	649	128	380	758	117	0	1,407	0.12
NG 12	295	55	145	300	102	0	595	0.30
NG 13	26	2	26	55	208	0	81	0.01
NG 14 Kwando (high density)	746	126	410	836	112	0	1,582	0.53
NG 14 Kwando (low density)	144	13	130	334	233	0	478	0.14
NG 15 Linyanti	85	16	45	94	111	0	180	0.07
NG 16 Selinda	128	25	114	234	183	0	362	0.09
NG 18 & 19 Khwai	569	112	342	713	125	0	1,282	0.30
NG 20 & 21 Splash	10	2	6	13	128	0	24	0.01
NG 22 Vumbra	91	18	82	178	196	0	269	0.14
NG 23 Duba Plains	0	0	0	0	0	0	0	0.00

Stratum	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density (animals km^{-2})
NG 24 Jedibe	0	0	0	0	0	0	0	0.00
NG 25 Jao	0	0	0	0	0	0	0	0.00
NG 26 Abu / EBS	0	0	0	0	0	0	0	0.00
NG 27 A & B & NG 30	122	17	89	184	151	0	305	0.09
NG 29	79	14	50	104	131	0	183	0.04
NG 31 & 17 Chitabe	0	0	0	0	0	0	0	0.00
NG 32 Stanleys	0	0	0	0	0	0	0	0.00
NG 33 & 34	56	10	37	79	140	0	135	0.06
NG 41 Mababe (high density)	0	0	0	0	0	0	0	0.00
NG 41 Mababe (low density)	0	0	0	0	0	0	0	0.00
NG 42 (high density)	111	19	102	217	196	0	328	0.12
NG 42 (low density)	18	1	19	42	228	0	60	0.01
NG 43 (high density)	0	0	0	0	0	0	0	0.00
NG 43 (low density)	0	0	0	0	0	0	0	0.00
NG 47 & 49	0	0	0	0	0	0	0	0.00
Nxai Pan NP (high density)	17	3	11	26	152	0	42	0.05
Nxai Pan NP (low density)	23	2	22	45	195	0	69	0.01
Maun East	473	28	464	988	209	0	1,461	0.20
Kwebe	25	1	23	64	258	0	89	0.03
Maun	0	0	0	0	0	0	0	0.00
Shorobe	0	0	0	0	0	0	0	0.00
Maun Southeast	173	16	89	230	133	0	403	0.39
Maun West	206	20	134	289	140	0	495	0.13
NG District Subtotal	**4,319**	**676**	**872**	**1,727**	**40**	**2,592**	**6,046**	**0.07**
TOTAL	**6,474**	**1,101**	**954**	**1,879**	**29**	**4,595**	**8,353**	**0.06**

Figure 50. Estimated density and observations for vulture on the 2018 dry-season aerial survey of northern Botswana.

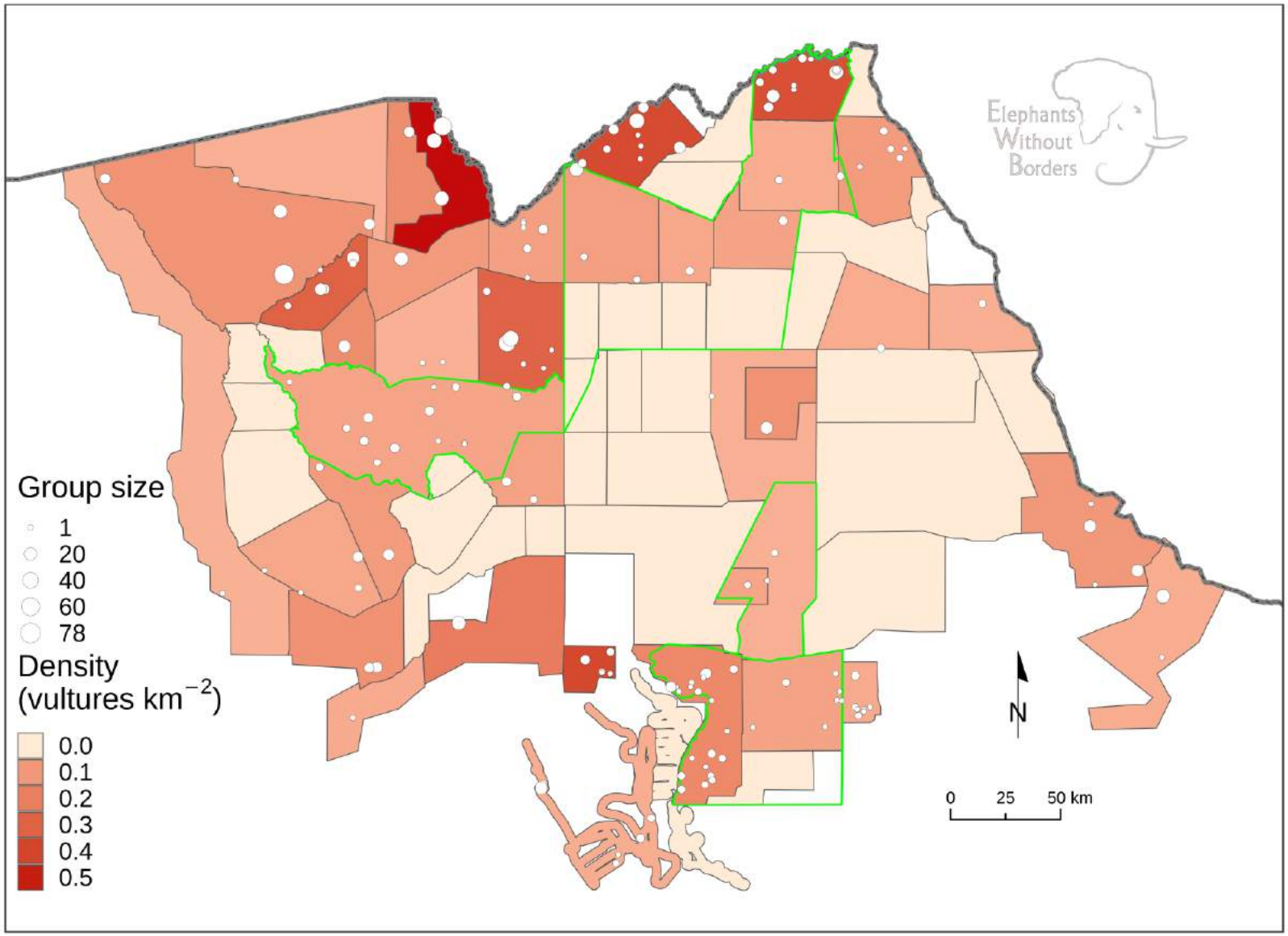


Table 51. Dry season population estimates for wattled crane

Stratum	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density (animals km^{-2})
Chobe (CH) district								
CH 1 Chobe Enclave	0	0	0	0	0	0	0	0.00
CH 2 Chobe FR (high density)	0	0	0	0	0	0	0	0.00
CH 2 Chobe FR (low density)	0	0	0	0	0	0	0	0.00
CH 4 Kasane FR	0	0	0	0	0	0	0	0.00
CH 5 N Plains	0	0	0	0	0	0	0	0.00
CH 7 & 8	0	0	0	0	0	0	0	0.00
CH 11	0	0	0	0	0	0	0	0.00
CH 12	0	0	0	0	0	0	0	0.00
Nogatsaa C	0	0	0	0	0	0	0	0.00
Chinamba (low density)	0	0	0	0	0	0	0	0.00
Chinamba (high density)	0	0	0	0	0	0	0	0.00
Chobe Mababe	0	0	0	0	0	0	0	0.00
Chobe River	0	0	0	0	0	0	0	0.00
Kazuma FR (total count)	0	0	0	0	0	0	0	0.00
Nogatsaa A and B	0	0	0	0	0	0	0	0.00
Savute East	0	0	0	0	0	0	0	0.00
Savute North	0	0	0	0	0	0	0	0.00
Savute South (high density)	0	0	0	0	0	0	0	0.00
Savute South (low density)	0	0	0	0	0	0	0	0.00
Sibuyu FR	0	0	0	0	0	0	0	0.00
CH District Subtotal	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0.00**
Central (CT) district								
CT 1 & 2 (high density)	0	0	0	0	0	0	0	0.00
CT 1 & 2 (low density)	0	0	0	0	0	0	0	0.00
CT 3	0	0	0	0	0	0	0	0.00
Ngwasha & Sepako	0	0	0	0	0	0	0	0.00
Mak. NP East	0	0	0	0	0	0	0	0.00
Mak. NP East (salt pans)	0	0	0	0	0	0	0	0.00
Mak. NP West	0	0	0	0	0	0	0	0.00
CT 4 & 7 (recce count)	0	0	0	0	0	0	0	0.00
Boteti River (recce count)	0	0	0	0	0	0	0	0.00
Gweta (total count)	0	0	0	0	0	0	0	0.00
Hainaveld (recce count)	0	0	0	0	0	0	0	0.00
Nata (recce count)	0	0	0	0	0	0	0	0.00
Rakops (recce count)	0	0	0	0	0	0	0	0.00
CT District Subtotal	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0.00**
Ngamiland (NG) district								
Moremi GR NG 28	300	54	97	194	65	105	494	0.06
NG 7 & 8 West Okavango	0	0	0	0	0	0	0	0.00
NG 10 & 11	284	56	145	289	102	0	573	0.05
NG 12	16	3	11	23	142	0	39	0.02
NG 13	0	0	0	0	0	0	0	0.00
NG 14 Kwando (high density)	24	4	22	44	185	0	68	0.02
NG 14 Kwando (low density)	0	0	0	0	0	0	0	0.00
NG 15 Linyanti	0	0	0	0	0	0	0	0.00
NG 16 Selinda	0	0	0	0	0	0	0	0.00
NG 18 & 19 Khwai	10	2	9	19	187	0	29	0.01
NG 20 & 21 Splash	26	5	14	28	110	0	54	0.01
NG 22 Vumbra	15	3	10	22	147	0	37	0.02
NG 23 Duba Plains	58	11	28	59	102	0	116	0.12

Stratum	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density (animals km^{-2})
NG 24 Jedibe	121	23	32	69	57	52	191	0.26
NG 25 Jao	170	29	27	60	35	110	230	0.28
NG 26 Abu / EBS	90	16	37	75	83	15	166	0.05
NG 27 A & B & NG 30	79	11	28	58	73	21	136	0.06
NG 29	0	0	0	0	0	0	0	0.00
NG 31 & 17 Chitabe	10	2	9	20	199	0	30	0.04
NG 32 Stanleys	46	8	33	69	151	0	115	0.04
NG 33 & 34	0	0	0	0	0	0	0	0.00
NG 41 Mababe (high density)	0	0	0	0	0	0	0	0.00
NG 41 Mababe (low density)	0	0	0	0	0	0	0	0.00
NG 42 (high density)	0	0	0	0	0	0	0	0.00
NG 42 (low density)	0	0	0	0	0	0	0	0.00
NG 43 (high density)	0	0	0	0	0	0	0	0.00
NG 43 (low density)	0	0	0	0	0	0	0	0.00
NG 47 & 49	0	0	0	0	0	0	0	0.00
Nxai Pan NP (high density)	0	0	0	0	0	0	0	0.00
Nxai Pan NP (low density)	0	0	0	0	0	0	0	0.00
Maun East	0	0	0	0	0	0	0	0.00
Kwebe	0	0	0	0	0	0	0	0.00
Maun	125	24	85	175	140	0	299	0.10
Shorobe	0	0	0	0	0	0	0	0.00
Maun Southeast	0	0	0	0	0	0	0	0.00
Maun West	0	0	0	0	0	0	0	0.00
NG District Subtotal	**1,373**	**251**	**211**	**425**	**31**	**948**	**1,797**	**0.02**
TOTAL	**1,373**	**251**	**211**	**425**	**31**	**948**	**1,797**	**0.01**

Figure 51. Estimated density and observations for wattled crane on the 2018 dry-season aerial survey of northern Botswana.

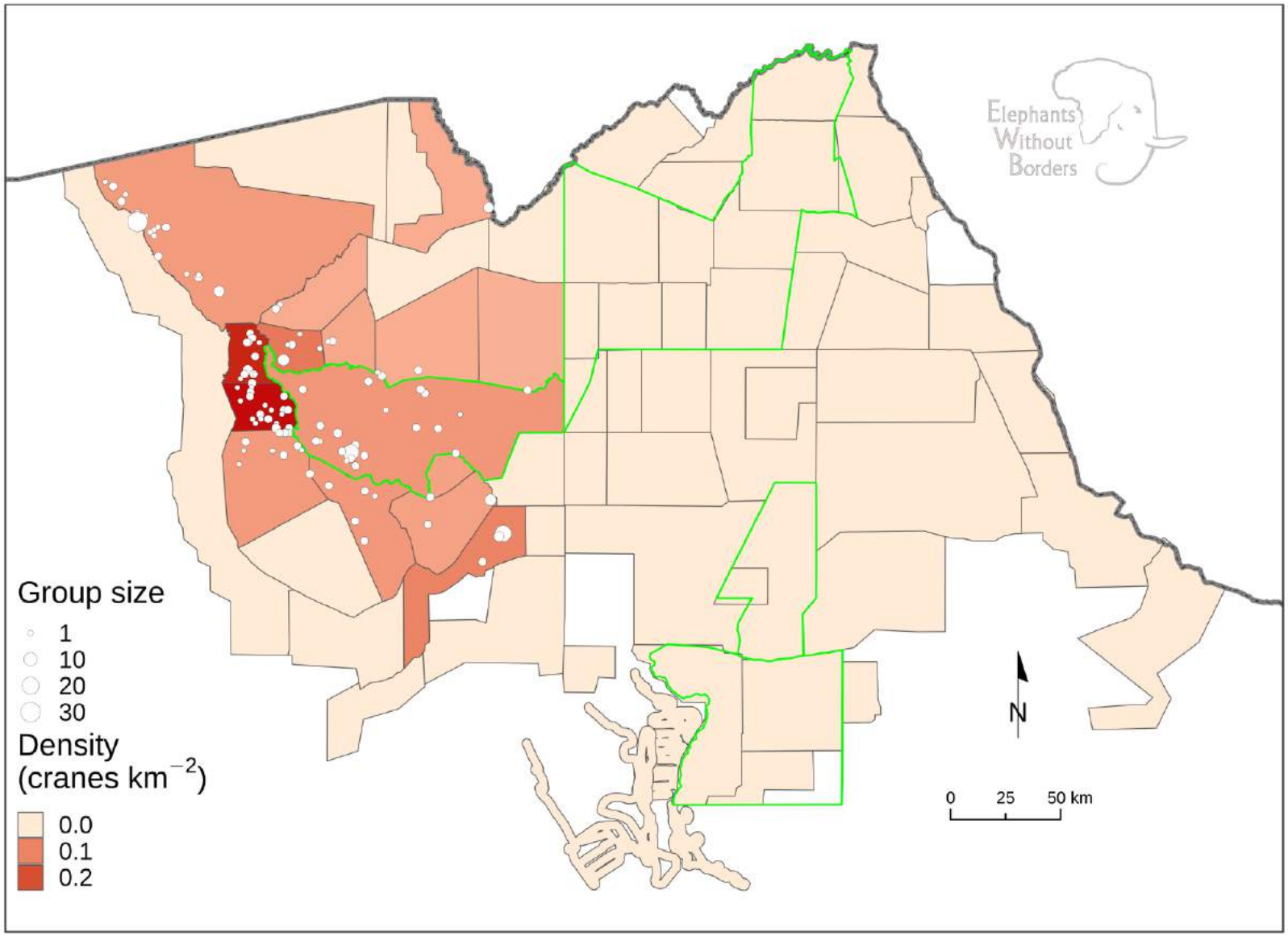


Table 52. Dry season population estimates for cow

Stratum	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density (animals km^{-2})
Chobe (CH) district								
CH 1 Chobe Enclave	2,164	373	732	1,515	70	648	3,679	1.71
CH 2 Chobe FR (high density)	2,070	348	875	1,855	90	215	3,925	3.10
CH 2 Chobe FR (low density)	0	0	0	0	0	0	0	0.00
CH 4 Kasane FR	216	36	202	433	200	0	649	0.50
CH 5 N Plains	334	28	322	717	215	0	1,051	0.21
CH 7 & 8	0	0	0	0	0	0	0	0.00
CH 11	0	0	0	0	0	0	0	0.00
CH 12	0	0	0	0	0	0	0	0.00
Nogatsaa C	0	0	0	0	0	0	0	0.00
Chinamba (low density)	0	0	0	0	0	0	0	0.00
Chinamba (high density)	0	0	0	0	0	0	0	0.00
Chobe Mababe	0	0	0	0	0	0	0	0.00
Chobe River	0	0	0	0	0	0	0	0.00
Kazuma FR (total count)	0	0	0	0	0	0	0	0.00
Nogatsaa A and B	0	0	0	0	0	0	0	0.00
Savute East	0	0	0	0	0	0	0	0.00
Savute North	0	0	0	0	0	0	0	0.00
Savute South (high density)	0	0	0	0	0	0	0	0.00
Savute South (low density)	0	0	0	0	0	0	0	0.00
Sibuyu FR	0	0	0	0	0	0	0	0.00
CH District Subtotal	**4,784**	**785**	**1,203**	**2,838**	**59**	**1,946**	**7,622**	**0.23**
Central (CT) district								
CT 1 & 2 (high density)	0	0	0	0	0	0	0	0.00
CT 1 & 2 (low density)	0	0	0	0	0	0	0	0.00
CT 3	0	0	0	0	0	0	0	0.00
Ngwasha & Sepako	477	84	335	686	144	0	1,163	0.21
Mak. NP East	0	0	0	0	0	0	0	0.00
Mak. NP East (salt pans)	0	0	0	0	0	0	0	0.00
Mak. NP West	1,172	208	594	1,206	103	0	2,378	0.56
CT 4 & 7 (recce count)	599	599	0	0	0	599	599	0.21
Boteti River (recce count)	0	0	0	0	0	0	0	0.00
Gweta (total count)	931	931	0	0	0	931	931	2.11
Hainaveld (recce count)	0	0	0	0	0	0	0	0.00
Nata (recce count)	988	988	0	0	0	988	988	0.41
Rakops (recce count)	0	0	0	0	0	0	0	0.00
CT District Subtotal	**4,167**	**2,810**	**682**	**3,831**	**92**	**2,810**	**7,999**	**0.17**
Ngamiland (NG) district								
Moremi GR NG 28	0	0	0	0	0	0	0	0.00
NG 7 & 8 West Okavango	43,742	3,807	5,499	11,029	25	32,713	54,771	8.41
NG 10 & 11	19,490	3,841	1,915	3,823	20	15,667	23,312	3.48
NG 12	5,351	998	1,249	2,583	48	2,768	7,934	5.45
NG 13	302	23	246	520	172	0	822	0.10
NG 14 Kwando (high density)	0	0	0	0	0	0	0	0.00
NG 14 Kwando (low density)	0	0	0	0	0	0	0	0.00
NG 15 Linyanti	0	0	0	0	0	0	0	0.00
NG 16 Selinda	0	0	0	0	0	0	0	0.00
NG 18 & 19 Khwai	0	0	0	0	0	0	0	0.00
NG 20 & 21 Splash	0	0	0	0	0	0	0	0.00

Stratum	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density (animals km^{-2})
NG 22 Vumbra	0	0	0	0	0	0	0	0.00
NG 23 Duba Plains	0	0	0	0	0	0	0	0.00
NG 24 Jedibe	11	2	9	20	187	0	30	0.02
NG 25 Jao	1,118	191	625	1,415	127	0	2,533	1.86
NG 26 Abu / EBS	0	0	0	0	0	0	0	0.00
NG 27 A & B & NG 30	0	0	0	0	0	0	0	0.00
NG 29	0	0	0	0	0	0	0	0.00
NG 31 & 17 Chitabe	0	0	0	0	0	0	0	0.00
NG 32 Stanleys	1,277	224	798	1,650	129	0	2,927	1.05
NG 33 & 34	0	0	0	0	0	0	0	0.00
NG 41 Mababe (high density)	0	0	0	0	0	0	0	0.00
NG 41 Mababe (low density)	0	0	0	0	0	0	0	0.00
NG 42 (high density)	0	0	0	0	0	0	0	0.00
NG 42 (low density)	0	0	0	0	0	0	0	0.00
NG 43 (high density)	0	0	0	0	0	0	0	0.00
NG 43 (low density)	0	0	0	0	0	0	0	0.00
NG 47 & 49	0	0	0	0	0	0	0	0.00
Nxai Pan NP (high density)	0	0	0	0	0	0	0	0.00
Nxai Pan NP (low density)	0	0	0	0	0	0	0	0.00
Maun East	13,800	817	3,690	7,866	57	5,934	21,666	5.96
Kwebe	1,371	55	1,417	3,936	287	0	5,306	1.53
Maun	17,758	3,420	1,920	3,927	22	13,831	21,686	14.00
Shorobe	1,024	103	598	1,660	162	0	2,685	2.51
Maun Southeast	3,164	293	700	1,799	57	1,365	4,962	7.15
Maun West	11,578	1,124	3,183	6,876	59	4,702	18,454	7.09
NG District Subtotal	**119,985**	**14,898**	**8,176**	**16,484**	**14**	**103,500**	**136,469**	**2.06**
TOTAL	**128,936**	**18,493**	**8,292**	**16,543**	**13**	**112,393**	**145,479**	**1.24**

Figure 52. Estimated density and observations for cow on the 2018 dry-season aerial survey of northern Botswana.

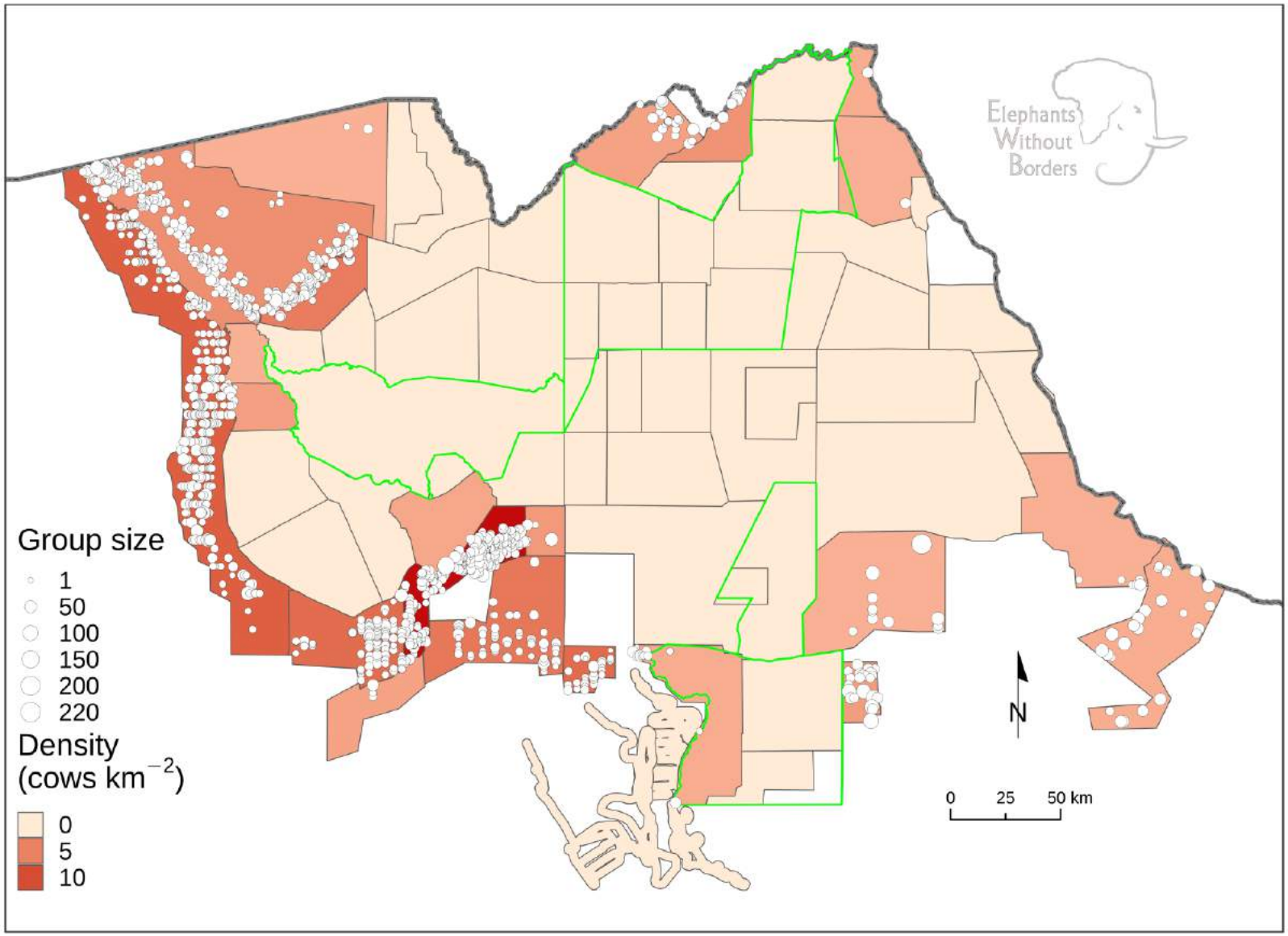


Table 53. Dry season population estimates for goats

Stratum	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density (animals km^{-2})
Chobe (CH) district								
CH 1 Chobe Enclave	122	21	79	164	134	0	286	0.10
CH 2 Chobe FR (high density)	54	9	51	107	201	0	161	0.08
CH 2 Chobe FR (low density)	0	0	0	0	0	0	0	0.00
CH 4 Kasane FR	0	0	0	0	0	0	0	0.00
CH 5 N Plains	0	0	0	0	0	0	0	0.00
CH 7 & 8	0	0	0	0	0	0	0	0.00
CH 11	0	0	0	0	0	0	0	0.00
CH 12	0	0	0	0	0	0	0	0.00
Nogatsaa C	0	0	0	0	0	0	0	0.00
Chinamba (low density)	0	0	0	0	0	0	0	0.00
Chinamba (high density)	0	0	0	0	0	0	0	0.00
Chobe Mababe	0	0	0	0	0	0	0	0.00
Chobe River	0	0	0	0	0	0	0	0.00
Kazuma FR (total count)	0	0	0	0	0	0	0	0.00
Nogatsaa A and B	0	0	0	0	0	0	0	0.00
Savute East	0	0	0	0	0	0	0	0.00
Savute North	0	0	0	0	0	0	0	0.00
Savute South (high density)	0	0	0	0	0	0	0	0.00
Savute South (low density)	0	0	0	0	0	0	0	0.00
Sibuyu FR	0	0	0	0	0	0	0	0.00
CH District Subtotal	**175**	**30**	**94**	**481**	**274**	**30**	**656**	**0.01**
Central (CT) district								
CT 1 & 2 (high density)	0	0	0	0	0	0	0	0.00
CT 1 & 2 (low density)	0	0	0	0	0	0	0	0.00
CT 3	0	0	0	0	0	0	0	0.00
Ngwasha & Sepako	0	0	0	0	0	0	0	0.00
Mak. NP East	0	0	0	0	0	0	0	0.00
Mak. NP East (salt pans)	0	0	0	0	0	0	0	0.00
Mak. NP West	0	0	0	0	0	0	0	0.00
CT 4 & 7 (recce count)	0	0	0	0	0	0	0	0.00
Boteti River (recce count)	0	0	0	0	0	0	0	0.00
Gweta (total count)	348	348	0	0	0	348	348	0.79
Hainaveld (recce count)	0	0	0	0	0	0	0	0.00
Nata (recce count)	0	0	0	0	0	0	0	0.00
Rakops (recce count)	0	0	0	0	0	0	0	0.00
CT District Subtotal	**348**	**348**	**0**	**0**	**0**	**348**	**348**	**0.01**
Ngamiland (NG) district								
Moremi GR NG 28	0	0	0	0	0	0	0	0.00
NG 7 & 8 West Okavango	14,810	1,289	3,256	6,531	44	8,280	21,341	2.85
NG 10 & 11	4,110	810	724	1,446	35	2,664	5,556	0.73
NG 12	214	40	138	286	133	0	501	0.22
NG 13	0	0	0	0	0	0	0	0.00
NG 14 Kwando (high density)	0	0	0	0	0	0	0	0.00
NG 14 Kwando (low density)	0	0	0	0	0	0	0	0.00
NG 15 Linyanti	0	0	0	0	0	0	0	0.00
NG 16 Selinda	0	0	0	0	0	0	0	0.00
NG 18 & 19 Khwai	0	0	0	0	0	0	0	0.00
NG 20 & 21 Splash	0	0	0	0	0	0	0	0.00
NG 22 Vumbra	0	0	0	0	0	0	0	0.00
NG 23 Duba Plains	0	0	0	0	0	0	0	0.00

Stratum	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density (animals km^{-2})
NG 24 Jedibe	0	0	0	0	0	0	0	0.00
NG 25 Jao	0	0	0	0	0	0	0	0.00
NG 26 Abu / EBS	0	0	0	0	0	0	0	0.00
NG 27 A & B & NG 30	0	0	0	0	0	0	0	0.00
NG 29	0	0	0	0	0	0	0	0.00
NG 31 & 17 Chitabe	0	0	0	0	0	0	0	0.00
NG 32 Stanleys	0	0	0	0	0	0	0	0.00
NG 33 & 34	0	0	0	0	0	0	0	0.00
NG 41 Mababe (high density)	0	0	0	0	0	0	0	0.00
NG 41 Mababe (low density)	0	0	0	0	0	0	0	0.00
NG 42 (high density)	0	0	0	0	0	0	0	0.00
NG 42 (low density)	0	0	0	0	0	0	0	0.00
NG 43 (high density)	0	0	0	0	0	0	0	0.00
NG 43 (low density)	0	0	0	0	0	0	0	0.00
NG 47 & 49	0	0	0	0	0	0	0	0.00
Nxai Pan NP (high density)	0	0	0	0	0	0	0	0.00
Nxai Pan NP (low density)	0	0	0	0	0	0	0	0.00
Maun East	17,279	1,023	4,475	9,539	55	7,741	26,818	7.47
Kwebe	773	31	793	2,203	285	0	2,975	0.86
Maun	6,262	1,206	1,023	2,092	33	4,170	8,354	4.94
Shorobe	219	22	208	577	264	0	796	0.54
Maun Southeast	2,786	258	1,267	3,257	117	0	6,043	6.30
Maun West	4,058	394	1,759	3,800	94	259	7,858	2.48
NG District Subtotal	**50,512**	**5,073**	**6,131**	**12,735**	**25**	**37,777**	**63,247**	**0.87**
TOTAL	**51,035**	**5,451**	**6,132**	**12,586**	**25**	**38,449**	**63,621**	**0.49**

Figure 53. Estimated density and observations for goats on the 2018 dry-season aerial survey of northern Botswana.

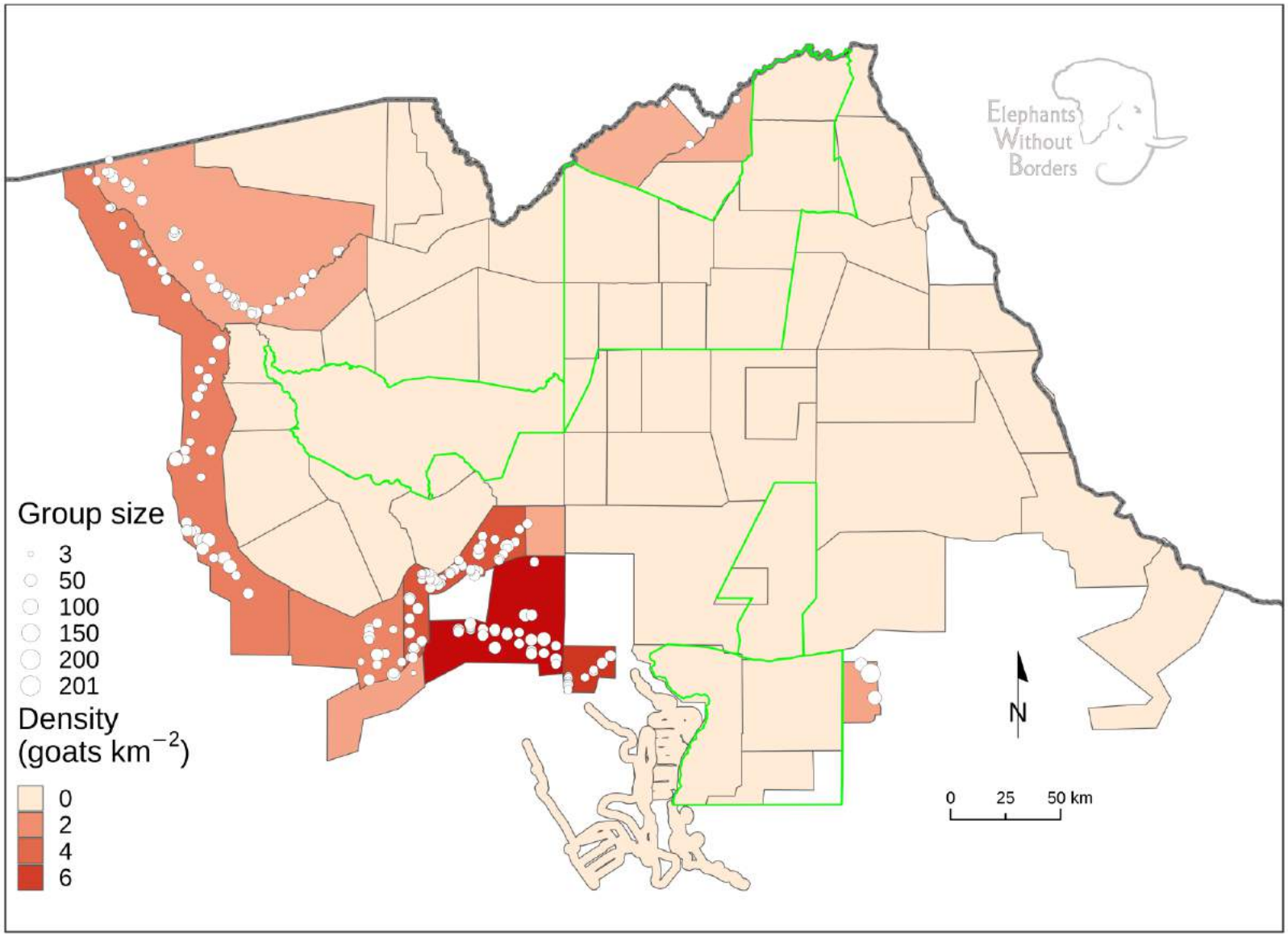


Table 54. Dry season population estimates for baobab

Stratum	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density (animals km^{-2})
Chobe (CH) district								
CH 1 Chobe Enclave	255	44	75	154	60	101	410	0.20
CH 2 Chobe FR (high density)	167	28	51	108	65	58	275	0.25
CH 2 Chobe FR (low density)	139	12	47	120	86	19	258	0.17
CH 4 Kasane FR	30	5	23	49	164	0	79	0.07
CH 5 N Plains	429	36	300	667	155	0	1,097	0.27
CH 7 & 8	94	7	44	96	102	0	190	0.07
CH 11	0	0	0	0	0	0	0	0.00
CH 12	0	0	0	0	0	0	0	0.00
Nogatsaa C	184	18	58	129	70	55	313	0.17
Chinamba (low density)	139	8	49	126	90	13	264	0.10
Chinamba (high density)	22	2	13	36	163	0	59	0.04
Chobe Mababe	5	1	5	11	205	0	16	0.01
Chobe River	75	14	35	73	98	2	148	0.06
Kazuma FR (total count)	1	1	0	0	0	1	1	0.00
Nogatsaa A and B	21	2	13	28	131	0	49	0.01
Savute East	17	2	11	25	149	0	42	0.02
Savute North	70	13	33	69	98	1	139	0.03
Savute South (high density)	0	0	0	0	0	0	0	0.00
Savute South (low density)	10	1	9	22	224	0	32	0.01
Sibuyu FR	191	36	51	105	55	86	295	0.16
CH District Subtotal	**1,848**	**230**	**337**	**696**	**38**	**1,152**	**2,545**	**0.09**
Central (CT) district								
CT 1 & 2 (high density)	0	0	0	0	0	0	0	0.00
CT 1 & 2 (low density)	114	5	88	204	179	0	318	0.02
CT 3	0	0	0	0	0	0	0	0.00
Ngwasha & Sepako	182	32	91	186	103	0	368	0.08
Mak. NP East	0	0	0	0	0	0	0	0.00
Mak. NP East (salt pans)	0	0	0	0	0	0	0	0.00
Mak. NP West	0	0	0	0	0	0	0	0.00
CT 4 & 7 (recce count)	27	27	0	0	0	27	27	0.01
Boteti River (recce count)	0	0	0	0	0	0	0	0.00
Gweta (total count)	10	10	0	0	0	10	10	0.02
Hainaveld (recce count)	0	0	0	0	0	0	0	0.00
Nata (recce count)	4	4	0	0	0	4	4	0.00
Rakops (recce count)	0	0	0	0	0	0	0	0.00
CT District Subtotal	**337**	**78**	**127**	**546**	**162**	**78**	**883**	**0.01**
Ngamiland (NG) district								
Moremi GR NG 28	150	27	30	61	40	89	211	0.03
NG 7 & 8 West Okavango	379	33	139	278	73	101	658	0.07
NG 10 & 11	320	63	81	162	51	158	482	0.06
NG 12	38	7	13	26	70	11	64	0.04
NG 13	26	2	17	36	137	0	62	0.01
NG 14 Kwando (high density)	24	4	13	27	112	0	50	0.02
NG 14 Kwando (low density)	0	0	0	0	0	0	0	0.00
NG 15 Linyanti	0	0	0	0	0	0	0	0.00
NG 16 Selinda	26	5	10	20	77	6	45	0.02
NG 18 & 19 Khwai	76	15	20	41	54	35	117	0.04
NG 20 & 21 Splash	10	2	6	13	127	0	23	0.01
NG 22 Vumbra	5	1	5	10	195	0	15	0.01
NG 23 Duba Plains	0	0	0	0	0	0	0	0.00

Stratum	Estimate	No. seen	Std. error	CI	% CI	Lower CL	Upper CL	Density (animals km^{-2})
NG 24 Jedibe	121	23	45	97	80	24	219	0.26
NG 25 Jao	53	9	15	34	64	19	87	0.09
NG 26 Abu / EBS	73	13	22	46	63	27	119	0.04
NG 27 A & B & NG 30	36	5	14	28	79	8	64	0.03
NG 29	17	3	8	17	100	0	34	0.01
NG 31 & 17 Chitabe	0	0	0	0	0	0	0	0.00
NG 32 Stanleys	57	10	28	59	103	0	116	0.05
NG 33 & 34	6	1	5	11	190	0	16	0.01
NG 41 Mababe (high density)	0	0	0	0	0	0	0	0.00
NG 41 Mababe (low density)	0	0	0	0	0	0	0	0.00
NG 42 (high density)	23	4	13	27	115	0	50	0.03
NG 42 (low density)	18	1	17	38	208	0	57	0.01
NG 43 (high density)	0	0	0	0	0	0	0	0.00
NG 43 (low density)	0	0	0	0	0	0	0	0.00
NG 47 & 49	109	5	76	179	165	0	288	0.03
Nxai Pan NP (high density)	6	1	5	12	216	0	18	0.02
Nxai Pan NP (low density)	128	11	67	139	109	0	266	0.06
Maun East	17	1	17	36	211	0	53	0.01
Kwebe	0	0	0	0	0	0	0	0.00
Maun	42	8	19	39	94	3	80	0.03
Shorobe	10	1	9	26	263	0	36	0.02
Maun Southeast	0	0	0	0	0	0	0	0.00
Maun West	62	6	19	40	65	21	102	0.04
NG District Subtotal	**1,830**	**261**	**209**	**414**	**23**	**1,416**	**2,244**	**0.03**
TOTAL	**4,015**	**569**	**416**	**823**	**20**	**3,192**	**4,837**	**0.04**

Figure 54. Estimated density and observations for baobab on the 2018 dry-season aerial survey of northern Botswana.