The status of the forest elephant in the world heritage Dja Faunal Reserve, Cameroon

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Abstract

Central African forest elephants (*Loxodonta africana cyclotis*) have declined by an estimated 62% between 2002 and 2011, largely as a result of poaching for the illegal ivory trade. They are now considerably more threatened than the Vulnerable African savannah elephant (*Loxodonta africana*), and effective monitoring of refugia populations is essential to inform management and conservation plans to secure a future for this megafaunal species.

Our forest elephant dung-based distance-sampling survey of the 5,260 km^2 World Heritage Dja Faunal Reserve (DFR) in Cameroon systematically covered 298.2 km of line transects with a further 1,681.4 km covered as recces. The population estimates of 0.042 individuals/km^2 (CV: 19.4%; 95% CI: 0.029–0.061) and 219 individuals (95% CI: 150–319) confirmed a significant decline over recent years. The low density of forest elephants in the DFR reflects similar losses experienced in other parts of Central Africa such as the heavily impacted Korup National Park (0.04 individuals/km^2).

Elephants now mainly persist in pockets within the northern part of the DFR, where the Cameroon Ministry of Forests and Fauna (MINFOF) has initiated a community support partnership agreement on sustainable access to forest resources, and increased law enforcement patrols and rapid response. The southern sector of the DFR is much more vulnerable to organised wildlife crime gangs operating from trafficking hubs outside traditional communities. The DFR management is implementing a community surveillance network and increasing SMART based patrolling, especially along the DFR's southern boundary, as well as in the south-eastern corner to secure the only existing forest elephant corridor. With improved security and appropriate engagement with local communities and private sector operators in the region, the remaining elephant population should start to expand across the DFR and its buffer zone, and numbers gradually increase across the wider landscape.

Résumé

Les éléphants de forêt de l'Afrique centrale (*Loxodonta africana cyclotis*) ont diminué d'environ 62% entre 2002 et 2011, ceci en grande partie à cause du braconnage pour le commerce illégal de l'ivoire. Ils sont à présent plus menacés que l' éléphant de savane (*Loxodonta africana*) et un suivi efficace de ces populations refuges est essentiel pour la mise à jour et l'implemenation des plans de gestion afin d'assurer un avenir pour cette espèce de mégafaune.

Cet inventaire par la méthode distance sampling a permis de couvrir 5,260 km^2 de la Réserve de Faune du Dja (RFD) site du patrimoine mondial avec 298.2 km de transects linéaires et 1,681.4 km de recces. Une estimation de la population d'éléphants à 0.042 individu/km^2 (CV: 19.4%; IC à 95%: 0.029 à 0.061) et 219 individus (IC à 95%: 150 à 319) a confirmé un déclin significatif de la population de cette espèce au cours des dernières années. La faible densité d'éléphants de forêt dans la RFD reflète les tendances à la baisse observées dans d'autres parties de l'Afrique centrale telle que le Parc National de Korup, fortement touché (0.04 individu/km^2).

Les éléphants persistent maintenant principalement dans les poches du la partie RFD, principalement dans les poches du secteur nord de la RFD où le Ministère Forêts et de la Faune (MINFOF) du Cameroun à initier un accord de partenariat d'appui aux communautés pour l'accès durable aux ressources forestières en plus de l'intensification des patrouilles de surveillance et de réponses rapides. Le secteur sud de la RFD semble être plus vulnérable aux gangs de la criminalité faunique opérant à partir de petites localités qui échappent à l'influence des communautés locales. L'unité de gestion de la RFD met en œuvre un réseau de surveillance communautaire et augmente les patrouilles avec l'approche SMART, en particulier le long des limites Sud et Sud-Est de la RFD pour sécuriser le seul possible couloir de migration des éléphants de cette aire protegée. Avec une protection améliorée, une implication appropriée des communautés locales et des opérateurs du secteur privé opérant autour de la RFD, la population d'éléphants restants devrait commencer à augmenter à l'interieur puis dans la zone tampon avant de progressivement se redistribuer dans l'ensemble du paysage.

Introduction

Central African populations of forest elephant (*L. a. cyclotis*) are in serious decline (Maisels et al. 2013). African forest elephants are estimated to have declined by 62% between 2002–2011 across the Central African forests (hereafter, the region), largely as a direct result of poaching for the illegal ivory trade (Maisels et al. 2013). Acting UNEP Executive Director Achim Steiner in 2013 stated that "In Central and West Africa, the elephant may soon disappear from whole areas unless urgent action is taken" (UNEP 2013). An important population of forest elephants inhabiting the south-east of Cameroon, representing a stronghold, has been recognised as a priority for conservation efforts (Brittain 2013). Monitoring population trends of this species across the region is essential to inform protected area (PA) management and conservation strategies aimed at securing a future for this megafauna species. To enable PA managers and governments to make informed decisions, reliable estimates of population size, density and distribution, and trends in these estimates, at regional and local scales are required. An understanding of the anthropogenic and ecological factors that influence the distribution of this species within its environment is also vital for adaptive management strategies (Stokes et al. 2010).

Elephant assessments are undertaken at landscape, national and regional scales (Thouless et al. 2016). Regional estimates are useful for gathering an overall status and trend of wide-ranging species, such as elephant. For such species, the concept of a conservation landscape (that is, a network of PAs separated and surrounded by alternative land use) provides a more effective framework for conservation actions (Stokes et al. 2010). Assessments at the spatial scale of individual reserves are also needed to help ensure they can continue to function as source populations and refugia in the future (Stokes et al. 2010, N'Goran et al. 2017). Regular surveys can provide early warning signs of precipitous declines as a result of intense poaching (Stokes et al. 2010). For example, within a decade (2004–2014), forest elephants within Minkébé NP declined by 78–81% (a loss of more than 25,000 elephants, Poulsen et al. 2017). This highlights that even in one of Central Africa's most remote PAs, potentially irreparable population declines can occur undetected, in less than the time taken for a single generation of elephants to advance to sexual maturity (Turkalo et al. 2017).

The primary objective of our study was to assess the status of forest elephant (and great apes, Bruce et al. 2018) in the Dja Faunal Reserve (DFR), in south-east Cameroon a World Heritage Site (UNESCO 2018; the DFR and its buffer zone constitute the Dja Biosphere Reserve). The DFR's extant megafauna is considered one of the Outstanding Universal Values (UNESCO 2018). This paper presents the study's findings on forest elephants. Distance sampling carried out through transect surveys of elephant dung was employed to estimate elephant population density and abundance (Hedges 2012). We used a standardised survey protocol to provide robust estimates for monitoring changes in the population over the long-term.

The survey also gathered information on the type, frequency, and distribution of human activities within the DFR. When combined with the information on the distribution of species, human activity data can provide insight into the importance of hunting pressure and human disturbance in diminishing wildlife populations. This also provides a robust baseline of data against which the effectiveness of management activities can be measured.

Materials and Methods

Study area and field data collection

The DFR, the largest protected area in Cameroon, is 5,260 km^2 (3°08′58.9″N, 13°00′00.1″E, fig. 1). Approximately 80% of the DFR is bordered by the Dja River, which forms a natural barrier and provides some limited protection, though crossing in canoes is common. The Biosphere Reserve outside the formal DFR is largely comprised of Forestry Management Units (FMUs), settlements, and community forests. There is also a 450 km^2 rubber plantation and a hydroelectric dam on the Dja River in the western buffer zone, both adjacent to the DFR boundary (fig. 1). There are no

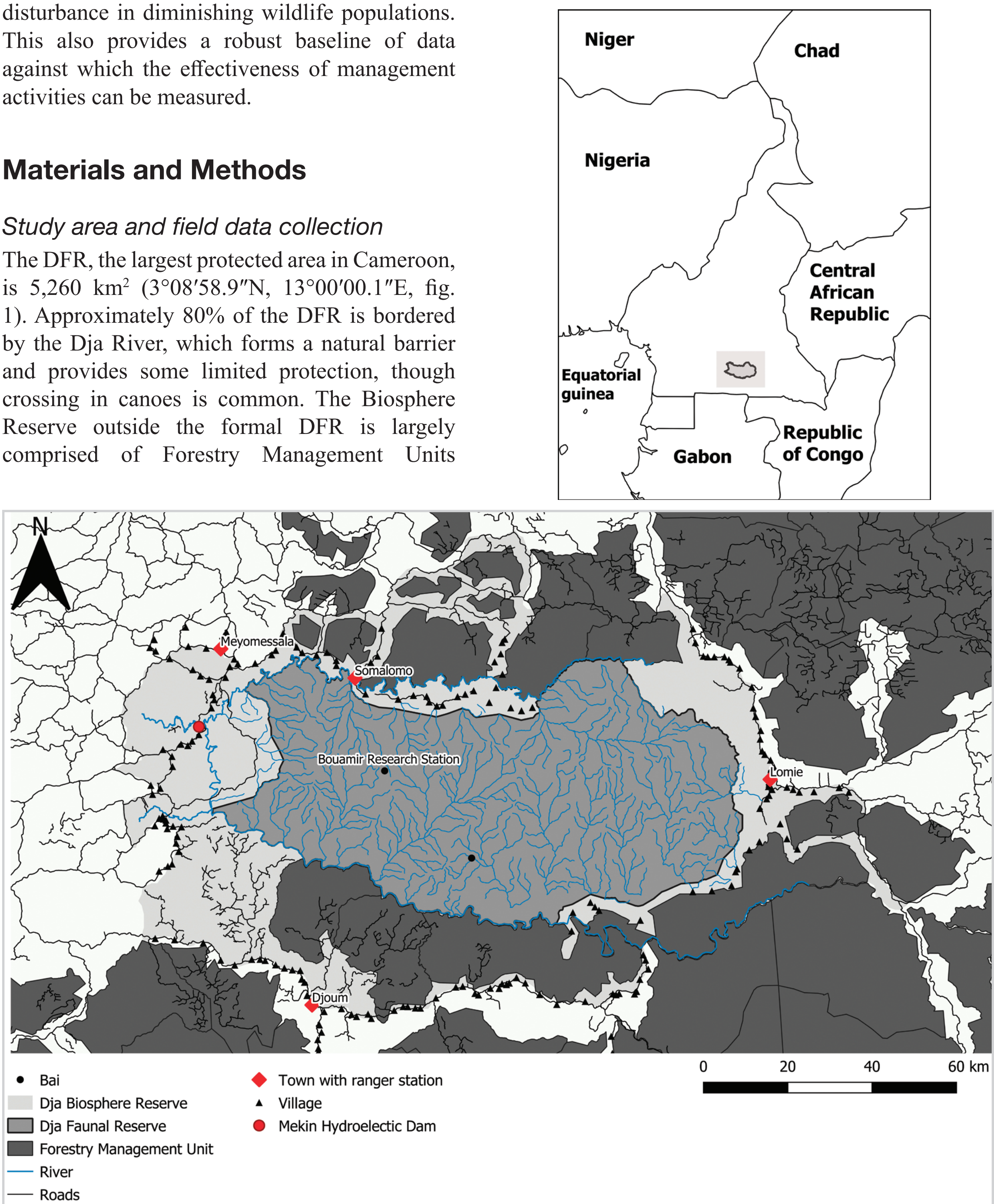

Figure 1. Location of the Dja Faunal Reserve, Cameroon.

recent reliable estimates of human population size surrounding the DFR. Estimates vary from 19,500 village inhabitants within the core zone to a further 30,000 within the wider area directly surrounding this zone (Fowler 2019, Ngatcha 2019). Expanding settlements and transport corridors to the south and east of the DFR are rapidly clearing natural forest and may soon result in isolation of the DFR, as intact forest corridors are lost, particularly in the south-eastern corner.

The DFR is a relatively flat plateau of round-topped hills and ranges in altitude from 600–800 m asl (MINFOF and IUCN 2015). The topography is mainly shallow valleys on either side of a ridgeline that cuts through the DFR east to west (MINFOF and IUCN 2015). On the floor of valleys, swamp habitat becomes more common. Tributaries throughout the DFR flow into the Dja River (UNESCO 2018, MINFOF and IUCN 2015). The three major types of forest in the DFR are *terra firma* mixed-species forest, mono-dominant forest where *Gilbertiodendron dewevrei* is the most abundant species, and periodically flooded forest (Djuikouo et al. 2010). The DFR supports a rich medium-to-large mammal fauna, including the Vulnerable African forest elephant, which is considerably more threatened than the Vulnerable *Loxodonta africana* (the African savannah elephant), with which it is merged by some specialists (Blanc 2008). The Critically Endangered Western lowland gorilla (*Gorilla gorilla gorilla*) and the Endangered central chimpanzee (*Pan troglodytes troglodytes*) also occur in the DFR. The DFR also has a diverse community of forest antelopes and three Vulnerable species of pangolins, namely the black-bellied pangolin (*Phataginus tetradactyla*), white-bellied pangolin (*Phataginus tricuspis*), and giant pangolin (*Smutsia gigantea*).

There are four main seasons: the long rains (August-November); the dry season (November-March); the short rains (March-May); and a shorter dry season (June-July) (MINFOF and IUCN 2015). During the dry season there is on average <100 mm of rainfall from a mean annual rainfall of approximately 1,570 mm (UNESCO 2018). The mean annual temperature is 23.5˚C–24.5˚C. The maximum temperature is reached in February and the minimum in July (MINFOF and IUCN 2015).

Within and around the DFR, poaching is occurring for subsistence, but largely through non-traditional means, such as guns and wire snares; and for the commercial and illegal wildlife trade (UNESCO 2018, Bruce et al. 2018). Around the DFR, other significant threats to biodiversity include mining, a proposed concrete plant on the river, logging, agricultural clearance for subsistence crops and commercial crops such as pineapple, loss of the last remaining large forested corridor if the south-eastern road is developed, rubber plantations (e.g. Sud-Cameroun Hévéa) and the associated demands for bushmeat, and the ecological impacts of existing (the Hydro Mekin) and planned hydroelectric dams (Muchaal and Ngandjui 1999, MINFOF and IUCN 2015).

Cameroon’s Ministry of Forests and Fauna (MINFOF) is responsible for the management of the DFR and the Biosphere Reserve. In order to facilitate management, the DFR has been divided into four sectors with a base responsible for each sector in the nearest town: Lomié (East Sector), Djoum (South Sector), Meyomessala (West Sector), and Somalomo (North Sector).

Line transect surveys

We first estimated the total length of transect we would need to achieve a desired precision in the density estimate for the forest elephant using the methodology from Hedges (chapter 9, 2012). We used the following equation (Buckland 2001) and data from a previous transect survey (MINFOF and IUCN 2015).

$$L = (b/\{cv_t(\hat{E})\}^2).(Lo/no),$$

where

L = estimate of total transect line length to be surveyed to achieve target coefficient of variation,

b = dispersion factor (= 3; Buckland et al. 2001),

cv_t = target coefficient of variation of density estimate $\hat{E}$,

Lo = total length of all transects (from previous survey)

no = total number of observations on all transects (from previous survey).

We estimated 286 km of transects were needed to achieve a 10% coefficient of variation for forest elephants (based on the 2015 MINFOF and IUCN survey comprising of 612 km of transects, MINFOF and IUCN 2015).

The survey, therefore, consisted of 286 one km transects systematically positioned with orientation east to west as the majority of watercourses in the DFR run north–south (fig. 2). We conducted the survey at the end of the dry season between 4 April 2018 and 3 June 2018 using eight teams. Each team had two observers, one looking up for great ape nests, while the other looking at ground level for elephant dung, human signs, and great ape nests. Each team also had two data recorders and four porters who walked at a distance behind the team and were responsible for carrying supplies and camping equipment. The observers were trained in identifying and ageing elephant dung and great ape nests. Forest elephant dung piles were aged according to the S-system (Hedges 2012), namely: S1: all boli are intact; S2: one or more boli (but not all) are intact; S3: no boli are intact, but coherent fragments remain (fibres are held together by faecal material); S4: no boli are intact; only traces (e.g., plant fibres) remain; no coherent fragments are present (but fibres may be held together by mud); S5: no faecal material (including plant fibres) is present. Perpendicular distance from the centre of each individual dung pile to the line transect was measured to the nearest cm.

The survey also recorded sign of human activity, both along line transects and during the approximately 3.8 km walk (hereafter recce) between transects. Types of human sign recorded were trails, snares, signs of passage, machete cuts, shelters and camps, firearms and ammunition, timber exploitation, direct encounters with people, and gunshots heard. Camps were defined as any structure used for sleeping within the forest evident from cleared ground and the presence of a fire pit or structures. However, as a caveat, it is impossible to differentiate poacher's trails and cuts from those of ecoguards and NGO work within the DFR.

All data was recorded using the Spatial Monitoring and Reporting Tool–Ecological Records (SMART-ER

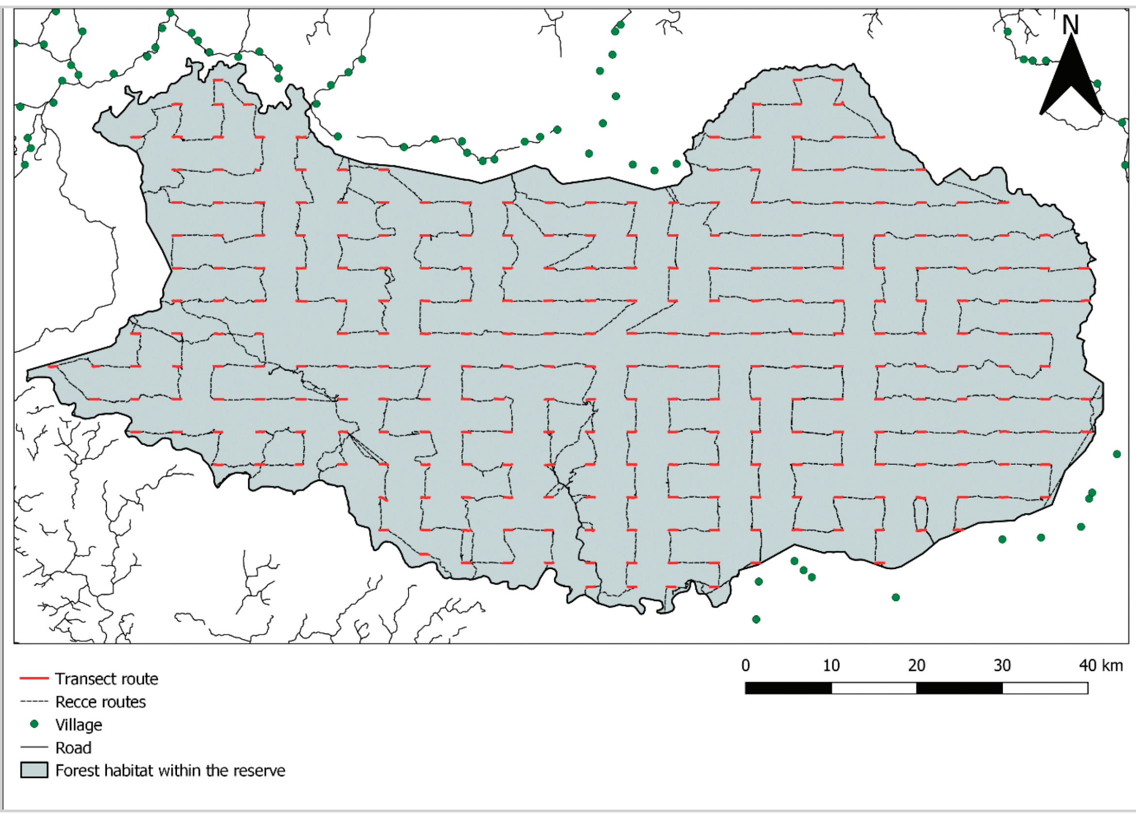

Figure 2. Location of transects and the associated routes between them (recces), systematically covering the entire Dja Faunal Reserve, Cameroon.

https://smartconservationtools.org) on Cedar Personal Digital Assistants (PDAs), and also in notebooks to back up data on the Cedar device. A Global Positioning Satellite (GPS) point with date and time was also taken for each observation and recorded in the notebook.

All data was exported from the PDAs into SMART. We checked all data entries within SMART against their paper counterparts to ensure that both were consistent with one another. We then exported the cleaned data in SMART into Excel and converted into suitable format for analysis in DISTANCE 7.2 software package (http://distancesampling.org/distance). We considered models of the detection function with the half-normal, hazard rate and uniform key functions with up to five cosine, simple polynomial and Hermite polynomial adjustment terms. Adjustment terms were constrained, where necessary, to ensure the detection function was monotonically decreasing. We selected among candidate models of the detection function by comparing AIC values. We also performed absolute model fit to the data using Chi-square test. All maps were produced using Quantum Geographic Information System (QGIS, http://qgis.osgeo.org).

Estimation of elephant dung decay rate

Over a period between April 2018 and September 2018, 85 fresh elephant dung piles were located and carefully marked across the study area. At the end of the study, the marked elephant dung piles were checked to see which had disappeared and which were still visible. The data on the state of the dung piles and time since dung deposition were analysed using logistic regression in R software package (http://www.R-project.org) to estimate the elephant dung mean decay rate and its variance. For the production rates, we used 19.77 elephant dung piles per day (Tchamba 1992).

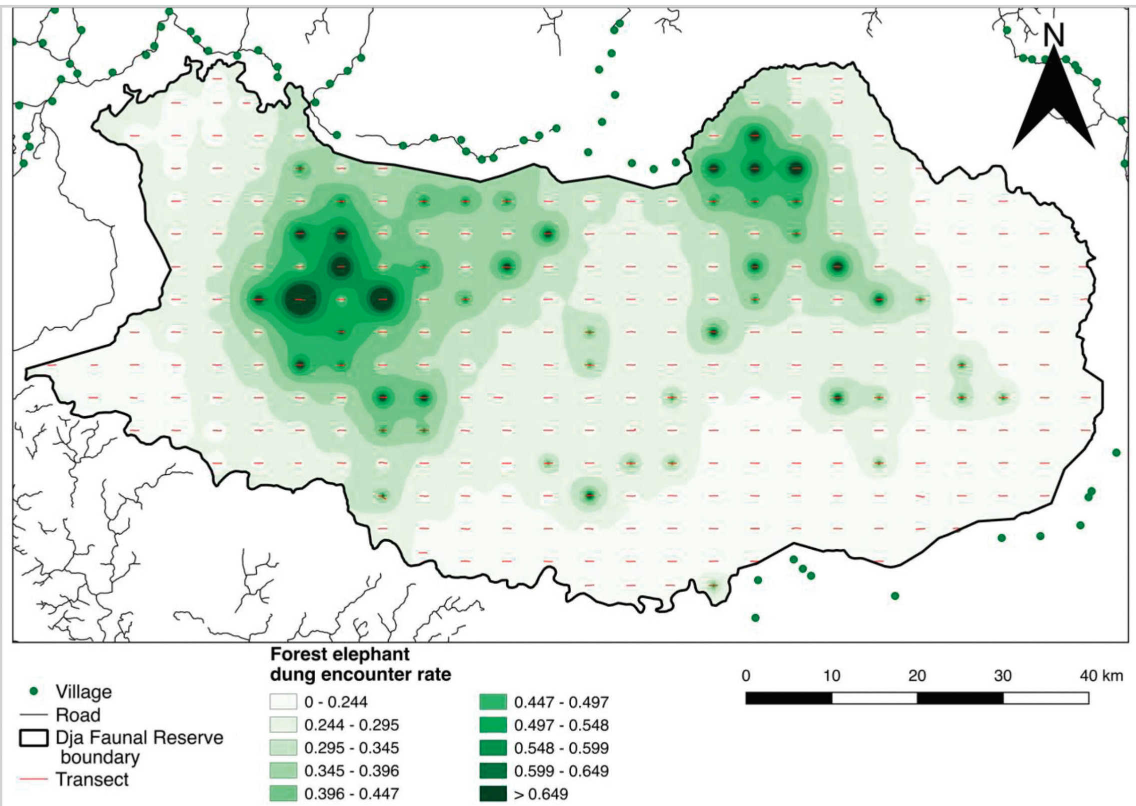

Figure 3. Distribution of forest elephant dung (dung/km) within the Dja Faunal Reserve, Cameroon. Locations of dung encounters along both transects and recces are also shown.

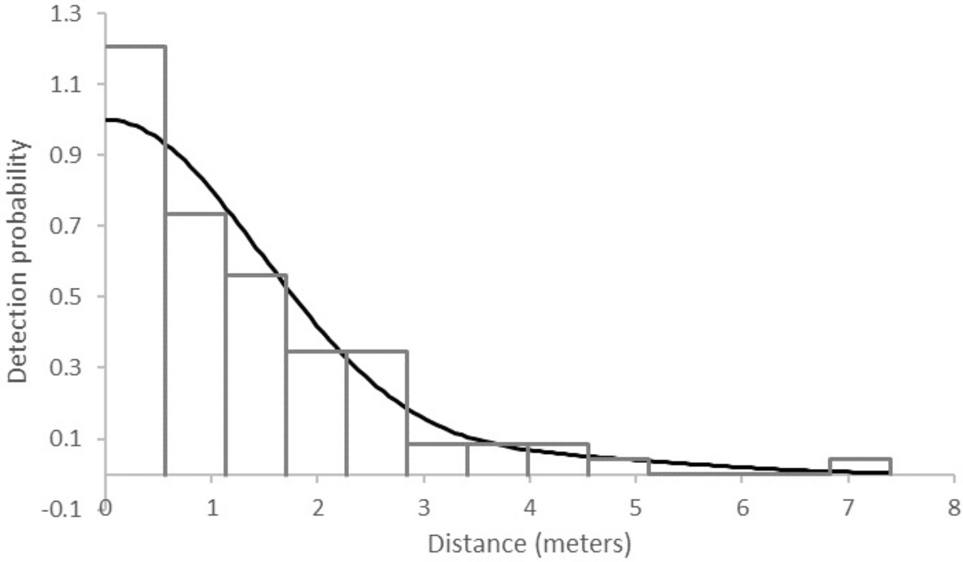

Figure 4. Detection probability as function of distance from half-normal line transect model fitted to forest elephant in the Dja Faunal Reserve, Cameroon (2018). The histograms of the observed distances are also shown.

Results

283 transects, totalling 298.2 km were completed. Two transects had to be abandoned due to flooding. One was abandoned as part of it was within a village. Recces covered a total distance of 1,681.4 km (fig. 2). In total, 167 elephant dung piles were encountered on transects during the survey. Of these, 82 were in the S1–S3 categories used for the distance analysis. The distribution of forest elephant dung observations is shown in fig. 3, as an encounter rate (dung/km) density contour map.

We estimated an elephant dung mean decay rate of 83.2 days (SE: 6.19). Exploratory analyses revealed no evidence of data collection errors. The half normal model with 2 cosine adjustments minimised AIC along with chi-square P value >>0.05 and was used to estimate density (fig. 4). Forest elephant dung density estimate was 68.43 piles/km^2 (95% CI: 48.24–97.07) and detection probability was 0.27 (SE: 0.02; 95% CI: 0.23–0.32). Effective strip width was 2.01 m (SE: 0.16; 95% CI: 1.71–2.36). Elephant density was estimated as 0.042 individuals/km^2 (CV: 19.4%; 95% CI: 0.029–0.061) with a population estimate of 219 individuals (95% CI: 150–319).

Human disturbance

A total of 359 human signs were encountered on the transects and 1,309 signs on recces resulting in an overall encounter rate of 0.84/km. The most prevalent signs encountered were established trails (0.27/km), machete cuts (0.17/km) and signs of passage such as marked trees and bent sticks (0.15/km). Of the signs directly attributable only to poaching the most prevalent was firearm accoutrements and ammunition (0.11/km), followed by snares (0.06/km). The distribution of human signs encountered on recces and transects is shown in fig. 5 as an encounter rate (signs/km) density contour map.

Discussion

This reserve–wide survey confirms that the forest elephant population within the DFR has diminished markedly over recent years in comparison to two earlier surveys by Williamson and Usongo (1995) and MINFOF and IUCN (2015) (Table 1). However, the MINFOF and IUCN (2015) survey used a dung decay rate of 90 days from Tchamba (1992), which also wasn't based on a study on elephant dung decay rate estimation. The Williamson and Usongo (1995) survey was conducted mainly in the northern sector of the DFR. For comparison, we analysed our study

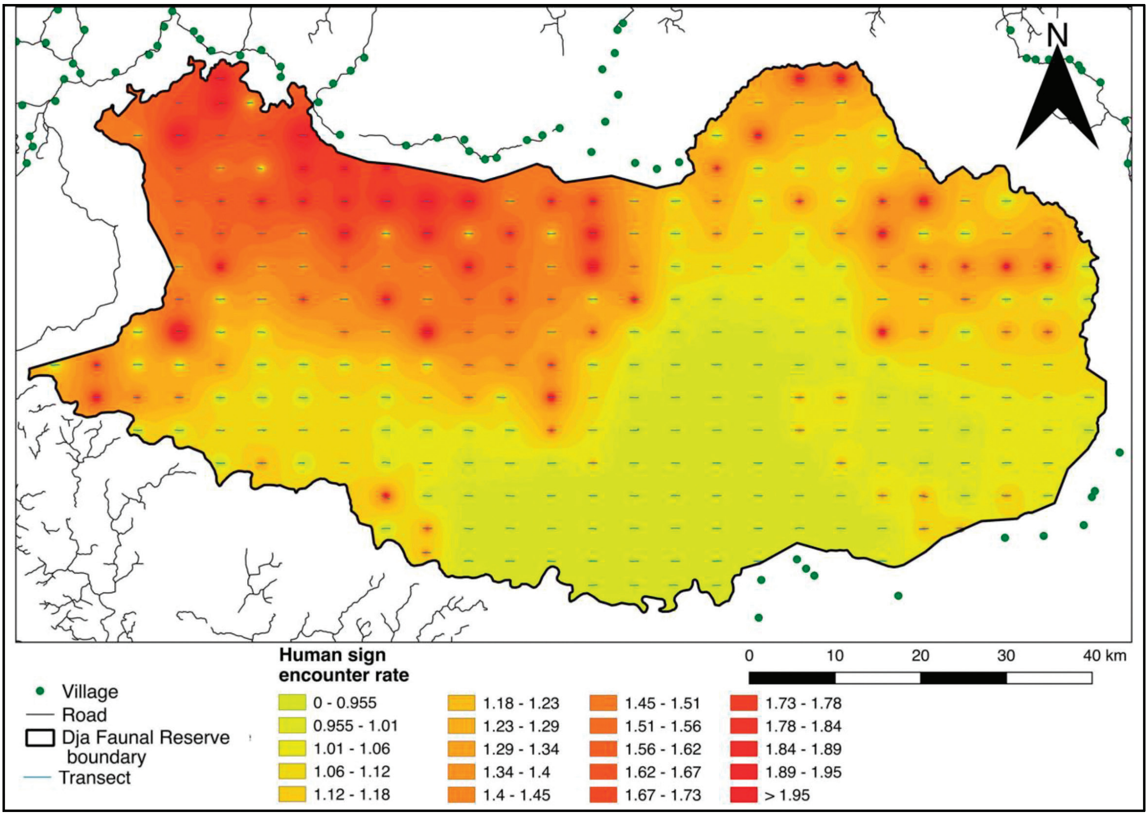

Figure 5. Distribution of signs of human activity (signs/km) within the Dja Faunal Reserve, Cameroon. Locations of signs of human activity encounters along transects and recces are also shown.

transects that were located in the 1995 survey area. Forest elephants in the sampled area have declined from an estimated 0.56 individuals/km^2 (95% CI: 0.33–0.96) in 1995 (Williamson and Usongo 1995) to 0.17 individuals/km^2 (95% CI: 0.10–0.31) in the current survey (a decrease of ~70%). However, for a wide-ranging species, such comparisons over longer time spans should be cautiously interpreted.

When compared to other national parks in Cameroon and northwest Central Africa (Table 1), the DFR currently has a low density of forest elephants (0.042 individuals/km^2), comparable to heavily impacted PAs, such as Korup National Park (0.04 individuals/km^2) (Kupsch et al. 2014). Minkébé NP in Gabon, approximately 100 km to the south of the DFR, has been reported to have lost an estimated 78% to 81% of forest elephant over the last decade (2004 to 2014) (Poulsen et al. 2017). Poulsen and colleagues (2017) estimate that in 2004 there was a population of circa 32,851 forest elephants (a density of 3.29 individuals/km^2) in the park compared to just circa 7,370 in 2014 (a density of 0.74 individuals/km^2) based on dung surveys. Minkébé NP (9,973 km^2) is approximately 90% larger than the DFR (5,260 km^2).

Drivers of declines

This catastrophic decline documented in forest elephants is most likely to be due to poaching for the illegal trade in ivory, with two recent ivory seizures of more than 100 tusks each from the town of Djoum just south of the DFR highlighting the continuing intensity of poaching activity[1]. There has been an intensification of illegal wildlife trade-related poaching in recent years throughout the region (Maisels et al. 2013, Abernethy et al. 2013, N'Goran et al. 2017). Regular movements of elephants into and out of the DFR have also been disrupted as roads surround the northern,

[1]https://www.zsl.org/conservation/news/anti-trafficking-officials-in-cameroon-seize-more-than-100-elephant-tusks

Table 1. Forest elephant population density estimates from recent surveys in national parks of Cameroon and northwest Central Africa.

Country	Site and survey	Forest elephant density estimate (individuals/km^2)
Cameroon	DFR 2018 (this study)	0.04 (95% CI: 0.03–0.06)
Cameroon	DFR 2015 (MINFOF and IUCN 2015)	0.08 (95% CI: 0.06–0.10)
Cameroon	DFR–northern sector only 1995 (Williamson and Usongo 1995)	0.56 (95% CI: 0.33–0.96)
Cameroon	DFR–northern sector only (this study with area corresponding to Williamson and Usongo 1995)	0.17 (95% CI: 0.10–0.31)
Cameroon	Lobéké NP (Nzooh et al. 2016a)	0.47 (95% CI: 0.31–0.73)
Cameroon	Nki NP (Nzooh et al. 2016b)	0.18 (95% CI: 0.11–0.29)
Cameroon	Boumba Bek NP (Nzooh et al. 2016b)	0.06 (95% CI: 0.03–0.09)
Cameroon	Campo Ma'an NP (Nzooh et al. 2016c)	0.12 (95% CI: 0.09–0.15)
Cameroon	Korup NP (Kupsch et al. 2014)	0.04 (95% CI: 0.02–0.07)
Cameroon	Mount Cameroon NP (Eno-Nku et al. 2013)	0.27 (95% CI: 0.17–0.45)
Republic of Congo	Noubalé-Ndoki NP (Stokes et al. 2010)	0.55 (95% CI: 0.40–0.75)
Gabon	Minkébé NP (Poulson et al. 2017)	0.74 (95% CI: 0.55–1.00)
Gabon	Lopé NP (Bezangoye and Maisels 2010)	0.92 (95% CI: 0.44–1.41)

western, and some parts of southern and eastern boundaries of the DFR, and increasing settlement which break the connections of contiguous forests to other forested landscapes. Forest elephants are known to avoid crossing unprotected roads in the Congo Basin, and a concern is that, with increasing infrastructure, forest elephants will adopt a 'siege' behavioural response (Blake et al. 2005). The increasing isolation of the DFR's elephant population may be creating negative demographic consequences, which also result in declining numbers. For example, smaller numbers can diminish genetic viability, reduce the demographic resilience of isolated populations, increase competition for food, and cause the breakdown of normal social cohesion within populations (Wittemyer et al. 2007, Blake et al. 2005). The species' ecological role in seed dispersal and maintaining forest clearings would also most likely have diminished (Theuerkauf et al. 2000). Expanding agriculture along the boundaries of the DFR also increases human-elephant conflicts, which may result in elephant injury and mortality. The only contiguous forest corridor that remains is in the south-eastern corner (fig. 1). This corridor needs to be maintained to ensure gene flow across the greater TRIDOM (Tri-National Dja-Odzala-Minkébé transborder forest), which connects DFR with protected areas such as Ngoyla Wildlife Reserve and Nki NP in Cameroon, and Minkébé NP in Gabon and Odzala NP in the Republic of Congo. If further development and settlement along an old logging track in the south-east corner of the DFR occurs as planned, this will also effectively isolate larger vertebrates.

Human activity within the DFR remains pervasive (MINFOF and IUCN 2015). Human signs were found throughout the DFR in this survey with the highest frequency of human signs encountered in the northwest of the DFR (fig. 5). While not all the signs of human activity are directly attributable to hunting or poaching, for example, machete marks and forest camps are also made by ranger patrols and researchers, we presume that areas that contain generally higher encounter rates of human sign, are likely to be experiencing greater hunting or poaching pressure than areas with lower encounter rates of all measured human sign. The frequent presence of humans across a large proportion of the DFR may also be pushing elephants away from key resources, such as swamps, bais, and fruiting trees, with associated stress on populations.

Common drivers of elephant density found by a number of studies include human population density, hunting intensity, weak law enforcement, poor governance, distance to roads and settlements, and proximity to infrastructure (Blom 2005, Blake et al. 2007, Maisels et al. 2013). In this study, areas containing the highest levels of human activity/signs of activity, being closer to significant infrastructure (Hydromekin Dam and Sud-Cameroun Hévéa rubber plantation) and associated human settlements, had the lowest encounter rates of forest elephant dung. The exception to this was around Bouamir Research Station located in the core of the north-west region, but the near permanent presence of ecoguards and visiting researchers may deter poachers and provide a functional refugia protecting them from hunting within this heavily impacted area of the DFR (Farfán 2019).

A proposed standard monitoring protocol for forest elephant of the DFR

Protected area managers should continue to adhere to best practice methods for distance sampling surveys (Hedges 2012). The distance sampling analysis used here with data collected through systematic line transects designed to achieve a desired coefficient of variation in estimates are recommended to periodically assess forest elephant population size and distribution, and trends in these population state variables. The DFR survey will be repeated in 2021. If populations continue to decline, then the survey effort (in transect length) required to achieve a set coefficient of variation would make transect sampling prohibitively inefficient within the DFR.

Conclusion

The documented decline in the elephant population (and great apes, Bruce et al. 2018) is placing significant risk on the Dja Faunal Reserve's World Heritage Site status being downgraded by UNESCO. The Cameroon Government is strengthening mitigating measures through the 2020–2025 Reserve Management Plan. Elephants continue to mostly persevere in the northern part of the DFR where local communities have exerted their traditional rights to collect non-timber forest products and to small-scale subsistence hunting. The DFR Conservation Service has initiated a community partnership agreement on sustainable access to forest resources and to date, these elephant refugia have also been receiving greater law enforcement both in terms of routine patrol coverage and rapid response following alerts from local communities. The southern part of the DFR is much more vulnerable to organised wildlife criminal gangs (OCG) especially from the southern elephant trafficking hub around the town of Djoum, which does not fall within traditional community areas. The presence of traditional subsistence hunters in the northern sector of the DFR may provide a disincentive to OCGs to operate there, compared to the more remote south where they can hunt with relative impunity. The DFR management is implementing a community surveillance network and increasing SMART based patrolling especially along the southern boundary of the DFR with its many exit roads. With improved security and appropriate engagement with local communities and private sector in the region, it is hoped that the remaining elephant population will start to expand across the Biosphere Reserve and numbers gradually increase. The Dja Biosphere Reserve is an integral component of TRIDOM transborder forest which covers 178,000 km^2, or 10% of the Congo Basin rainforest. It offers one of the last remaining opportunities for the long-term conservation of the forest elephant, great apes and other threatened species in the region.

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