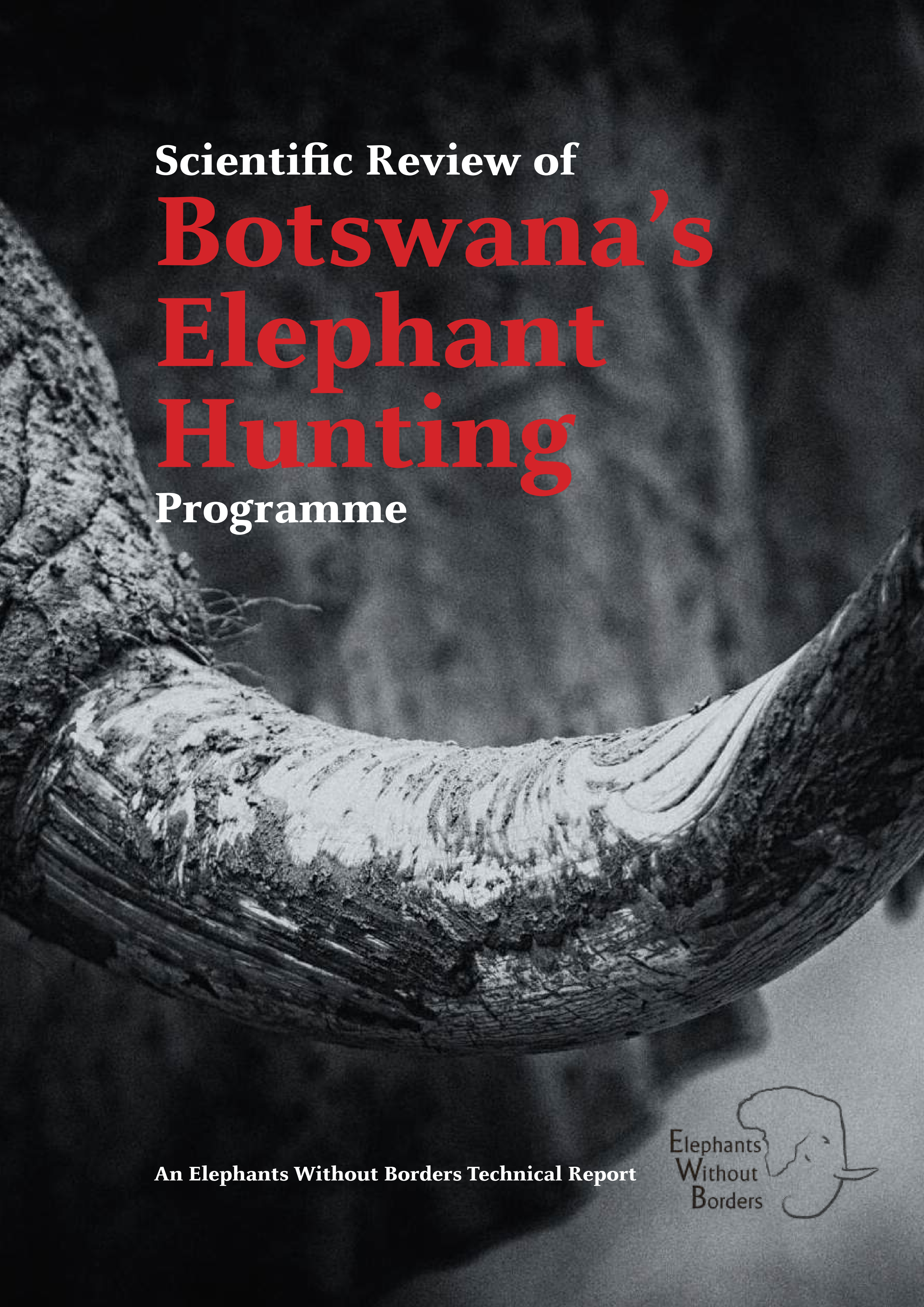

Scientific Review of Botswana's Elephant Hunting Programme

An Elephants Without Borders Technical Report

Elephants Without Borders

Scientific Review of

Botswana's Elephant Hunting

Programme

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Summary

1. In 2019, Botswana ended a five-year moratorium on the hunting of African savanna elephants (*Loxodonta africana*). Here, we provide expert, outside review of the hunting programme and its scientific basis. Notably, we used simulation models to determine how hunting quotas and environmental changes may affect elephant populations and expected trophy sizes.

2. Elephant populations in Botswana currently total ~140,000. The northern Botswana population, which includes 94% of the country's elephants, has been stable since 2010. The current annual hunting quota of 410 elephants is 0.3% of the national population.

3. In Botswana, hunters prefer to kill larger, older bulls with big tusks. Our models show that any amount of hunting significantly reduces the number of mature bulls in the population, and the level of reduction increases with quota size. Hunting 0.3% of the population annually reduces the number of the oldest bulls, ≥50 years old, by 50% compared to no hunting. Mature bulls play important roles in elephant populations, so their numbers should be considered when setting quotas.

4. Botswana's elephants now face increasing mortality due to drought, disease, poaching, and human-elephant conflict. Because bull numbers are already limited, any increase in mortality rates due to these causes will further reduce bull populations. Such reductions will also cause hunters to take younger, smaller bulls. To date, the Botswana Department of Wildlife and National Parks (DWNP) has not incorporated drought, poaching, or other sources of elephant mortality into planning for hunting.

5. Our models show that current quotas of 0.3% result in a relatively small pool of mature bulls and a population that is sensitive to increases in mortality from drought or poaching. In our models, setting the annual hunting quota to a 0.1% or 0.2% rate (140-280 elephants in Botswana today) consistently produces a much more resilient population with larger numbers of mature bulls. As a result, hunting at 0.1% or 0.2% lessens the effects of drought, poaching, or any other factors that increase elephant mortality.

6. DWNP has repeatedly stated that hunting 1% of the elephant population annually is sustainable. This is false and easily demonstrated with our simulation models. Hunting 1% of the population eliminates older bulls in a short time.

7. Current quotas for elephants in Botswana assume a single, well-mixed elephant population. In reality, hunting and non-hunting areas are distinct, and hunting can only be sustained with regular, net movements of elephants from non-hunting to hunting blocks. Anything that prevents such movements will affect hunting. DWNP has stated that their hunting quotas will be based on elephant numbers in hunting blocks. Current quotas, however, are around 0.9% of the population in hunting blocks, an unsustainable level if one looks only at the population in those blocks.

8. Much of DWNP's justification for elephant hunting rests on a model developed by Craig et al. (2011). That model, however, has two flaws that make it invalid: invented survival values and a lack of density dependence. Consequently, the model is not fit to be the basis for elephant management. Despite this, the Craig model remains a central reference in DWNP's justifications for elephant hunting in Botswana.

9. DWNP claims that harvested tusk sizes were stable from 1996-2013, which implies that elephant hunting is sustainable. But during that time, actual harvests averaged just 0.16% of the population per year. Current quotas are 0.3% of the population. Outcomes from hunting at those lower rates tell us nothing about future impacts of hunting at higher rates

10. Because elephants reproduce slowly, risks of overhunting are significant. Our model shows that a 10-year poaching outbreak (500 killed per year) will reduce trophy sizes for 50 years after the outbreak ends. Additionally, DWNP's method of monitoring hunting by examining trophy (tusk) sizes is unlikely to detect depletion of bull numbers in time to prevent overhunting.

11. To ensure that elephant hunting is sustainable, we recommend increased monitoring for poaching as well as monitoring bull age structure in hunting blocks. We also recommend that regular, high-intensity surveys of northern Botswana continue every 4 years. Such surveys should be expanded to other parts of the country with hunting.

12. Based on our model results, we recommend limiting hunting to a maximum quota of 0.2% of the total population per year, ~280 elephants. With quotas at 0.3%, the lack of resilience to poaching, drought, or other changes in mortality risks depletion of bulls and reduced trophy sizes on hunts. Limiting hunting to 0.2% annually would increase the resilience of the population to environmental changes. Future levels of poaching, drought, and disease are unknown, so the precaution of making the hunting quota 0.2% will help to make the hunting programme "future proof."

Elephants Without Borders

Introduction

In 2019, Botswana ended a five-year moratorium on elephant hunting, with trophy hunts resuming in 2021. Throughout Africa, elephant hunting has been controversial, with a variety of claims made about its sustainability, its benefits to local communities, and its effect on elephant welfare, behaviour, and populations.

The Botswana Department of Wildlife and National Parks (DWNP) has been strongly in favour of elephant hunting and has submitted to CITES documents stating that elephant hunting is not detrimental to the population (DWNP 2021, 2024). Such a finding is required for CITES to approve exports of elephant trophies such as tusks. Likewise, in response to a recent letter from several environmental organisations calling for a hunting ban, the Ministry of Tourism made a number of strong claims about elephant hunting (Modukanele 2025). One contention was that hunting ~400 elephants per year would have "hardly any impact" on the population. Another contention was that elephant hunting would reduce human-elephant conflict. These claims made by the government are strong, and they should be met with scrutiny to be sure that the hunting programme is sustainable.

In this document, we review the status of Botswana's elephant population, recent results from elephant hunting in Botswana, and whether or not the claims about hunting being non-detrimental are supported by the evidence. We offer a new simulation model of elephant hunting (described further in Appendix 1), which should replace the very poor model that DWNP has previously relied upon to justify its quotas. Finally, we make suggestions for ways to improve the hunting programme to ensure its sustainability and the sustainability of elephant populations in Botswana.

Our goal here is neither to oppose hunting nor to promote it. Rather, we hope to demonstrate how hunting might impact elephant populations and to suggest practices for mitigating any harms to the population and Botswana's wildlife-based economy.

Botswana's elephant population

The current best estimate of Botswana's elephant population is approximately 140,000. Of this, the vast majority are found in northern Botswana, where a 2022 survey estimated 132,000 elephants, with a 95% confidence interval of 120,000-144,000 (Bussière and Potgieter 2023). Surveys conducted by DWNP in 2004, 2006, and 2013 produced much higher estimates, each exceeding 150,000, for northern Botswana (Chase et al. 2016). Those numbers appear to be unrealistically high, as surveys by Elephants Without Borders (EWB) in 2010, 2014, and 2018 each estimated around 130,000, which is roughly in agreement with the 2022 estimate (Schlossberg and Chase 2024). As a result, we deem it unlikely that northern Botswana has had over 150,000 elephants in recent years.

A 2018 aerial survey found an additional 6,500 elephants in south-central Botswana (DWNP 2021). Another ~1,000 are found in the Northern Tuli Game Reserve, and ~300 are thought to live around the Bobonong area in CT27 (DWNP 2021). Taken together, this produces an estimate of 140,000 elephants, with 95% confidence interval of 127,000 – 153,000.

In northern Botswana, home to ~94% of the country's elephants, elephant populations have been stable since 2010 (Schlossberg and Chase 2024). Though DWNP frequently cites the statistic that elephant populations grew at a 6% annual rate from 1981 to 2006 (DWNP 2021), this is irrelevant today. Between the 2018 and 2022 surveys, there was no significant change in elephant numbers (Schlossberg and Chase 2024).

For the 2010-2022 period, using the core areas covered by the 2010 survey, the overall population growth rate was -0.3% per year and was not significantly different from zero (Schlossberg and Chase 2024). Taken together, these data points suggest a relatively stable population in northern Botswana. Whether or not numbers are changing outside of northern Botswana is unknown due to lack of high-intensity, repeated surveys.

Elephant populations in the well-studied Okavango Panhandle region have been controversial because of human-elephant conflict (Buchholtz et al. 2023). A 2019 report suggested that elephant populations in the panhandle had been growing by 7% per year since 1996 (DWNP 2021). Data from EWB and the 2022 Kavango Zambezi Transfrontier Conservation Area (KAZA) survey, however, found that the population is essentially unchanged since 2010 (Schlossberg and Chase 2024). As in the rest of northern Botswana, previous high growth rates in the panhandle seem to have given way to a more stable population recently.

Though elephant numbers in northern Botswana appear stable, recent surveys show one worrying trend. Carcass ratios, the number of carcasses relative to the number of live and dead elephants combined, have been steadily increasing on surveys in northern Botswana since 2010 (Schlossberg and Chase 2024). This trend continued through the 2022 KAZA survey, meaning that higher ratios are not just an artefact of methods used on the 2010-2018 EWB surveys. Carcass ratios are an indicator of mortality rates, so this could mean that death rates are rising in elephants (Douglas-Hamilton and Burrill 1991).

The exact cause of increasing carcass ratios is unknown, though poaching, drought, and diseases are possibilities, as discussed below. Anything that increases elephant mortality rates over multiple years will potentially impact the sustainability of elephant hunting, as we demonstrate below. Some scientists have stated that rising carcass ratios are a normal part of a stable or stabilizing population like Botswana's. This is incorrect and easily demonstrated with our population models. Under any assumptions about carcass longevity, carcass ratios should not increase significantly after a population reaches carrying capacity (unpublished data).

Elephant hunting overview

Prior to 1983, elephant hunting was legal in Botswana. The practice was discontinued in 1983, however, due to concerns about shrinking trophy sizes. Elephant hunting resumed in 1996 and continued through 2013 (DWNP 2021). In 2014, the government imposed a hunting moratorium. The policy was reversed in 2019, when the government issued 86 hunting licenses to citizens and 72 to non-citizens.With the onset of COVID-19, many of the 2019 and 2020 licenses were purchased by wealthy local businessmen eager to hunt elephants after a five-year moratorium. In 2019, a hunter shot one of EWB's satellite-collared elephants. With international clients deterred by COVID-19, many wealthy people in Botswana bought citizen licenses or quotas, and elephants were hunted—though the exact number taken remains unknown.

In absolute terms, hunting quotas have gradually risen over time in Botswana (Table 1). For assessing the sustainability of hunting, however, the percentage of the total population to be hunted is the key variable. DWNP's recent publications have used unrealistic estimates of numbers, as discussed above, to calculate historical population sizes (DWNP 2021, 2024). We recalculated quotas using more realistic population sizes, with the population increasing at a mean rate of 1.2% annually between 1996 and 2025, with the rate decreasing over time (Table 1).

Year	Official quota (elephants)	Official quota (% of pop.)	Actual harvest (elephants)	Actual harvest (% of pop.)	Estimated population
1996	77	0.08	33	0.03	100,000
1997	78	0.08	51	0.05	102,167
1998	168	0.16	99	0.09	104,284
1999	168	0.16	113	0.11	106,350
2000	168	0.16	155	0.14	108,362
2001	180	0.16	133	0.12	110,317
2002	192	0.17	132	0.12	112,214
2003	192	0.17	139	0.12	114,051
2004	192	0.17	147	0.13	115,828
2005	192	0.16	173	0.15	117,543
2006	270	0.23	252	0.21	119,196
2007	290	0.24	253	0.21	120,788
2008	307	0.25	269	0.22	122,317
2009	354	0.29	271	0.22	123,784
2010	341	0.27	308	0.25	125,190
2011	400	0.32	286	0.23	126,536
2012	388	0.3	298	0.23	127,823
2013	396	0.31	322	0.25	129,051
2014	0	0	0	0	130,222
2015	0	0	0	0	131,339
2016	0	0	0	0	132,401
2017	0	0	0	0	133,410
2018	0	0	0	0	134,369
2019	0	0	0	0	135,280
2020	0	0	0	0	136,142
2021	325	0.24	219	0.16	136,960
2022	281	0.2	197	0.14	137,734
2023	312	0.23	167	0.12	138,466
2024	388	0.28			139,158
2025	410*	0.29			139,812

Table 1. Hunting quotas, actual harvests, and estimated total population sizes for elephants in Botswana. Data from DWNP (2024).

** The 2025 quota was increased from 410 to 431 just prior to completion of this report. This would represent 0.31% of the total population.*

Between 1996 and 2013, official quotas gradually increased from 0.08% of the population to 0.31% of the population. But hunters did not utilize the entire quota in any of these years. Actual harvests averaged just 75% of the official quota. Consequently, the true hunting rate, as a percentage of the population, had a maximum of 0.25% and averaged just 0.16%.

For 2021-2025, official quotas have been significantly higher than they were in most of 1996-2013, both as a percentage of the population and in absolute numbers (Table 1). Nonetheless, through 2023, the latest year with data available, the actual harvest rate was well below the quota, averaging 194 elephants or 0.14% of the population. Still, higher levels of harvest are clearly possible. From 2009 to 2013, hunters killed a mean of 304 elephants per year or 0.24% of the population.

Understanding elephant age structure

In Botswana, only bulls with tusks weighing ≥11 kg can be hunted legally. This corresponds to a minimum age of ~20 years old (Whyte and Hall-Martin 2018). Thus, the number of mature bulls in the population is the key factor affecting the sustainability and economic viability of trophy hunting. Elephant hunters prefer bulls with larger tusks (Muposhi et al. 2016), and tusks grow throughout the life of an elephant (Whyte and Hall-Martin 2018). This means that hunters are more likely to kill older bulls, ≥30 years old, than younger bulls. As a result, an economically viable hunting system must provide sufficient numbers of mature bulls for hunters, and considering the age structure of the elephant population is critical.

Mortality rates of adult bulls increase with age (Lee et al. 2011, Wittemyer et al. 2013). Consequently, even without hunting, older bulls will make up only a small fraction of the total elephant population. For instance, in two Tanzanian populations experiencing little poaching and no legal hunting, bulls aged 25-39 made up only 5.4% of the total population (Jones et al. 2018). Bulls ≥40 years old were just 0.8% of the population.

Hunting further reduces the already low number of mature bulls in the population. In our simulation model of elephant hunting, any amount of hunting reduces equilibrium numbers of mature bulls (Fig. 1). In fact, the degree of reduction in bull numbers is directly proportional to the hunting rate. With long-term hunting at Botswana's current quotas of ~0.3% of the population annually, the number of bulls ≥30 years old will be 24% lower than in a population without hunting. The number of the oldest bulls, ≥50 years, would be 50% lower. See Appendix 1 for model details.

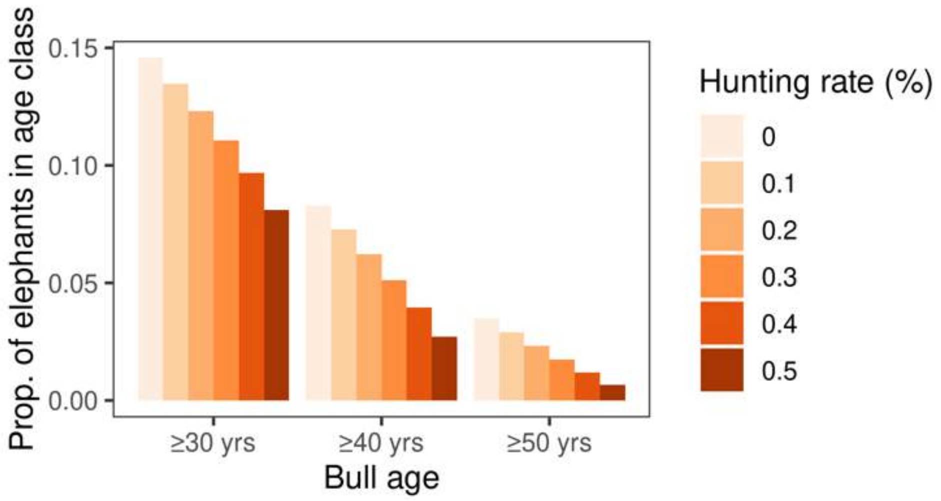


Fig. 1. Effects of hunting on the proportion of the elephant population that is mature bulls in simulated elephant populations. Models do not include poaching or drought (see below).

Because the number of mature bulls is low to start with, removing hundreds of bulls per year has a measurable impact on the population. Hunters do not necessarily have to kill only the oldest bulls to reduce their numbers per Fig. 1. In Botswana, hunters frequently kill "middle-aged" bulls in their 30s or even their 20s. For 1996-2013, the mean estimated age of hunted elephants was 37 years (Craig et al. 2011). That means that most harvested elephants were killed before they could reach 40 or 50 years old. Hunting, therefore, limits the number of bulls that will reach the oldest age classes.

Why should Botswana be concerned about the population of older bulls so long as numbers are sufficient for hunting? Older bulls play several important roles in elephant populations. First, older bulls are repositories of knowledge about the landscape. Despite a reputation for being solitary, bull elephants actually spend 63% of their time in groups (Chiyo et al. 2014). Within these groups, older bulls often act as leaders when groups are travelling (Allen et al. 2020). Older bulls may know the locations of water in times of drought or safe pathways to traverse human-dominated landscapes. Younger bulls are not born with this knowledge and must learn by following older ones. Second, the presence of older bulls reduces inappropriate aggression in younger bulls.

In two studies, older males' presence reduced younger males' misplaced aggression against other species or against vehicles (Slotow et al. 2000, Allen et al. 2021). Third, older males are responsible for most matings, due to out-competing younger males, suppressing musth in younger males, or the preferences of females. In one Tanzania population, where poaching dramatically reduced numbers of older bulls, a few remaining older bulls were responsible for a large proportion of matings (Ishengoma et al. 2008). The oldest males are preferred by females for mating, as they have demonstrated their capacity for longevity and their ability to compete successfully with other males (Poole 1989b, Poole et al. 2011). Thus, local reductions in numbers of older bulls could potentially reduce the genetic health of elephant populations.

How many mature bulls does an elephant population need to maintain the vital functions that bulls provide? The answer is unknown. The precautionary principle, however, requires that numbers be kept relatively high to avoid a breakdown of bull social networks and a reduction in mating opportunities for females. Even at the "conservative" (DWNP 2021, p. 5) target of a 0.3% hunting rate, 50% of the oldest bulls are likely to be lost relative to a population without hunting (Fig. 1). And, as discussed in the next section, the 50% loss projection is likely an underestimate.

Other factors that can affect hunting

Simple models of elephant hunting, like the one used in Fig. 1, assume that nearly all elephant mortality is due to hunting or natural causes that remain constant over time. But hunting is not the only factor that can kill mature bulls or reduce their availability to hunters. Poaching, drought, human-elephant conflict, and disease are all affecting elephants in Botswana. These factors have not been incorporated into planning for elephant hunting. Likewise, DWNP's hunting regulations consider Botswana's elephants to be a single, well-mixed population with little consideration of spatial factors and the separation between hunting and non-hunting areas. Maintaining a viable hunting programme requires treating the population realistically. Failure to consider the factors described below could result in Botswana harvesting bulls at unsustainable levels.

Poaching

Throughout Africa, poaching has devastated populations of savanna elephants (Wittemyer et al. 2014, Chase et al. 2016). Though Botswana has not experienced the extreme levels of poaching observed elsewhere, poachers have been killing elephants in the northern part of the country recently. In just 2017-2018, for instance, we observed 156 poached elephant carcasses during aerial surveys, which led to an estimate of 400 elephants killed in five poaching hotspots (Schlossberg et al. 2019). Subsequent observations confirm that poaching has continued in northern Botswana. Between 14 October 2023 and 28 May 2025, we located 120 poached elephants in just a small area of northern Botswana, primarily in NG15 and NG18, west of Chobe NP (Fig. 2). Additionally, between 23 November 2023 and 20 May 2024, law enforcement agencies made seven interceptions of armed poaching gangs exiting Botswana with elephant tusks from freshly killed elephants (Appendix 2). Over this six-month period, approximately 103 tusks were confiscated, with a combined weight of 2,939 kilograms. These statistics speak directly to the scale and persistence of cross-border poaching[1].

[1] Ivory poaching in Botswana persists with alarming regularity. While finalising this report, on 10 September 2025, the Botswana Defence Force intercepted a group of foreign poachers along the Linyanti River in northern Botswana. The suspects abandoned a cache of thirteen large elephant tusks, later confirmed to have been taken from elephants recently killed within concession NG15. The corresponding carcasses were discovered in the field, displaying unmistakable signs of poaching; the faces hacked open to extract tusks, tails severed, and the remains deliberately concealed beneath vegetation to evade detection. Over the past six years, organized foreign ivory poaching syndicates have been responsible for the illegal killing of elephants in northern Botswana. Despite multiple interceptions and "contacts" with these groups, there are no verified records of arrests made by Botswana authorities. This absence of successful law enforcement outcomes indicates a continuing enforcement deficiency and underscores the challenges in effectively deterring cross-border ivory poaching operations. (See Appendix 2 – Elephant Poaching Interceptions.)

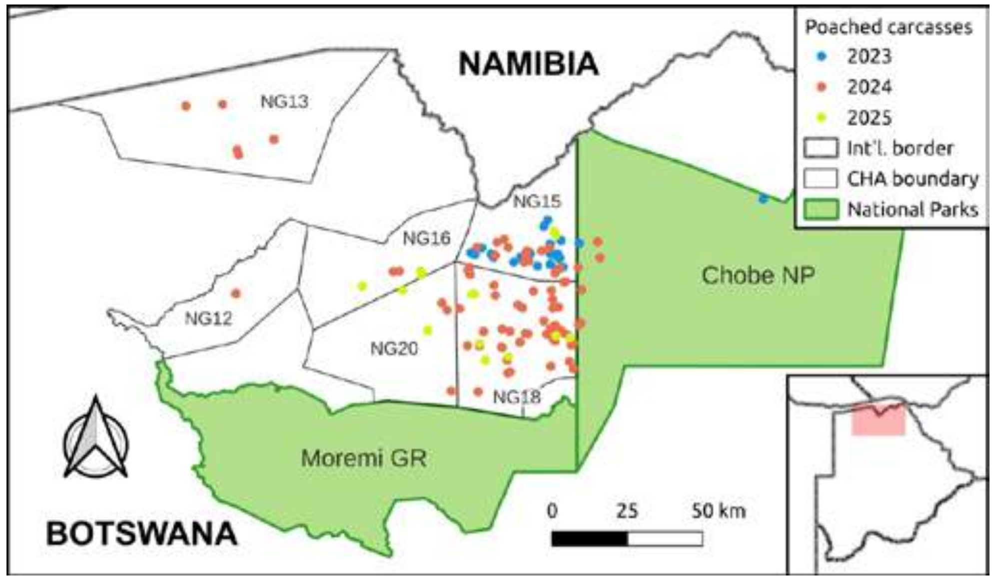


Fig. 2. Locations of poached carcasses reported by EWB, northern Botswana, 2023-2025. Inset shows main map area in Botswana.

For hunting, the most significant aspect of recent poaching is that poachers are targeting older bulls. In 2018, of 47 elephants killed by poachers that we could age and sex, all were bulls, and their mean age was 41 years old (Schlossberg et al. 2019). During that study, we aged a larger sample of bull carcasses that had died from causes other than poaching. These had a mean age of 29 years at death. The elephants that were not poached had more young bulls than the poached sample and, the mean age of 29 years at death is consistent with the life history of elephants. The same trends in poaching targets have continued through 2025 (unpublished data). Thus, poachers in Botswana are targeting the largest bulls, presumably for the ivory in their large tusks, which still fetches a high price on the international market.

In our simulation models of elephant hunting, both the number of mature bulls in the population and the expected trophy sizes for legal hunters decrease with the poaching rate (Fig. 3). Even relatively low levels of poaching, on the order of ~100 bulls per year, have measurable impacts on the population and trophy sizes (Fig. 3). As noted above, it is very likely that >100 bulls are currently being poached per year in Botswana.

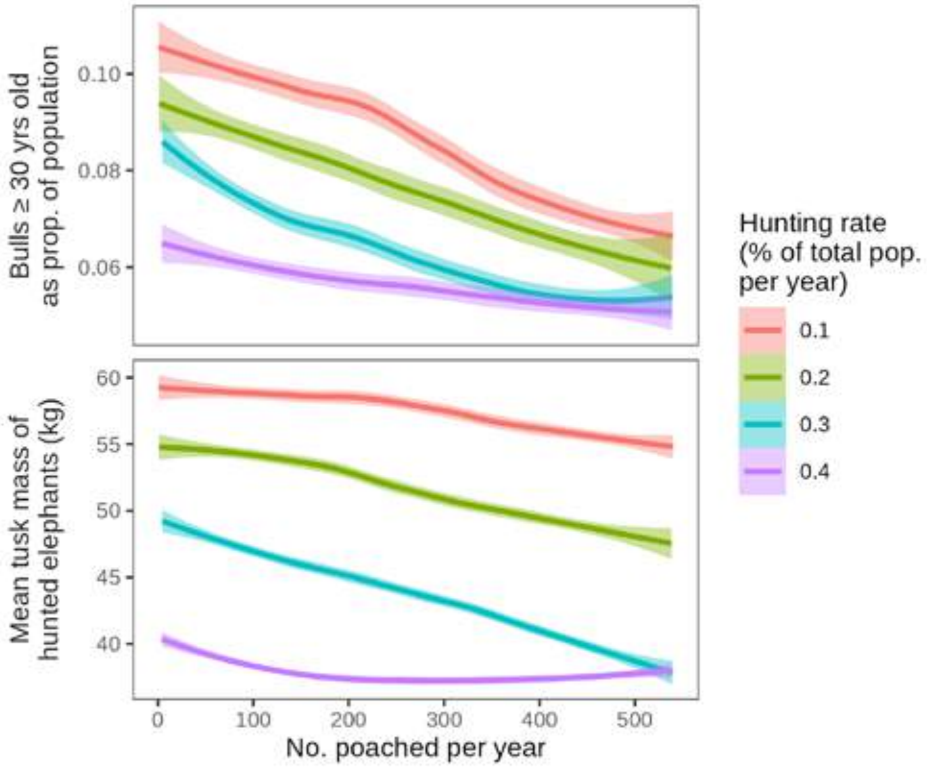


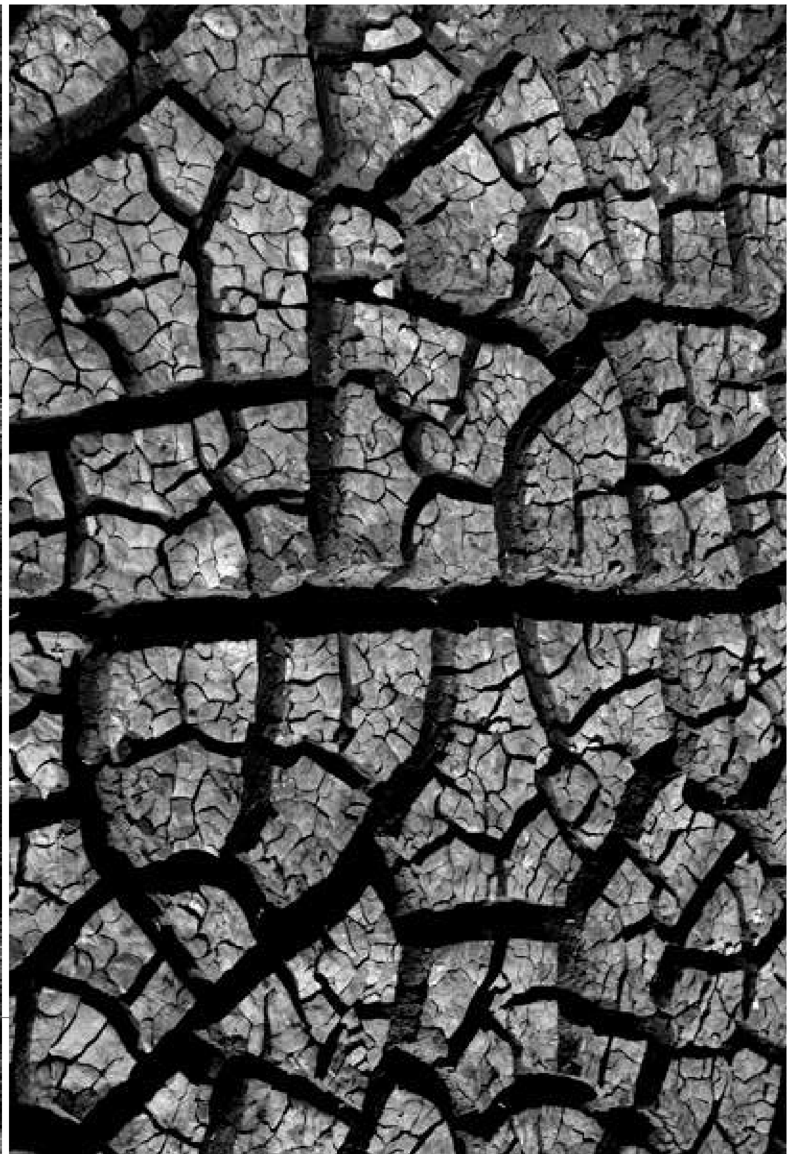
Fig. 3. Effects of selective poaching on bull population structure and hunting outcomes in simulation models. Lower plot shows combined tusk mass from both tusks. Lines are LOESS smooths ± 1 SE.

The results in Fig. 3 make sense because poaching and hunting both have roughly equivalent effects on the bull population, as each targets older bulls. Consequently, the effective hunting rate is essentially the hunting rate plus the poaching rate. Failure to include the effects of poaching when setting hunting quotas could result in overhunting that reduces trophy sizes and the average age of the bull population. If 400 elephants per year is considered a sustainable quota, that number should be adjusted down by the number of bulls poached per year to set the hunting quota.

One implication of these results is that good estimates of poaching rates are important for setting sustainable hunting quotas. Currently, there is little regular, systematic monitoring of poaching outside of Botswana's sole Monitoring the Illegal Killing of Elephants Programme site in Chobe NP. As discussed above, most documented poaching in recent years has taken place outside of the park.

Regular surveillance of areas experiencing poaching should be an important component of elephant management going forward. Because poachers remove tusks by mutilating the corpses of elephants, poached bulls can often be identified from photos taken during surveillance flights or aerial surveys. This means that aerial surveys can be a useful tool for monitoring for poaching over relatively large areas. We discuss this further below.

Recent poaching in Botswana has been highly selective, focusing on relatively large bulls. Elsewhere in Africa, poachers have been far less discriminating, killing elephants of both sexes and all ages (Mondol et al. 2014). The conclusions above and in Fig. 3 refer to selective poaching of bulls. If poaching in Botswana ever becomes indiscriminate, with females and younger males being killed, then the implications for hunting would be much graver. Indiscriminate poaching is likely to be incompatible with hunting because Botswana would be losing living bulls while also losing the potential for bull populations to be replenished through reproduction and ageing of younger bulls.



Drought

Several studies have shown that periods of drought reduce elephant survival (Foley et al. 2008, Wato et al. 2016). Armbruster & Lande (1993) and Lee et al. (2022) both reported that drought primarily affects survival of older females and young elephants of both sexes. These studies agreed that adult males were little affected by drought. Despite this fact, drought can have significant impacts on population size and its age distribution, both of which affect hunting. Droughts that kill calves or adult females will temporarily reduce fecundity, impacting the future production of bulls.

If drought were rare, it would have little impact on hunting. The current annual probability of severe drought in southern Africa is ~5% (Abiodun et al. 2019). Climate models, however, predict that by 2050-2080, under likely scenarios for climate change, severe droughts may happen in 20% of years (Abiodun et al. 2019). Under worst-case scenarios, drought frequency could approach 40%. In Botswana, the three most severe droughts in a dataset going back to 1950 all occurred in the last 12 years (Fig. 4). Thus, increased frequency of severe drought due to climate change may already be affecting southern Africa.

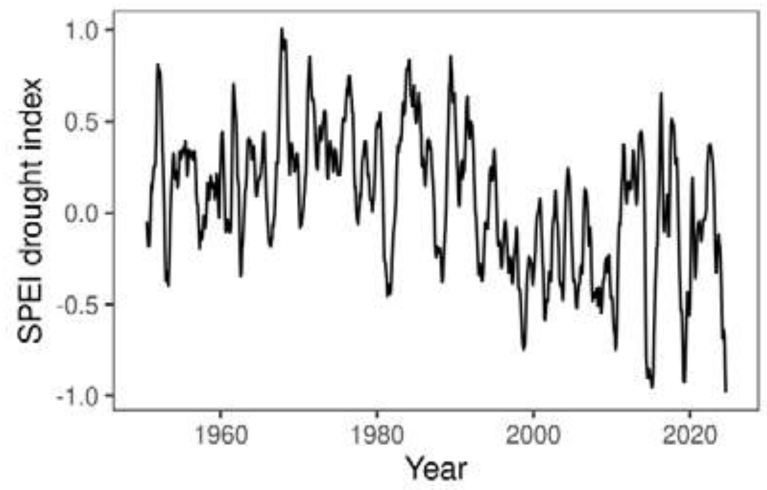


Fig. 4. Twelve-month, centered, running mean of the Standardised Precipitation Evapotranspiration Index (Beguería et al. 2014). Values <0 indicate drought; more negative values are more severe.

When we applied the demographic impacts of drought from Armbruster & Lande (1993) in our simulation models, we found strong effects of drought frequency on hunting. The annual drought probability had a direct, negative effect on the number of mature bulls in the population as well as mean trophy sizes (Fig. 5). Drought, therefore, poses a threat to the viability of hunting and needs to be accounted for when setting quotas. One notable result from Fig. 5 is that even under relatively high drought frequencies, hunting quotas of 0.1% and 0.2% still produce larger trophies on average than would be obtained with 0.3% annual quotas and no drought. Thus, lower hunting rates appear more resilient to drought than the higher ones.

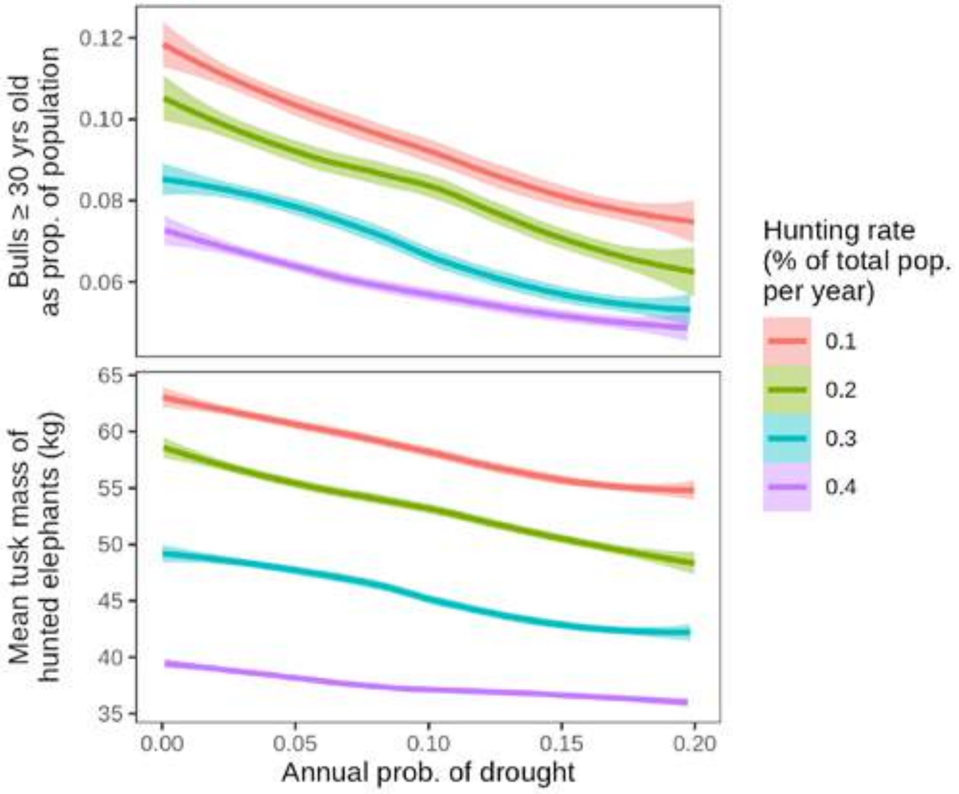


Fig. 5. Effects of drought frequency on hunting outcomes and bull population structure in simulation models. All conventions as in Fig. 3.

Disease

In 2020, ~350 elephants died in a small region of northern Botswana, likely due to bacterial septicaemia (Van Aarde et al. 2021, Foggin et al. 2023). Seasonal pans in this area also harbour viruses potentially lethal to elephants (Skoog et al. 2025). In the historical record, mass mortality of elephants due to disease appears uncommon (Grobler et al. 1995, Azeem et al. 2020).

Future disease outbreaks, however, could affect elephant hunting, as any new source of mortality will affect population size and age structure. To date, however, disease outbreaks in Botswana's elephants have been sporadic and limited in scope and duration. The stochastic nature of these events makes predicting how they might affect elephant hunting difficult. Regular monitoring for disease outbreaks will, therefore, be important, and any sustained mortality of elephants beyond background levels should be incorporated into planning for hunting. If a large outbreak occurs, precautionary reductions in hunting quotas in the vicinity can be used to mitigate potential harms to the population (see discussion of poaching outbreaks, below, for a related example).

Problem Animal Control

Human-elephant conflict (HEC) has resulted in injuries and deaths to people in Botswana as well as damage to crops and other property (Gupta 2013, Buchholtz et al. 2023). To stop or mitigate HEC, DWNP has used lethal control (or problem animal control, PAC) to remove elephants that are harming human life or property. Between 2010 and 2020, a mean of just 10 elephants per year (range: 0-34) were killed by DWNP due to HEC (DWNP 2024). After 2020, however, many more elephants have been killed: 91 in 2021, 90 in 2022, and 146 in 2023.

For purposes of managing hunting, this exponential increase in PAC is concerning. Since 2021, the number of elephants being killed each year by DWNP may be on the same order as the number being killed by poachers (see above). Poaching at a rate of ~100 per year has measurable impacts on hunting (Fig. 3). The 146 animals killed in 2023 are 0.1% of Botswana's total elephant population. If this continues year after year, this is a large enough number to potentially influence hunting outcomes, especially if the killing is happening in hunting blocks.

To date, DWNP has not released any information on the ages and sexes of elephants killed under the PAC programme. Killing bulls will have a larger and more immediate impact on hunting than killing females or young elephants. In other areas of Africa where HEC has been studied, older and larger males are key participants (Chiyo et al. 2012), and this is likely the case in Botswana as well. Because we lacked data on the age- and sex-distribution of animals killed, we did not attempt to model effects of PAC on hunting. But killing elephants in the numbers observed recently, especially if they are mature males, will influence hunting and should be accounted for in planning.

Tusk damage

In the wild, many adult male elephants have broken or missing tusks, likely due to fighting with other males (Steenkamp et al. 2007, Haynes and Klimowicz 2015). Chase (2007) reported that 38% of adult males in northern Botswana had at least one broken or missing tusk. Surveys show that hunters strongly prefer to harvest elephants with both tusks intact (Chase 2007). If hunters avoid harvesting bulls that have broken or missing tusks, this will reduce the effective number available for hunting in much the same way that drought or poaching does. Of course, unlike poaching or drought, tusk damage does not prevent bulls from fulfilling other ecological and reproductive functions in elephant populations. To date, DWNP has not incorporated loss of bulls due to missing or broken tusks into their quota setting mechanisms.

We modeled the effects of tusk damage, measured as the annual proportion of bulls ≥20 years that experience significant, new tusk damage, on hunting. In the models, damaged tusks made bulls unattractive to hunters. As with drought and poaching, higher levels of tusk damage led to decreased trophy sizes because fewer of the largest trophy-quality bulls were available (Fig. 6).

As with drought (Fig. 5), lower hunting rates were more resilient to effects of tusk damage. Even with a relatively high damage rate of 0.02 yr^{-1}, at 0.2% annual hunting, the mean trophy size of harvested elephants will be larger than one would expect with a hunting rate of 0.3% and an unrealistic damage rate of 0. The report by Craig et al. (2011) that largely forms the basis for DWNP's claims about the sustainability of elephant hunting makes no mention of tusk damage. As a result, that report overestimates the number of elephants available to hunters in the population, and its estimates of predicted trophy sizes under different hunting quotas are likely too large.

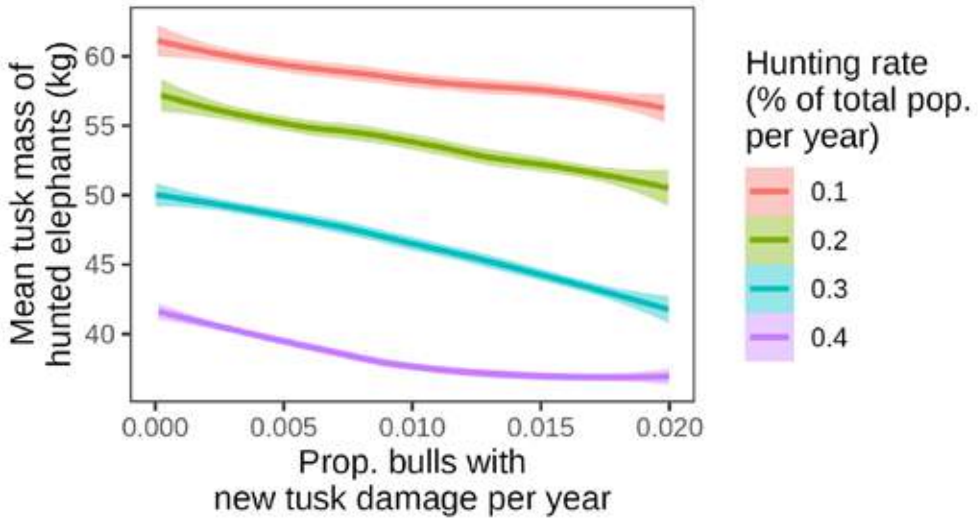


Fig. 6. Effects of the rate of tusk damage on hunting outcomes in simulation models. All conventions as in Fig. 3.

Elephant populations in hunting and non-hunting blocks

DWNP's finding of non-detriment (NDF) for elephant hunting states, "The annual CITES quota is to be based on the total population of elephants in all hunting blocks and must not exceed 0.5% of that estimated population" (DWNP 2021, p. 34). Using the 2022 KAZA survey of northern Botswana, we estimated that northern Botswana's hunting blocks hold ~40,000 elephants (Bussière and Potgieter 2023). Including the additional elephants in central and southern Botswana, we can add a few thousand more, for a total of ~45,000 elephants. If the quota were 0.5% of the population in the hunting blocks, as stated in the NDF, the total hunting quota would be around 225. The actual quota for 2025 is 410 elephants. This represents approximately 0.9% of the elephants in the hunting blocks and greatly exceeds DWNP's self-imposed 0.5% limit.

Is hunting at a 0.9% rate sustainable? Four times in the 2021 NDF, DWNP states that quotas of up to 1% are "eminently sustainable in biological terms" (though potentially incompatible with an economically viable hunting industry). We used our model to ask what would happen if elephant hunting quotas were set at 0.9%, the effective harvest rate if hunting blocks are considered on their own, for an extended period of time. Results show that the overhunting is rapid and severe, with mature bulls (≥ 30 years) disappearing from the population within 25 years (Fig. 7). This is true despite starting in year 1 with a population that has never been hunted and has large numbers of mature bulls. With a hunting quota of 0.9%, trophy sizes quickly diminish to the minimum size that hunters will accept in the model. Obviously, hunting at this rate is not sustainable. Per Figs. 3 and 6 above, the quota would have to be cut by at least 2/3 to be sustainable and economically viable if it is to be based solely on numbers in the hunting blocks.

Of course, treating the hunting blocks as completely separate from the non-hunting areas is not biologically realistic. Most hunting areas are not fenced or otherwise separated from the non-hunting areas in ways that would bar elephant movements. Additionally, elephants can have vast home ranges, migrate seasonally, and disperse to new home ranges from time to time. As a result, the hunting blocks and non-hunting areas are better considered a metapopulation, a group of subpopulations connected by dispersal. As Fig. 7 shows, if the hunting areas are considered in isolation, these areas are certainly a population "sink" for mature bulls, an area where mortality exceeds the production of new mature bulls by reproduction and ageing. On the other hand, the non-hunting blocks should be areas where production of bulls exceeds mortality, or "sources." In a metapopulation, sinks can have stable populations so long as there is regular immigration from source populations (Pulliam 1988). So, if bulls are regularly dispersing from the non-hunting areas into the hunting areas, then hunting can be maintained.

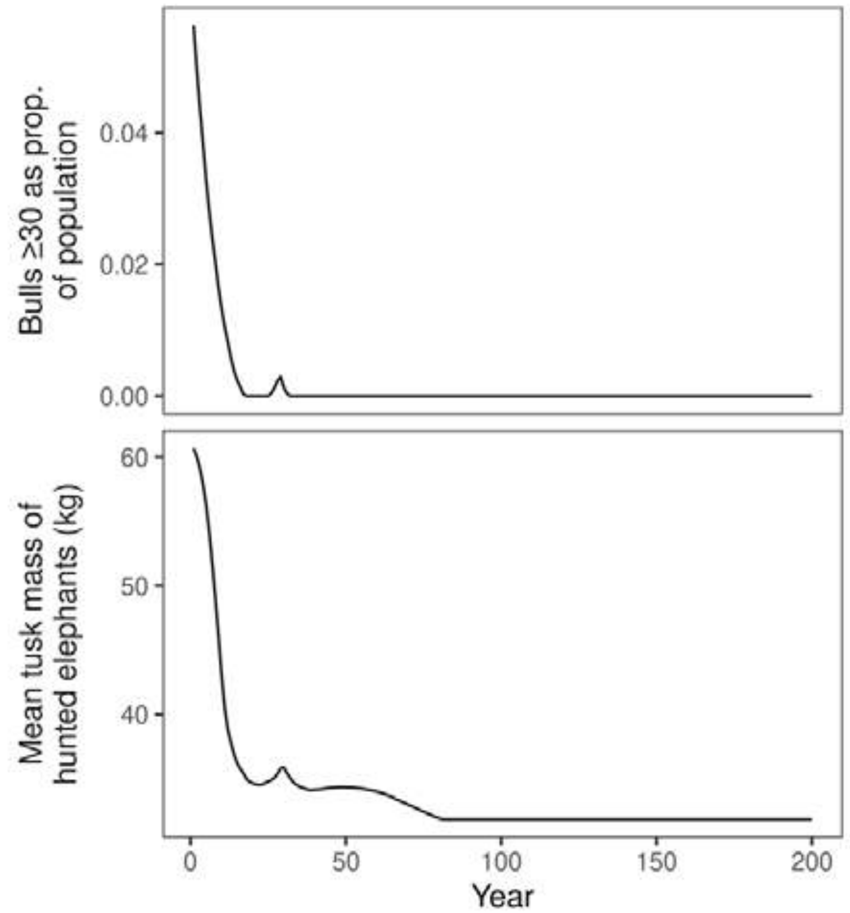
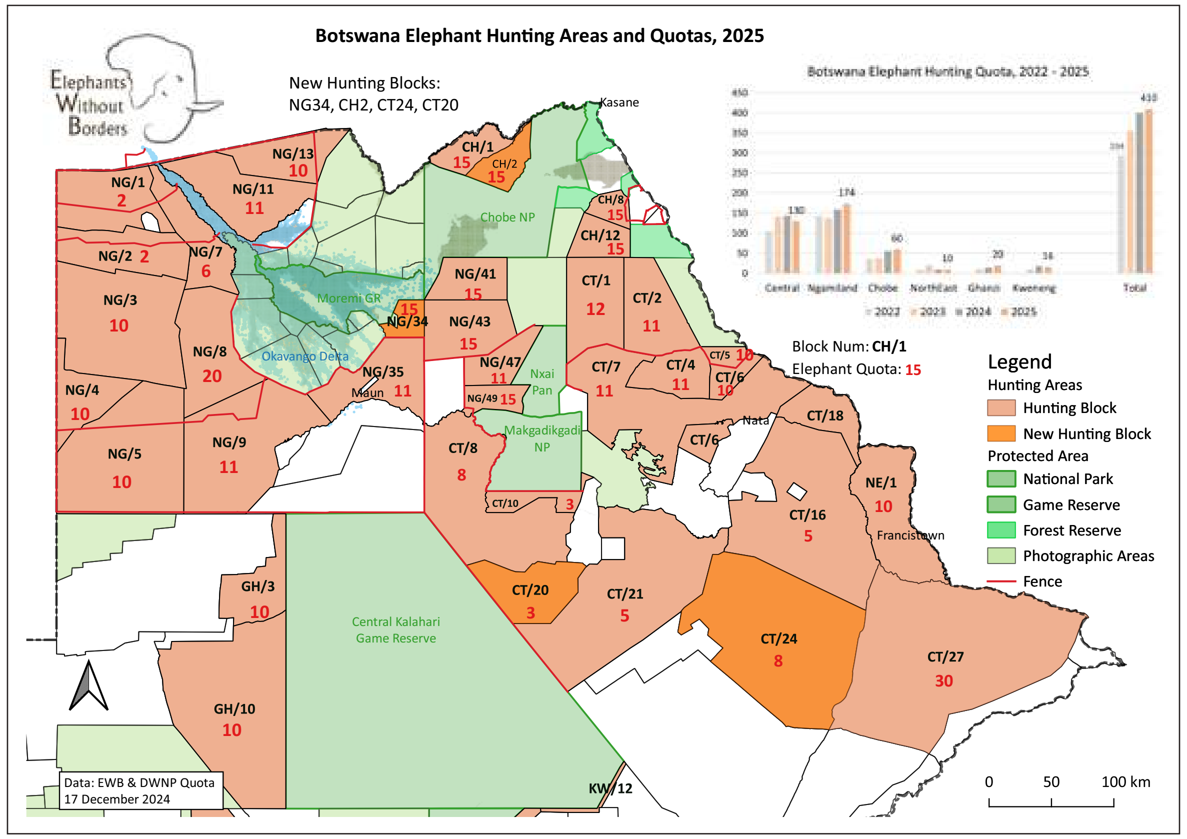


Fig. 7. Effects of hunting at a rate of 0.9% per year on hunting outcomes and bull population structure in simulation models. Lower plot shows combined tusk mass from both tusks.


Botswana Elephant Hunting Areas and Quotas, 2025
Elephants Without Borders
New Hunting Blocks:
NG34, CH2, CT24, CT20
Kasane
Botswana Elephant Hunting Quota, 2022 - 2025
Central
Ngamiland
Chobe
NorthEast
Ghanzi
Kweneng
Total
2022
2023
2024
2025
Block Num: CH/1
Elephant Quota: 15
Legend
Hunting Areas
Hunting Block
New Hunting Block
Protected Area
National Park
Game Reserve
Forest Reserve
Photographic Areas
Fence
Chobe NP
Moremi GR
Okavango Delta
Maun
Nxai Pan
Makgadikgadi NP
Nata
Francistown
Central Kalahari Game Reserve
Data: EWB & DWNP Quota
17 December 2024
0
50
100 km

But how many elephants need to be dispersing from the non-hunting areas each year? We used our simulation to find out. We split the model population into hunting and non-hunting zones with equilibrium population sizes that approximate the ratios observed in Botswana today (~95,000 in non-hunting areas and ~45,000 in hunting areas). Other than hunting, survival rates and fecundity were identical in the two populations. To mimic dispersal, each year a fixed fraction of all bulls of legal hunting age were moved from the non-hunting population to the hunting population. In the real world, bulls can move in both directions. For purposes of modelling hunting, however, the net dispersal is what matters. We might expect mature bulls to preferentially move from non-hunting areas with higher bull densities to hunting areas with fewer bulls. The hunting areas should have reduced competition with other bulls and increased mating opportunities.

Fig. 8 shows the effects of different numbers of bulls dispersing from non-hunting areas to hunting areas. In Fig. 8, the hunting rates shown treat the entire metapopulation, hunting and non-hunting areas, as a single population for calculating quotas. This is how Botswana appears to be currently calculating quotas, as discussed above. We note two important results here. First, for any given hunting rate, trophy sizes increase with immigration up to a threshold level and then are relatively flat. So, each hunting rate requires a certain level of movement to maximise trophy sizes, and that level increases with hunting rate. With hunting at 0.1%, trophy sizes reach a maximum around a 0.025 emigration rate. With hunting at 0.3%, emigration needs to be ~0.05 for trophy sizes to reach a maximum. Second, when there is little or no net movement, older bulls are overharvested in the hunting blocks, and hunting is not likely to be sustainable. This replicates our finding from Fig. 7.

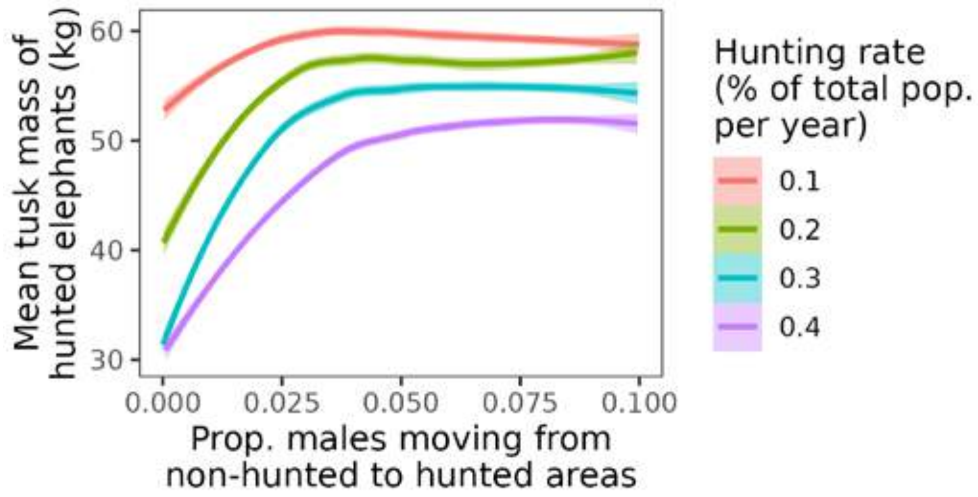


Fig. 8. Effects of the number of males moving from non-hunted areas to hunted areas on hunting outcomes in simulation models. All conventions as in Fig. 3.

The results in Fig. 8 have four major implications for managing hunting in Botswana. First, hunting in Botswana is absolutely reliant on production of bulls in non-hunting areas. If bulls were not regularly dispersing from the non-hunting blocks, hunting would essentially be impossible at the quotas that Botswana is using. At a quota of ~400 bulls per year, hunting areas will be sink populations for mature bulls in Botswana. Source populations for mature bulls are likely to be the protected areas with large numbers of elephants, including Chobe NP and Moremi GR as well as the Kwando, Selinda, and Khwai WMAs.

Second, the health of the elephant populations in non-hunting areas is as important as the health of the hunted subpopulations. If poaching reduces the numbers of bulls in non-hunting areas, then fewer bulls will eventually be available in the hunting blocks. As discussed above, much of the poaching that EWB has documented in recent years has been outside of hunting zones. In the long run, however, this could still affect hunting trophies and numbers of bulls in hunting blocks.

Third, because hunting depends on bulls' moving from non-hunting areas, any barriers to movements will potentially affect hunting. Building new fences or repairing old fences could constrain movements. Likewise, expansions of settlements or agriculture could hinder elephants' ability to move from non-hunting areas. Elephant movements need to be considered as part of planning for elephant hunting.

Finally, elephant populations in central and southern Botswana are likely poorly connected with the large population in the north. As a result, the elephants in these areas should be considered a distinct population, and hunting quotas should be based on the number of elephants in these regions alone, not counting any elephants from further north. Thus, areas south of the Central Kalahari Game Reserve as well as the hunting blocks in southeast Botswana should have their quotas set based solely on local populations. To aid in setting quotas, we suggest that relatively high-intensity population surveys be done in the region.

In theory, immigration from non-hunting blocks could sustain hunting with moderate quotas indefinitely. In practice, however, there is no guarantee that elephants will always make such movements. We observed a worrying sign when we analysed data from the 2018 and 2022 surveys in northern Botswana. After a 7-year moratorium, elephant hunting resumed between these two surveys. When we compared elephant populations in hunting blocks and non-hunting areas between the surveys, we found that numbers of elephants had decreased in the hunting blocks and increased in the non-hunting areas (Schlossberg and Chase 2024).

Two surveys is too little data to make strong conclusions about movements, but this suggests that elephants could be avoiding areas with hunting. This is the opposite of what is necessary to maintain a viable hunting programme. Regular monitoring will be necessary to ensure that elephants are not avoiding hunting blocks, as this would shift hunting outcomes to the left on Fig. 8 and necessitate lower quotas.

Comments on the government's hunting plan

DWNP's (2021) NDF for elephant hunting makes a number of questionable, misleading, and in some cases false statements about hunting. As noted above, DWNP falsely states that hunting at a 1% annual rate is "eminently sustainable in biological terms." Hunting at this rate would rapidly eliminate most or all older bulls, leading to reduced genetic diversity, increased aggression in younger bulls, and the loss of knowledge, critical for survival, possessed by older bulls. The NDF also states that hunting will be based on the populations in the hunting blocks, but this seems very unlikely based on current quotas. As demonstrated above, hunting blocks will experience rapid loss of older bulls unless they are regularly immigrating from non-hunting areas (Fig. 7).

In the NDF, many of the conclusions about the sustainability of hunting are based on a model developed by Craig et al. (2011). That model is highly flawed and relies on incorrect assumptions, making it unsuitable for use in planning for elephant hunting. First and foremost, their model does not incorporate any density dependence. Their model population simply grows forever at its maximal rate. To prevent unrealistic population totals in their model, the authors decided that some fraction of the population would emigrate from Botswana each year. This is made up from whole cloth and has no relationship to the real world. Several studies have shown that density dependence, a decrease in fecundity or survival at higher densities, occurs in elephants (Fowler and Smith 1973, Chamaillé-Jammes et al. 2008, Lee et al. 2011, Foley et al. 2024). Moreover, if thousands of elephants were emigrating from Botswana each year, then the same would be occurring in neighbouring populations in Namibia and Zimbabwe, some of which have relatively high densities. These large numbers of emigrating elephants simply do not exist. Nearly every large mammal whose demography has been studied experiences density dependence (Bonenfant et al. 2009). As elephant populations increased in northern Botswana, mortality rates likely increased, and fecundity likely decreased, resulting in a population that has been stable for years (Schlossberg and Chase 2024).

Failure to include density dependence makes the model of Craig et al. (2011) unrealistic because reproductive rates are always maximal, with new bulls always being produced at the highest possible rate to replace those hunted. In northern Botswana today, reproduction is likely depressed by relatively high elephant densities in the largest subpopulations.

Another major issue with the report by Craig et al. (2011) is their claim that hunting is sustainable based on the stability of tusk sizes of harvested elephants over the 1996-2010 period. We question the claim that tusk sizes were stable over time. Data from DWNP show a decreasing, though non-significant trend, for mean tusk masses over 1996-2013 (DWNP 2024). Also, even if tusk sizes were stable, this does not imply that elephant hunting is sustainable, for two reasons. First, both the official quotas and actual harvest rates during 1996-2013 were low. The official quota, as a percentage of the entire population, averaged 0.20%, and the actual harvest rate averaged 0.16% (Table 1). Today, the quota is 0.3%, though it is too soon to know what the realised quotas will be going forward. As shown above, hunting quotas of 0.1-0.2% produce relatively large trophy sizes indefinitely in model populations, so long as drought and poaching are not too frequent. Hunting at a 0.3% rate produces smaller trophies and substantially reduces the number of mature bulls in the population (Fig. 1). Drawing any conclusions about future hunting at a 0.3% rate based on a time period when the rate was just 0.16% is incorrect.

Second, as long as there is a sufficient number of trophy-quality bulls in the population, we would expect a similar distribution of trophy sizes each year. If hunters' preferences for trophies of certain sizes do not change over time, and the population can meet those preferences, then the distribution of tusk sizes should be similar from year to year. In our models, in the absence of significant poaching or drought, once the population reaches an equilibrium, there is little change in trophy sizes (a function of elephant age) or bull numbers from year to year. In fact, even if the model population is growing, the trophy size distribution remains stable because hunters' preferences are stable (unpublished data).

A final issue with the report by Craig et al. (2011) is that key survival rates were invented for their model. Rather than using previously published survival estimates for elephants, the authors rejected several estimates from peer-reviewed publications as being too high or too low to meet their notions of what survival rates and population growth rates should be. Instead, the authors essentially invented survival curves. Even after a draft report was complete, the authors went back and invented new survival curves to better fit the data on tusk sizes. The use of made-up survival rates makes the conclusions of the Craig et al. (2011) report unreliable. To make matters worse, the authors used the same survival rates for male and female elephants. Peer-reviewed studies based on many years of field work consistently show that female elephants have higher survival rates and greater longevity than males (Gough and Kerley 2006, Lee et al. 2011, Wittemyer et al. 2013). Even if the survival rates used in the Craig report were accurate for males and females combined, male survival would still be greatly overestimated. This would bias the report towards predicting larger trophy sizes and lower impacts of hunting than would be expected in reality.

For our report, we took age- and sex-specific survival and mortality data from the well-studied Amboseli population (Lee et al. 2011). These long-term datasets were published in 2011, the same year that the Craig report was published. If anything, using data from the Amboseli population biases our model to be optimistic about hunting. The Amboseli population, living in a park-pastoralist landscape, experiences fewer anthropogenic impacts than many Botswana elephants. Furthermore, the data that we used from the Amboseli population were screened so that human-caused mortality was not included in survival estimates. Amboseli's elephants are the best studied on the planet. Thus, our model results should be much more trustworthy than those that DWNP has relied upon thus far.

Building a resilient hunting system

Above, we showed that poaching, drought, elephant movements, and tusk damage can each interfere with elephant hunting by reducing trophy sizes and, for all but tusk damage, reducing bull numbers. But what happens when we combine these factors, as would happen in the real world? As shown in Fig. 9, combining these four factors reveals that they have additive effects on elephant hunting. Thus, all of the factors in Fig. 9 need to be included when setting elephant hunting quotas, or Botswana risks overhunting that depletes mature bulls.

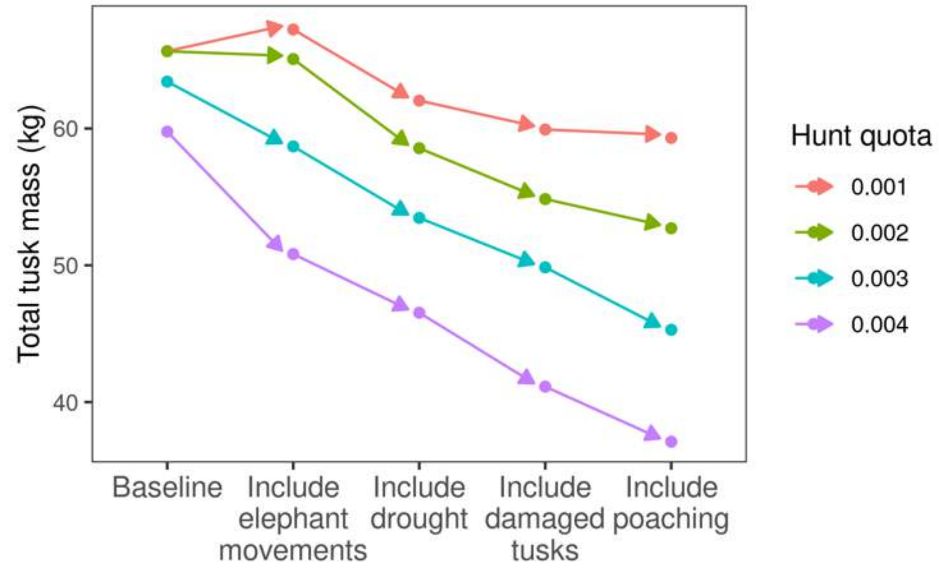
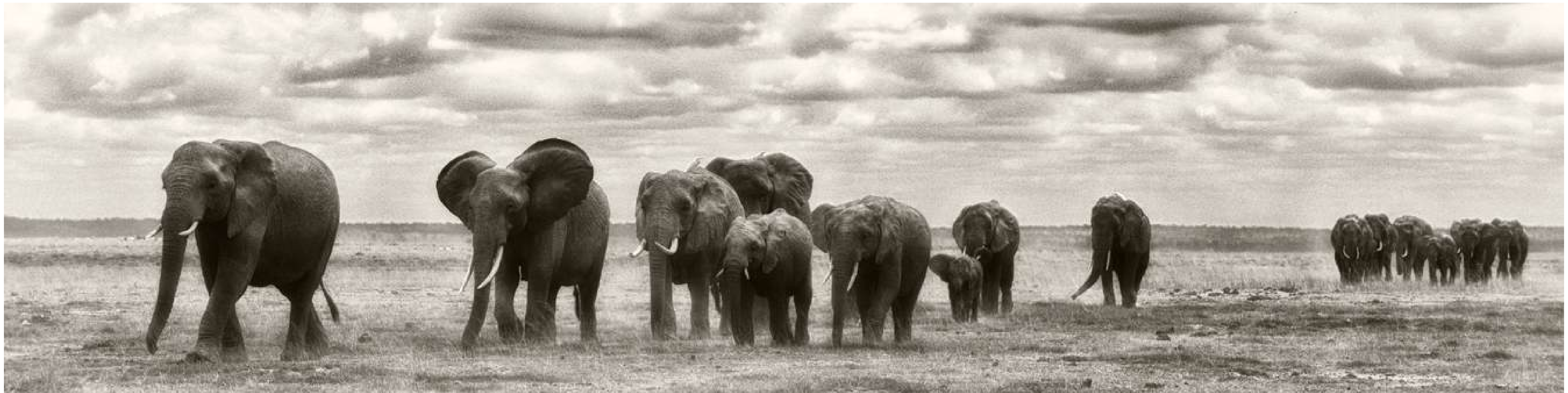


Fig. 9. Effects of four factors on hunting outcomes in simulation models. Arrows indicate that each factor on the x-axis was added to the factors to the left. Plot shows combined tusk mass from both tusks.



In Fig. 9, we used arbitrary levels of the four factors. In reality, future levels of poaching and drought are unknown, and the frequency of elephant movements is difficult to quantify. But one clear result from our modelling is that lower hunting rates are more resilient to these factors. With a hunting rate of 0.1%, the four factors in Fig. 9 reduce trophy sizes by 13%. But with a hunting rate of 0.3%, trophy sizes are reduced by 27%. The same result is apparent in Figs. 3 and 5. Lower hunting rates are less influenced by drought or poaching than higher hunting rates are. This makes sense because lower hunting rates leave a larger pool of mature bulls in the population, resulting in a greater buffer against any changes that reduce bull numbers or reduce their availability for hunting.

Because there is still much uncertainty in how drought, poaching, or other factors will affect elephant populations in the future, we believe that the precautionary principle should be applied to the management of elephant hunting in Botswana. This principle requires being as prudent as necessary to ensure that elephants are not negatively affected by unforeseeable events. Following the precautionary principle would increase the likelihood that when drought or poaching occurs, harm to elephant populations or loss of income from hunting will be minimal.

To illustrate why a precautionary approach is important, we modelled effects of a 10-year poaching outbreak on a population previously at equilibrium with hunting at a 0.3% rate per year. Poaching during the outbreak was set at ~500 bull elephants per year. We note that during a poaching outbreak in 2017-2018, we estimated ~400 bulls were killed, and this was based on aerial surveys not specifically designed to look for poached elephants (Schlossberg et al. 2019).

Results (Fig. 10) illustrate three features of elephant population management that have been ignored by DWNP. First, as expected, a 10-year poaching outbreak results in a decline in trophy sizes during the outbreak due to a loss of large bulls. But that decline continues for 10 more years after the outbreak has ended. This should not be surprising because anything that results in increased death rates of bulls, even temporarily, reduces the number of mature bulls available to hunters. When bull numbers are depleted, continued hunting at the same rates forces hunters to take smaller and younger bulls than previously. Consequently, the average trophy size continues to decline for ~10 years in this model until younger bulls that avoided poaching begin to age into trophy-sized age classes.

Second, full recovery from overhunting is extremely slow. In our model population, mean trophy sizes required ~60 years from the beginning of the poaching outbreak to return to the values seen prior to the outbreak (Fig. 12). The only way that mature bulls can be produced in a depleted population is for younger bulls to age into maturity, and this takes decades. Contrary to the model in Craig et al. (2011), an elephant population near carrying capacity reproduces slowly. Thus, the process of bull numbers returning to their pre-outbreak levels is similarly slow.

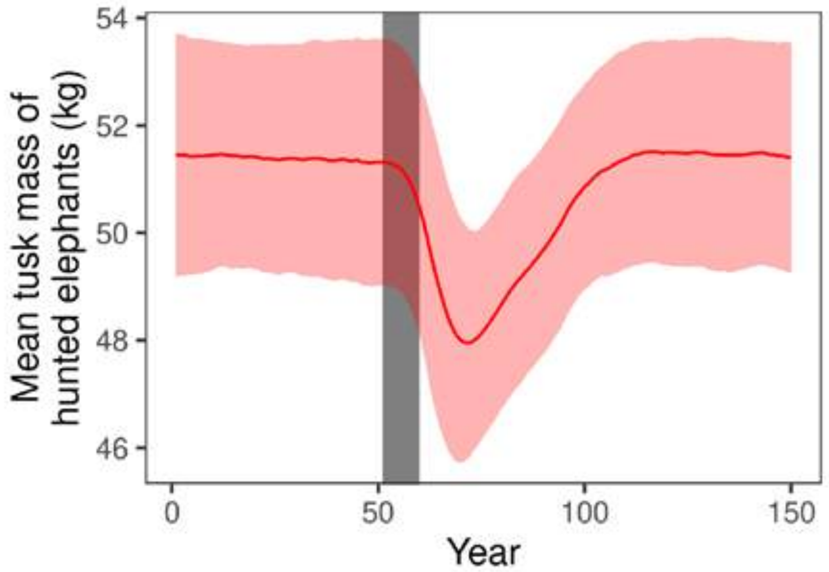


Fig. 10. Effects of 10-year poaching outbreak (grey bar) on trophy sizes (mean ± 1 SE) in simulated elephant populations.

Third, detecting a poaching outbreak through its effects on hunting trophies may be difficult. DWNP (2021) has stated that they will monitor tusk sizes of hunted animals to allow for adaptive management of quotas. In practice, random fluctuations in trophy size over time may make it impossible to detect when overhunting is occurring. In the simulations, only 40% of the mean decline in trophy sizes occurs during the 10 years of the poaching outbreak. The remainder occurs after the poaching is over.

To further examine how well analysis of trophy sizes would detect an event that reduces bull populations, we examined 400 individual simulations from Fig. 10. Simulations differed in the timing of drought events that influenced fecundity, calf survival, and adult female survival. For each simulation, we used a Z-test to compare the mean trophy size in year 60 (the final year of the poaching outbreak) with trophy sizes in the 50 years preceding the outbreak. By year 60, only 25% of simulated populations showed a significant decrease in trophy size. But by year 70, 90% of simulated populations exhibit a decrease in trophy size. Thus, trophy sizes alone are a poor way to monitor the population's health.

How should DWNP avoid the overhunting that can occur during and after a poaching outbreak? One possibility is to use a better monitoring system. Imagine an alternative to the scenario in Fig. 10 where, instead of using unreliable trophy sizes to monitor the population, regular monitoring for poaching is happening. In this scenario, surveys in year 3 of the outbreak detect the poaching, and a temporary one-third reduction in hunting quotas, to 0.2% per year, is imposed until one year after the poaching ends.

Under this scenario (Fig. 11), the reduction in trophy sizes after the poaching outbreak is 65% lower than in Fig. 10. Some reduction in trophy sizes is unavoidable because poaching reduces bull populations. But the effect is substantially mitigated by a small reduction in legal hunting. And, in fact, mean trophy sizes actually increase during the period of lower quotas because fewer elephants are being harvested.

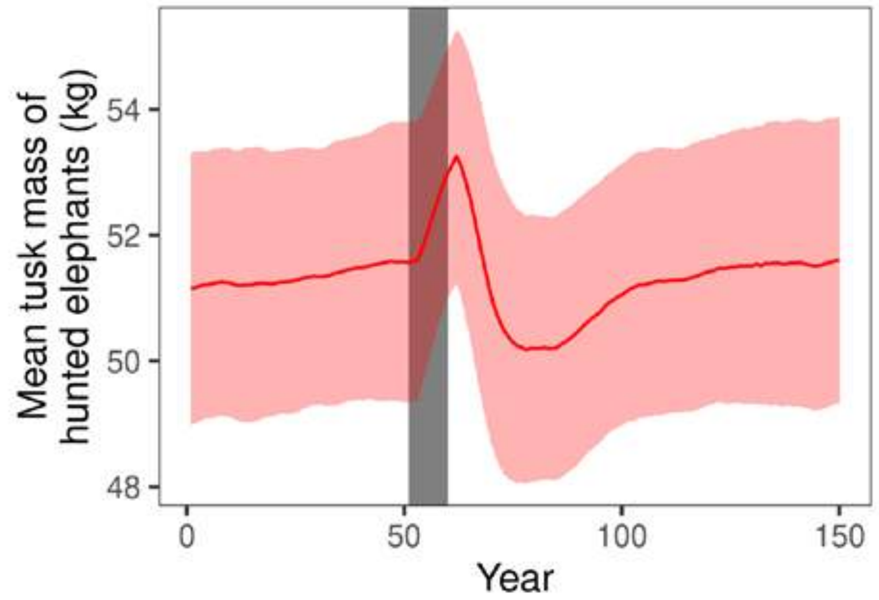


Fig. 11. Effects of 10-year poaching outbreak (grey bar) on trophy sizes (mean ± 1 SE) in simulated elephant populations. In these models, hunting quotas are reduced from 0.3% of the population to 0.2% in years 53-61.

Another alternative to the scenario in Fig. 10 is for DWNP to use a lower baseline hunting quota that results in a larger population of bulls. These additional bulls would provide a buffer against increased mortality due to poaching.

We modelled the poaching outbreak scenario with baseline hunting quotas of 0.1%, 0.2%, and 0.3%. Results were striking: lower hunting quotas result in a much smaller decrease in trophy sizes during and after the poaching outbreak. The relative decrease with a 0.2% hunting rate is approximately one half of the decrease with a 0.3% hunting rate. The decrease with a 0.1% hunting rate is even smaller.

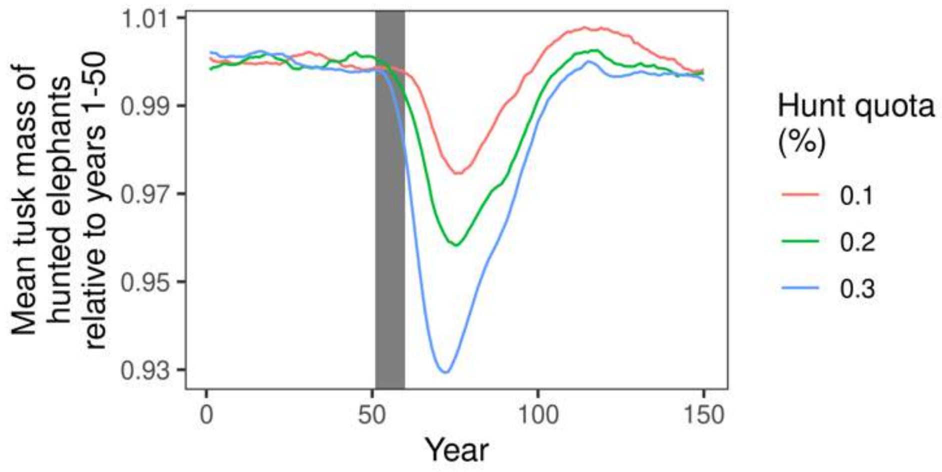
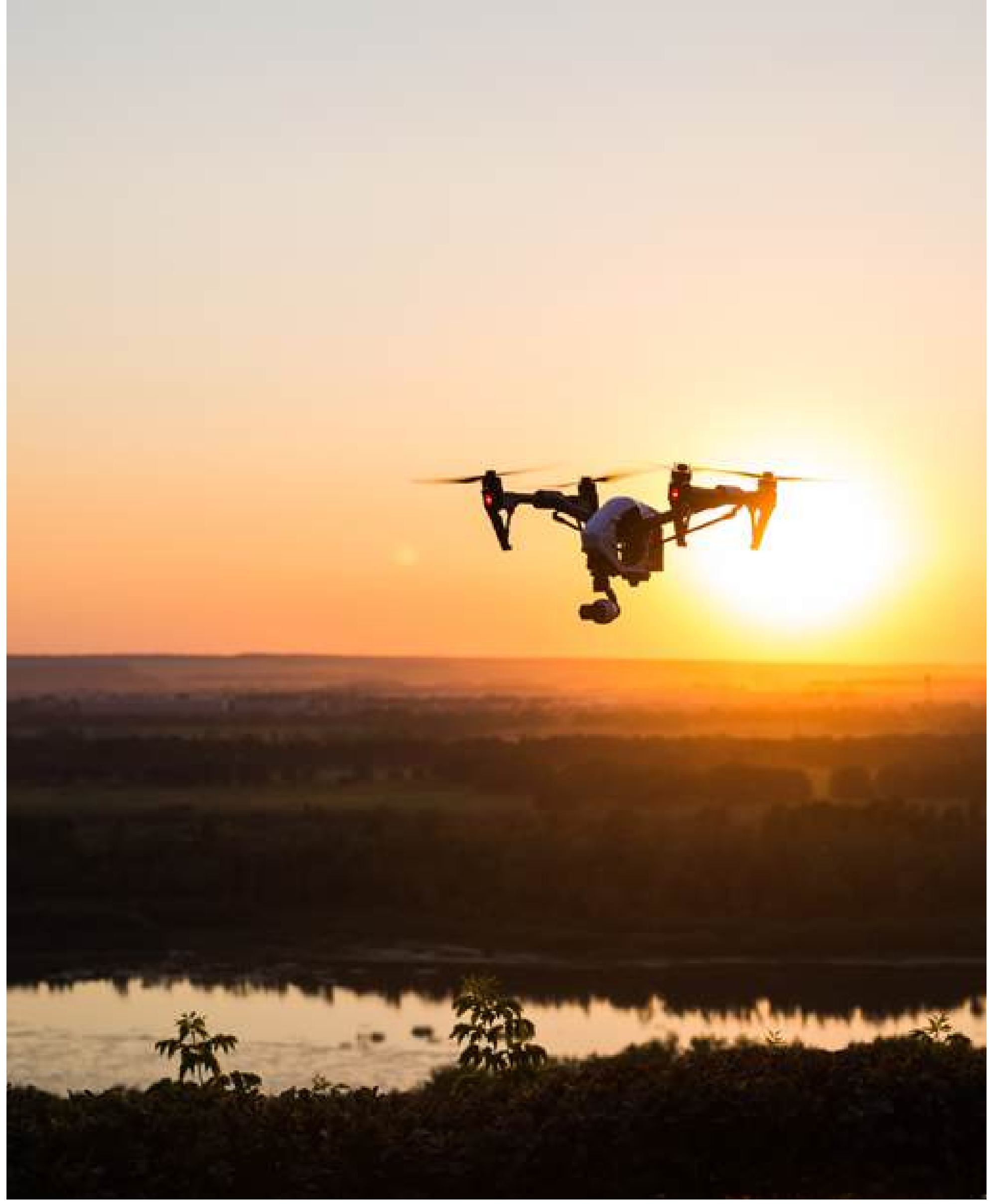


Fig. 12. Effects of 10-year poaching outbreak (gray bar) on trophy sizes in simulated elephant populations. Y-axis shows mean trophy sizes relative to the pre-outbreak sizes in years 1-50.

Figs. 10-12 have two key implications for managing elephant hunting in Botswana. First, hunting at 0.3% leaves little room for error. Hunting at this rate depletes numbers of the oldest bulls by at least 50% compared to a population without hunting (Fig. 1). Thus, when changes such as a poaching outbreak or drought increase bull mortality, the population has little buffer to avoid significant impacts to hunting as well as significant depletion of bull numbers. Applying the precautionary principle, hunting at a rate of 0.3% appears to be too high to avoid harm to the population when unanticipated events happen. Hunting at a 0.2% or 0.1% rate, however, reduces the harm to the population during the poaching outbreak and results in larger numbers of mature bulls surviving.

A second implication of the poaching outbreak models is that DWNP cannot solely rely on monitoring tusk sizes to track elephant hunting. Hunters can make up for a reduction in the number of large bulls by putting in more effort to find them. Thus, changes in quota size will be a lagging indicator of overhunting. By the time that trophy sizes are declining noticeably, future reductions in trophy sizes and depletion of mature bulls are inevitable.

Today, professional hunting guides use drones, camera traps, and dedicated trackers to locate and follow the largest bulls, often before their clients even arrive in Africa. As a result, hunters will likely be insulated from any moderate reductions in bull numbers in the wider population. Only when mature bulls are heavily depleted will hunters be unable to locate them. Consequently, the adaptive management scheme that DWNP proposes, based on trophy sizes, is insufficient. A much better alternative is to conduct regular, precise surveys of elephant populations and to monitor continually for poaching and environmental conditions, as discussed in the next section.



Monitoring recommendations

We have four suggestions for enhancing and improving elephant monitoring in Botswana as part of the hunting programme.

1) Continue and expand regular surveys in northern Botswana

DWNP has previously supported regular, high-intensity surveys of elephants in northern Botswana. Since 2010, these have taken place every four years. These surveys are critical for measuring population size, establishing temporal trends, and determining how elephant distribution is changing. The 2017-2018 poaching outbreak was first detected during the 2018 aerial survey (Schlossberg et al. 2019).

We recommend continuing these surveys no less often than every four years. The 2022 KAZA survey was the first in recent years to fully cover hunting blocks west and south of the Okavango Delta. Though few elephants were found here, if hunting is occurring in these blocks, then they should be part of the coverage area for future surveys.

2) Expand surveys in other hunted areas in central and southern Botswana

Beyond northern Botswana, regular surveys at moderate to high intensity, like the 2022 KAZA survey, should be conducted in any areas where hunting is taking place. Ensuring that hunting quotas are tailored to the population size requires good population estimates. As noted above, because the northern and southern elephant populations in Botswana are not well connected, the southern population should be considered separately for setting quotas. This will require regular surveys in these areas.

3) Age structure monitoring

The age structure of Botswana's elephant population will determine the economic viability of hunting and whether or not there are sufficient numbers of mature bulls to maintain their functions in the population. We suggest that DWNP conduct regular assessments of age structure in hunting blocks. This will ensure that numbers of mature bulls are sufficient and allow informed adjustments to hunting quotas if necessary. Because data collected will include numbers of calves, this monitoring can help determine if reproduction is occurring at expected rates. This is important for hunting because reproductive rates at any time will determine future numbers of bulls.

Methods for ageing elephants are described in Poole (1989a) , Lee & Moss (1995), Moss (1996), and Shrader et al. (2006). Typically a sample of 150 animals is recommended by demographers. But because mature bulls make up a small proportion of the population, we suggest a sample size of at least 50 adult bulls (≥20 years old) and preferably ≥100 bulls per hunting block assessed.

Initially, targets for monitoring should be blocks with relatively large elephant populations. These could include NG11, CH1, CT5, and CT6. Monitoring should be conducted every 3-5 years to establish trends. Fortunately, once observers are trained, collecting data on each CHA should require only a few days per sampling occasion.

4) Poaching monitoring

Finally, regular monitoring for poaching should be a part of the hunting programme. As discussed above, hunting and poaching have similar, additive effects on bull populations, and poaching outbreaks can reduce bull numbers and affect hunting for decades afterwards. Thus, monitoring for poaching is nearly as important as monitoring legal harvests.

DWNP urgently needs to prioritise consistent monitoring of known poaching hotspots, areas that continue to be targeted by the same cross-border poaching syndicates (Fig. 2). These hotspots are too large to easily be surveyed from the ground. Thus, aerial surveillance is critical. But at present, DWNP lacks operational aircraft, and the capacity of the Botswana Defence Force air wing is limited.

Given Botswana's current economic constraints, drones could offer a cost-effective surveillance solution. Elsewhere in Africa, drones are being used to monitor poaching, and new technology may even allow autonomous detection of poachers (Mulero-Pázmány et al. 2014, Bondi et al. 2018). Additionally, DWNP must be open to deeper collaboration with conservation organisations already detecting poached elephant carcasses in the field. These partnerships could significantly strengthen anti-poaching efforts, if acted on swiftly and strategically.

Final recommendations for hunting

1) Set maximum hunting quotas at 0.2% of the population.

Elephant management that includes hunting in Botswana should have three goals for the long term. First and most obvious is to maintain an economically viable hunting industry by providing sufficient numbers of trophy-quality bulls for hunters. Second should be to maintain enough mature bulls in the population for them to fulfill their biological functions of mating, providing knowledge to younger bulls, and preventing inappropriate behavior. The third goal follows directly from the first two: ensure that the hunt is resilient to both anticipated and unanticipated external factors such as drought, poaching, disease, human-elephant conflict, and movements of elephants.

Our models show that meeting the third goal will be easiest if hunting quotas are kept in the 0.1-0.2% range. As quotas increase beyond 0.2%, the number of mature bulls in the population decreases to the point where the population is not resilient to environmental changes that reduce the numbers of bulls. This is a consistent finding of all of our modelling exercises above.

One obvious criticism of our recommendation is that effective quotas, actual harvest numbers divided by the estimated population size, are already in the range of 0.1-0.2% (Table 1). But the results from 1996-2013 show that as hunting quotas increase, the actual offtake increases as well. In Table 1, the correlation between the quota and the offtake for 1996-2013 is 0.97. So, there is reason to believe that actual harvests will soon increase to be nearer quotas, as the hunting industry recovers following the moratorium.

A quota of 0.2% would still allow hunting 280 elephants per year, which is more elephants than have been harvested in most previous years of hunting and just 13% less than the maximum number hunted in any year (Table 1). Setting the quota at this precautionary level should allow the hunt to avoid the worst effects of drought (Fig. 5) and poaching (Fig. 3). With hunting at a 0.2% rate, the number of mature bulls in the population should be large enough to act as a buffer against any unanticipated threats to the population. By contrast, hunting at a 0.3% results in a much smaller buffer and greater risk that mature bulls will be overhunted.

2) Increase transparency, data sharing, and collaboration

For the past four years, Elephants Without Borders has repeatedly submitted formal requests to DWNP and the Ministry of Environment seeking access to basic, non-sensitive information, such as annual hunting quotas, individual trophy measurements, and the number, age, and sex of elephants killed through sport hunting or PAC. This information, as outlined in Botswana's Elephant Management Plan, should be in the public domain.

Despite multiple letters and follow-ups, none of these requests have received a response. This lack of engagement undermines principles of transparency, accountability, and inclusive conservation governance. The summary information, including total numbers of animals killed and mean trophy sizes, released in the NDF reports (DWNP 2021, 2024) is not sufficient to fully evaluate the sustainability of hunting or the impacts of PAC.

We respectfully call for improved transparency and data sharing by DWNP and the Ministry, and at the very least, a professional courtesy of responding to formal correspondence from stakeholders. Open access to data is essential for evidence-based decision-making and public trust in conservation policies.

We also note with concern that both the Elephant and recently released Leopard Management Plans were authored by Conservation Force—a U.S.-based organisation with a well-documented pro-hunting agenda. These plans were developed with limited public consultation and minimal stakeholder input within Botswana. The involvement of an entity heavily funded by the hunting industry in drafting national management frameworks presents a clear conflict of interest, which risks compromising the objectivity, scientific integrity, and long-term sustainability of these policies.

Collaborative, transparent processes are vital if Botswana is to maintain its reputation as a global leader in wildlife conservation. If elephant hunting in Botswana is sustainable, then there should be nothing damaging or embarrassing in the data preventing its being shared with the public. Releasing this data could increase public confidence that elephant hunting in Botswana is sustainable.

3) Honoring photographic zones within multipurpose hunting WMAs

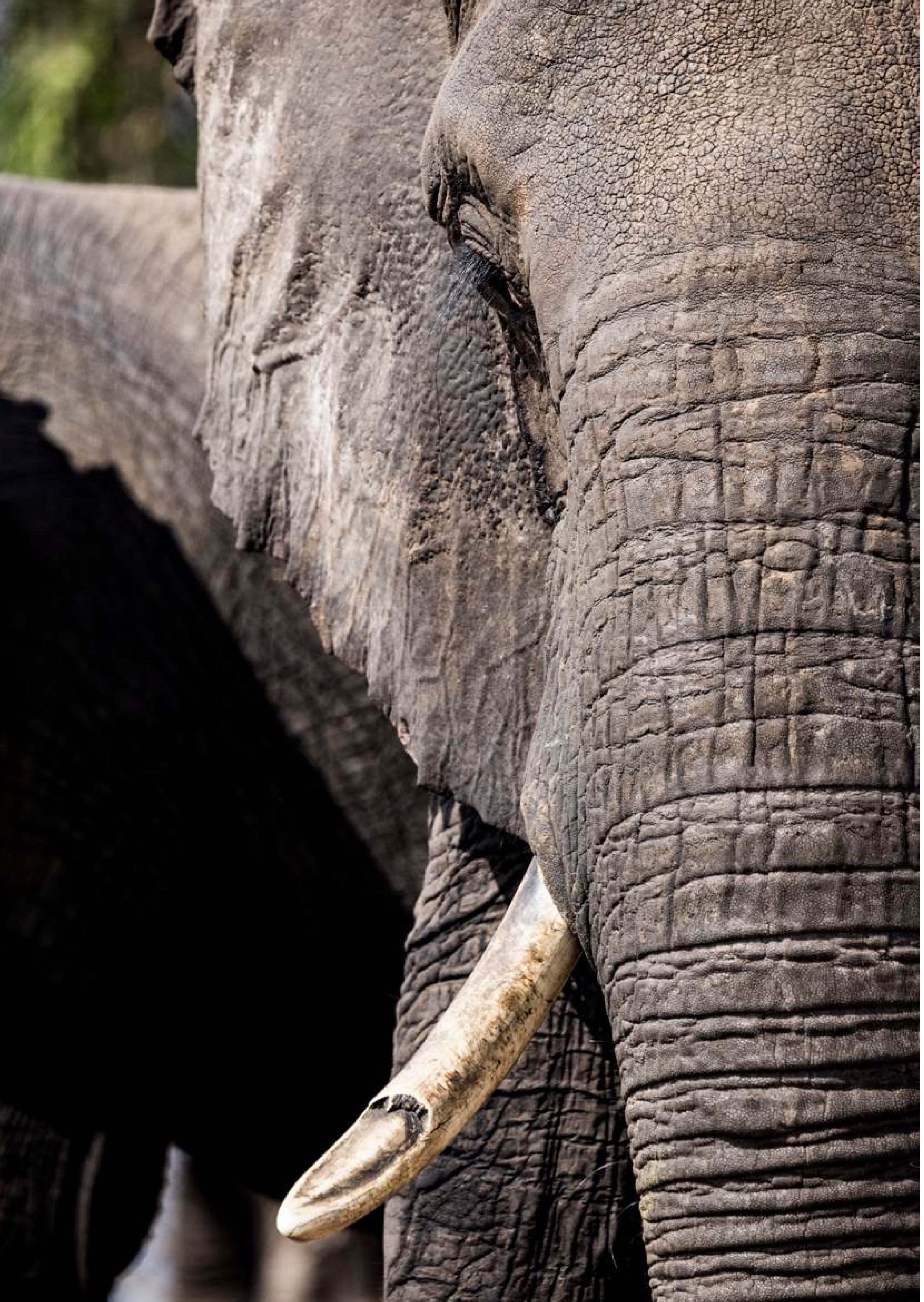
Hunting concessions are obligated to comply with their approved management plans and must not authorize hunting in zones designated for photographic tourism. These non-consumptive areas within hunting concessions are not incidental; they perform a critical role as conservation corridors, preserving habitat connectivity and facilitating regional wildlife movements.

A prime example is the NG13 triangle (577 km²), located east of the Northern Buffalo Fence, extending to the Kwando River and north along the Namibian border adjacent to Bwabwata National Park. Until 2021, this area has been free from hunting for more than 40 years and was deliberately reserved for photographic tourism, recognizing its strategic role as the ecological bridge between Botswana's Okavango Delta and Angola. Yet despite this status, NG13 remains the only segment of this transboundary corridor within Botswana where hunting is now permitted. This anomaly undermines the integrity of the entire landscape, which otherwise enjoys full protection from the Delta to the Namibian border, by creating an ecological bottleneck that jeopardizes the movements of elephants across one of Southern Africa's most important transboundary corridors.

4) Risks of Extending the Hunting Season into the Wet Season

Historically, Botswana's hunting season extended from mid-April to the end of September, aligning with the cool dry season. Since hunting was reinstated in 2019, however, the DWNP has extended the hunting period well into the wet season, in some cases as late as December, in designated Wildlife Management Areas (WMAs). We recognise the rationale for extending the hunting period—or even allowing year-round hunting—in certain mixed-use landscapes where human–elephant conflict is high and requires urgent management. However, within WMAs, hunting should remain strictly limited to the dry season.

Extending hunting into the wet season (October–December) coincides with the natural dispersal of elephants. During this period, bulls roam more widely in search of fresh forage and water, often moving into concessions and mixed-use areas where they become highly vulnerable to being targeted. This substantially increases the risk of shooting older elephants; individuals of immense ecological and genetic importance.



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We are equally indebted to our donors, whose generous support made this report possible. Their commitment to conservation, transparency, and evidence-based policy has enabled us to conduct the research, and analysis, to bring this report to completion. Without their vision and trust in our work, this contribution to Botswana's ongoing dialogue on elephant management and hunting policy would not have been possible.

Finally, we acknowledge the dedicated efforts of our colleagues and collaborators. Their passion, perseverance, and professionalism continue to drive forward the mission of conserving elephants and safeguarding Botswana's natural heritage for the benefit of all Batswana, now and in the future.

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Elephants Without Borders

Appendix 1:
Simulation models

Demographic Parameters

Our simulations used two-sex, age-structured matrix population models. We obtained age-specific survival and fecundity values from the long-term research project in Amboseli National Park, Kenya (Lee et al. 2011). We used their published survival rates that were due to natural causes alone, which allowed us to separately control anthropogenic mortality in the models. To allow for density dependence, we did not use Lee et al.'s estimates for first-year survival (see below).

Matrix Projection Models

We used two-sex, age-structured, 144 x 144 projection matrices in our models, representing 72 years and the two sexes. The projection matrix, **A**, for year t was

$$\boldsymbol{A}(t)=\begin{bmatrix}\frac{\boldsymbol{B}_f(t)}{2}+\boldsymbol{S}_f(t) & \mathbf{0}\\ \frac{\boldsymbol{B}_m(t)}{2} & \boldsymbol{S}_m(t)\end{bmatrix}$$

with male and female birth matrices $\boldsymbol{B_f}$ and $\boldsymbol{B_m}$ and male and female survival matrices $\boldsymbol{S_f}$ and $\boldsymbol{S_m}$ (Rogers 1975). We used a birth-pulse model with pre-breeding census so that $\boldsymbol{B}$ incorporated first-year survival and density dependence. We assumed a 1:1 sex ratio at birth (Moss 2001, Visscher et al. 2004).

All birth and survival matrices were 72 x 72. The births matrix, **B**, had the following formulation for females:

$$\boldsymbol{B}_f=\begin{bmatrix}m_1 s_{0f} & m_2 s_{0f} & \cdots & m_{72} s_{0f}\\ 0 & 0 & \cdots & 0\\ \vdots & \vdots & \ddots & \vdots\\ 0 & 0 & \cdots & 0\end{bmatrix}$$

where m_x is fecundity measured in offspring year^{-1} female^{-1} for age class x. $\boldsymbol{B}_m$ was identical except for the use of s_{0m}. The survival matrices were distinct for each sex and had survival values on the first sub-diagonal, as here for females:

$$\boldsymbol{S}_f=\begin{bmatrix}0 & 0 & \cdots & \cdots & 0\\ s_{1f} & 0 & \cdots & \cdots & \vdots\\ 0 & s_{2f} & 0 & \cdots & \vdots\\ \vdots & 0 & \ddots & \ddots & \vdots\\ 0 & 0 & 0 & s_{71f} & 0\end{bmatrix}$$

Each year's simulation began by projecting the population to allow for births and natural deaths. For population size vector $n(t)$, with one component for each sex- and age-class,

$$n(t+1)=\boldsymbol{A}(t)n(t).$$

Density Dependence

Density dependence has been reported in several elephant populations (Fowler and Smith 1973, Chamaillé-Jammes et al. 2008, Foley et al. 2024). Our models included two forms of density dependence: 1) a negative effect of density on calf survival in the first year after birth and 2) a negative effect of density on fecundity (Fowler and Smith 1973). For each of these values, we parameterized the effect as

$$Y=Y_{min}+(Y_{max}-Y_{min})\left[1-\left(\frac{N}{K}\right)^{\gamma}\right] \qquad \text{(Eq. 1)}$$

where Y is the density-dependent parameter with specified minimum and maximum values, N is elephant population size, K is the population at which Y is reduced to $Y_{\min}$, and γ is a shape parameter. For $\gamma < 1$, the density-dependence curve is concave from above, and $\gamma > 1$ produces a curve that is convex from above. If $\gamma = 1$, Y decreases linearly with N. Because density dependence in large mammals is typically manifest near carrying capacity, convex from above curves are more likely than concave curves (Sibly et al. 2002). We tested γ values from 1 to 3.5 and found no effect on model outcomes (unpublished data). Thus, we arbitrarily selected a value of $\gamma = 2.38$ to use in simulations. We used $K = 140{,}000$ in the models, which is the estimated size of the Botswana elephant population. Because all hunting quotas were defined as a percentage of the total population, changing K has no effect on any outcomes. As noted in the report, the main elephant population in northern Botswana has had stable numbers since 2010, so modeling a population near equilibrium was appropriate.

In the simulations, we treated first-year survival and fecundity separately. For fecundity, we assumed that density-dependence would reduce fecundity by the same proportion for all maternal age classes. Thus, for fecundity, Y in Eq. 1 was a multiplier for fecundity values from Lee et al. (2011), with $Y_{max} = 1$ and $Y_{\min} = 0.55$, which was the maximum proportional decrease in fecundity observed at high densities in Fowler and Smith (1973). For first-year survival, we used $Y_{\max} = 0.98$, the highest reported value in Van Aarde et al. (2008), and $Y_{\min} = 0.60$, based on the lowest reported value in Fowler and Smith (1973). The resulting values from Eq. 1 were the s_{0m} and s_{0f} values used in the projection matrices.

To determine if our results were sensitive to the above parameters for density dependence, we ran models with varying levels Y_{max} and $Y_{\min}$ for first-year survival. Specifically, we ran models with varying levels of poaching and hunting rates, repeating the analysis from Fig. 3 in the main report. We did this for each of nine different combinations of Y_{max} and $Y_{\min}$ for first-year survival. Results showed no effect of Y_{max} and $Y_{\min}$ on hunting outcomes (Fig. A1). The plots for each combination of the two variables are nearly identical. We ran a similar sensitivity analysis on $Y_{\min}$ for fecundity and found no effect of this parameter on model results (unpublished data). Thus, the Y_{max} and Y_{min} values used in the report had little or no effect on our conclusions about hunting.

Hunting

In the simulations, after projecting birth and deaths for each year, we next simulated hunting and, if included in the model, poaching. Because the relative timing of poaching and hunting was uncertain, if a model included poaching, we divided the poaching into two periods by dividing the poaching rate in half. The first half of the poaching was followed by all of the hunting and then the second period of poaching. Changing the relative timing of hunting and poaching has little impact on model results (unpublished data).

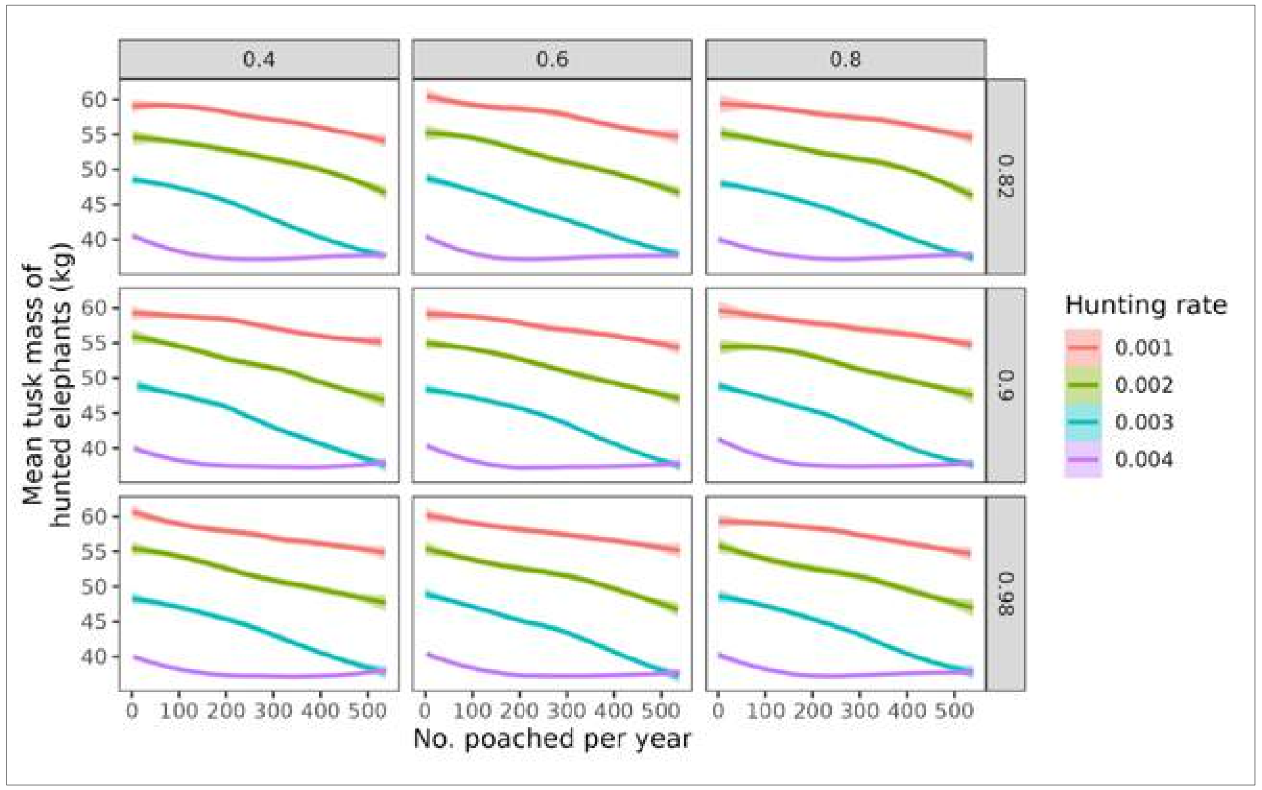

Figure A1. Effects of Y_{max} and Y_{min} (Eq. 1) for first-year survival on results from simulated hunting under different levels of poaching. Columns indicate different values of Y_{min}, and rows indicate different values of Y_{max}. The middle plot in the lowest row shows results for values used in the main report (see Fig. 3).

In each simulation, hunting quotas for each year were set as a percentage of the total elephant population. As in Botswana, hunting in the model was restricted to male elephants at least 20 years of age. Elephant tusk size increases predictably with age (Pilgram and Western 1986, Whyte and Hall-Martin 2018), so we used elephant age as a proxy for tusk size in the models.

To simulate hunting, we had to estimate hunting rates by age class. In Botswana, elephant trophy hunters are selective and prefer males with larger tusks. We used a selectivity function, σ_x, to describe hunters' relative preferences for harvesting elephants as a function of age, x. Because hunters prefer older elephants, we constrained σ_x to be non-decreasing. To allow σ_x to take a variety of shapes, we modeled it as

$$\sigma_x = [f(x)]^{\alpha} \quad \text{(Eq. 2)}$$

where f is a non-decreasing function of x, and $\alpha > 0$. If we restrict $f(x)$ to be in [0,1], changing α shifts the curve to the left or right while roughly maintaining its shape. We translated σ_x values to numbers of animals hunted by age class, H_x, via the following equation:

$$H_x = \frac{\sigma_x n_x Q}{\Sigma(\sigma_x n_x)} \quad \text{(Eq. 3)}$$

where Q is the total hunting quota for the given year, and n_x is the number of elephants in the population in age class x. In Eq. 3, σ_x is essentially a weight that, along with elephant numbers, determines the relative number of elephants hunted in each age class. When the variance across age classes in σ_x is large relative to the variance in n_x, H_x will primarily be determined by σ_x. When the variance in n_x is relatively large, H_x will primarily be determined by n_x. We note that for some combinations of selectivity function and male age distribution, some H_x can exceed the corresponding n_x. In such cases, we iteratively shifted the excess quota from that age class to the next younger age class for which $\sigma_x > 0$ and $n_x > 0$ after initially allocating hunting quotas via Eq. 3.

To estimate σ_x, we combined data on the ages of elephants hunted legally in Botswana with the age distribution of living elephants in Botswana. For hunting, we used data from elephants hunted legally in Botswana between 1996 and 2010. Our dataset consisted of the masses of elephant tusks from harvested animals. For each elephant, we selected the larger of the two tusk masses and used that for analysis to avoid any error due to damaged tusks. We estimated the age of hunted elephants in years as

$$age = 5.2\left(m^{\frac{1}{1.645}}\right)$$

where m is the mass of the larger tusk in kg. We used Chase's (2007) data to estimate the age structure of living male elephants in Botswana. Chase (2007) reported male elephant numbers by 10-year age classes. To estimate numbers by 1-year class, we smoothed the proportions by 10-year class using a quadratic generalized linear model with a logit link. This model had a pseudo-R^2 of 0.96.

We assumed that the elephant tusks in our dataset had been harvested from a population with age distribution as in Chase (2007). This allowed us to estimate a selectivity function that would produce the given age distribution of hunted animals from the given distribution of live males. We did this by defining d_x as the proportion of all hunted males that were in age class x so that

$$d_x = \frac{H_x}{Q}.$$

Dividing both sides of Eq. 1 by Q and simplifying leads to the equation:

$$d_x = \frac{\sigma_x n_x}{\Sigma(\sigma_x n_x)}. \quad \text{(Eq. 4)}$$

Neither individual n_x values nor their sum, N, were known for Botswana. However, if we define

$$p_x = \frac{n_x}{N},$$

then divide the numerator and denominator of the right side of Eq. 4 by N, we obtain

$$d_x = \frac{\sigma_x p_x}{\Sigma(\sigma_x p_x)}. \quad \text{(Eq. 5)}$$

In Eq. 5, the p_x values for Botswana were available from the age distribution of live male elephants in Chase (2007). The d_x values were available from the data on tusk sizes and ages of hunted elephants in Botswana. Consequently, this equation could be analyzed as a regression problem with x data points and unknown σ_x. We cannot estimate σ_x values independently, but if we constrain the values to follow a function as in Eq. 2, they are estimable. We used non-linear least squares regression to estimate σ_x for three different formulations of $f(x)$ per Eq. 2: linear, logarithmic, and logistic. The logistic function was

$$f(x) = [1-(1-b)e^{-cx}]$$

with b and c to be estimated. We used Akaike's Information Criterion to choose the best formulation from the three options. The logistic model was strongly preferred.

The resulting selectivity function is shown in Fig. A2A. Comparing the age distributions of hunted elephants from our dataset and the predicted values from Eq. 5 shows a good fit to the data (Fig. A2B).

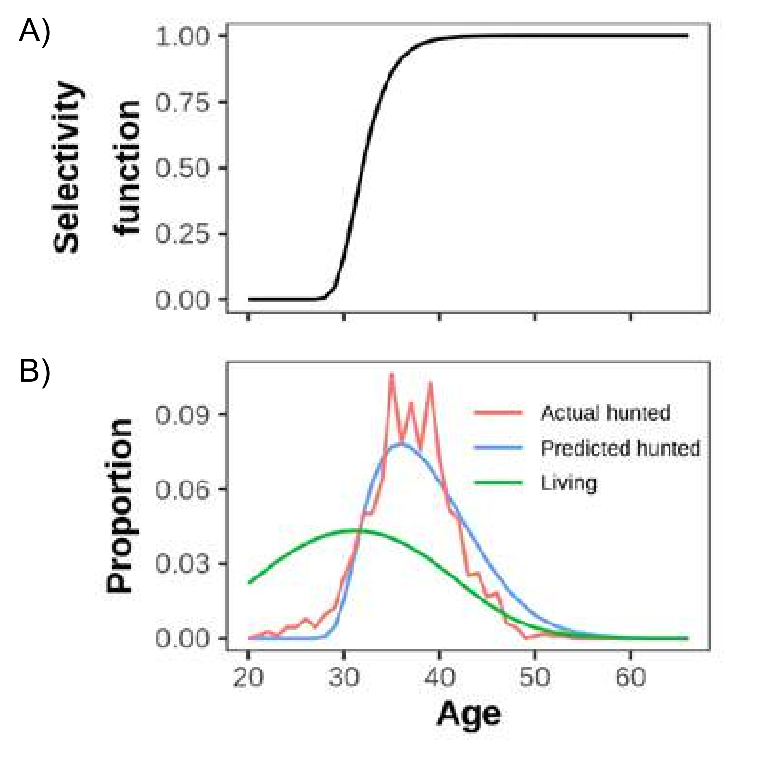

Fig. A2. Estimated (A) selectivity function and (B) predicted versus actual ages at harvest for hunted male elephants in Botswana. In (B), the estimated age distribution of living male elephants from Chase (2007) is shown for reference.

Poaching

In the models, we restricted poaching to adult males ≥20 years old, based on previous studies of elephant poaching and recent data from Botswana (Barnes and Kapela 1991, Schlossberg et al. 2019). As noted in the main report, poachers in Botswana appear to be selecting for older males. As with hunting, the total number of bulls poached per year was calculated as a proportion of the entire population.

We used a selectivity function for poaching in the same manner as we did for hunting. Reliable data on selectivity of poachers, however, was not available. We assumed that poachers would be more opportunistic and less selective than hunters. Consequently, we used the following equation for poaching selectivity, with $\alpha < 0$:

$$\sigma_x = 1 - x^{\alpha}.$$

We used this formulation because it produced a variety of potential shapes for the selectivity curve (Fig. A3). When we modeled the effects of poaching selectivity on outcomes in our simulation models, we found very little effect (Fig. A4). As a result, we elected to use -10 as the value for all of the models used in the report. Accordingly, selectivity increased rapidly from age 20 to age 30 and then was relatively flat for older ages.

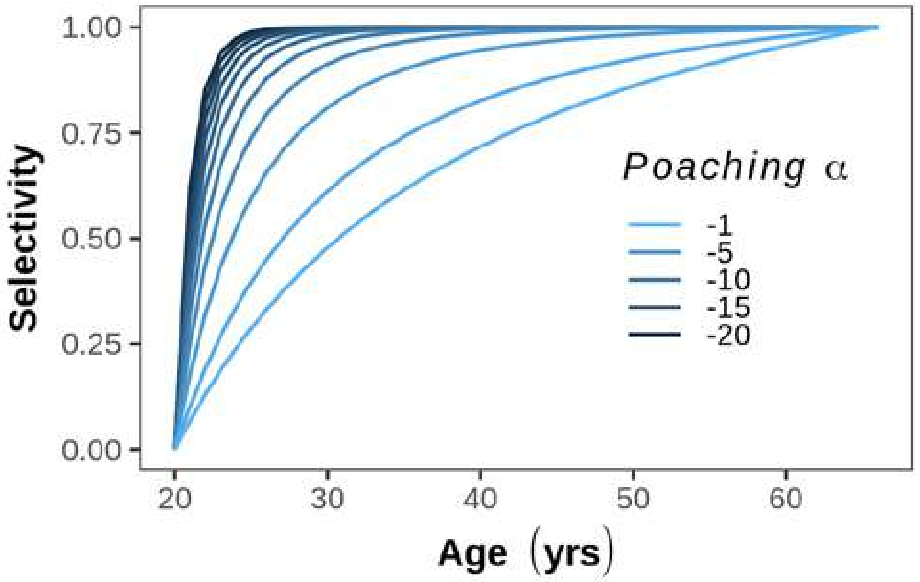

Fig. A3. Poaching selectivity curves for selected values of poaching α, as used in simulation models.

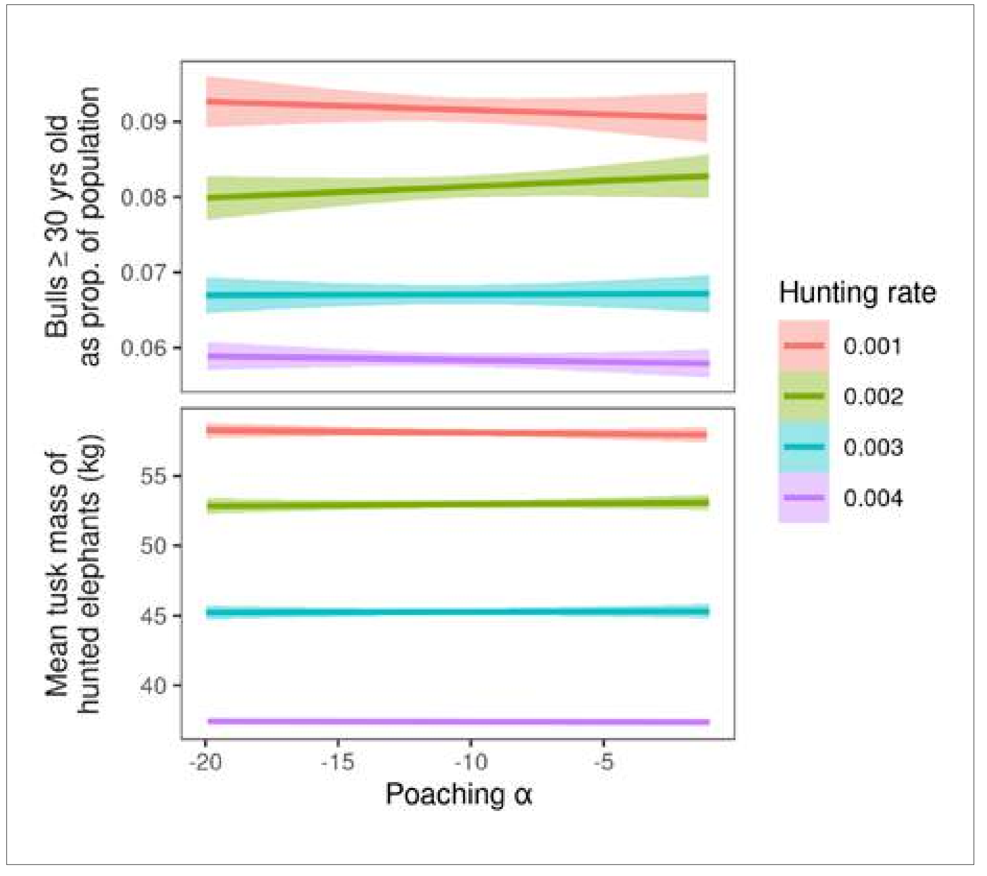

Fig. A4. Effects of poaching α on hunting outcomes in simulation models. The poaching rate was fixed at 0.15% per year.

Running Models

Each simulation began with an initial age- and sex- distribution for the population calculated from the projection matrix (Caswell 2001). Note that this distribution does not include drought, hunting, or poaching effects, so it is not identical to the distribution expected after running the simulation. Except where otherwise noted, model results shown in the report were means from years 181-200 of the simulation. By year 180, model populations had reached equilibrium and there were no lingering effects of initial population vectors (unpublished data).

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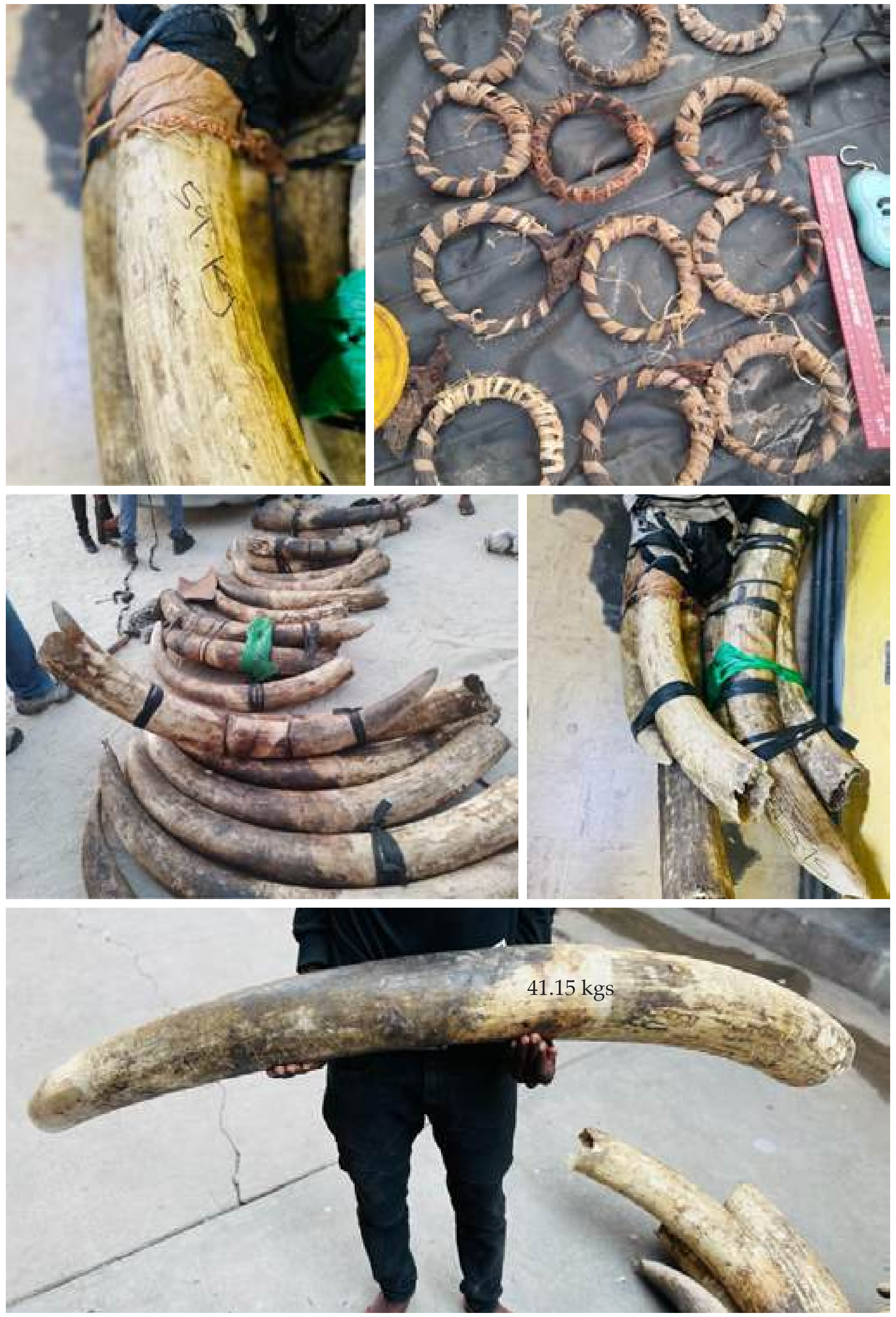
Appendix 2:

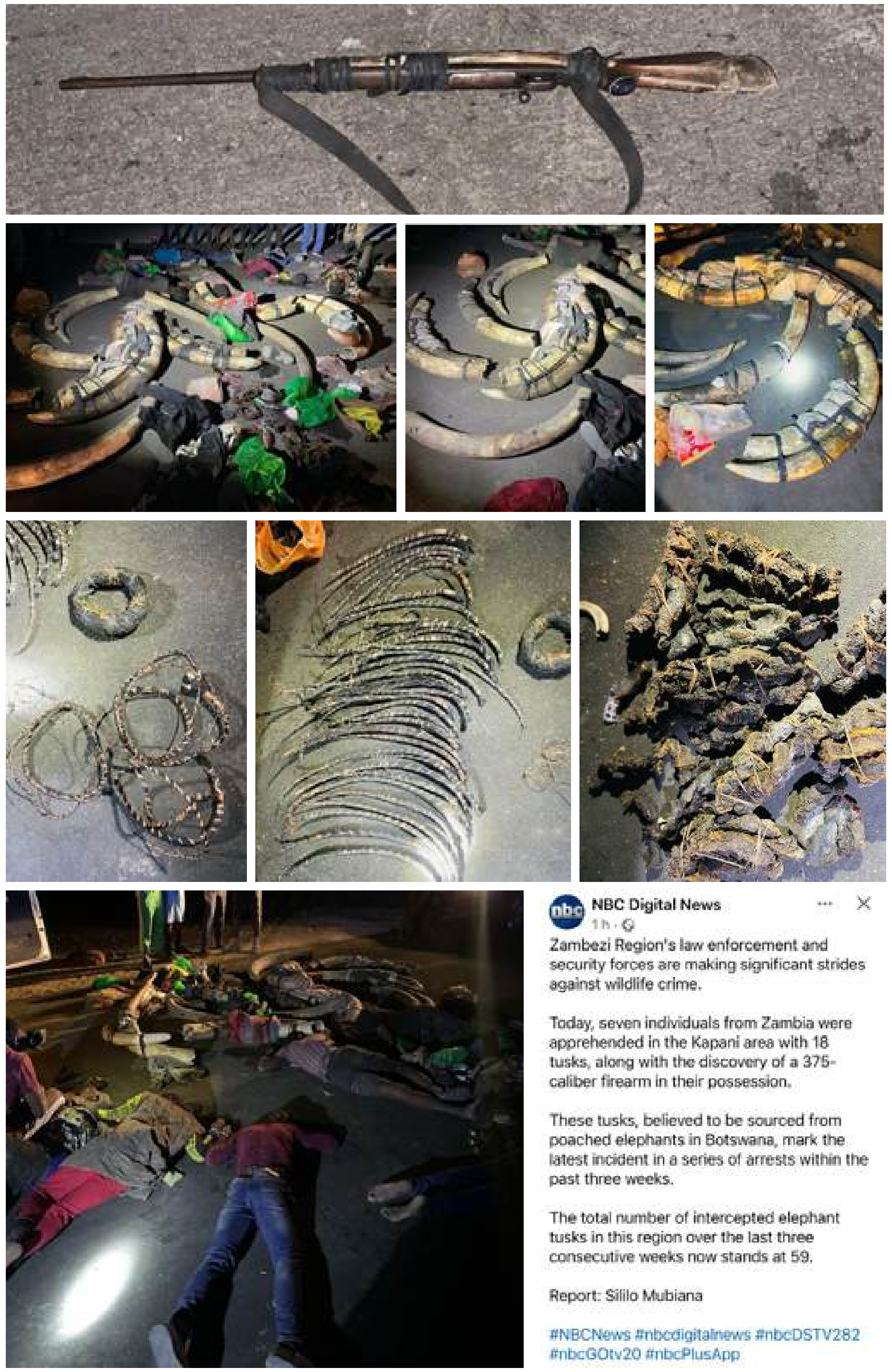
Elephant poaching interceptions and economic cost of elephant poaching in Botswana.



23 November 2023 — A consignment of 26 elephant tusks weighing 652 kg was intercepted. Poaching syndicates typically issue consignment orders of around 600 kg of ivory, equivalent to approximately ten large bull elephants. Poachers use portable scales to weigh tusks in the field and stop once they reach the required quota, after which the ivory is carried by porters across Botswana's border.

26 November 2023 – 15 elephant tusks
Blow up mattresses used to cross the waters of the Okavango Delta.

03 December 2023 – 9 elephant tusks intercepted south of the Savuti Channel.



NBC Digital News
1h ·
Zambezi Region's law enforcement and security forces are making significant strides against wildlife crime.

Today, seven individuals from Zambia were apprehended in the Kapani area with 18 tusks, along with the discovery of a 375-caliber firearm in their possession.

These tusks, believed to be sourced from poached elephants in Botswana, mark the latest incident in a series of arrests within the past three weeks.

The total number of intercepted elephant tusks in this region over the last three consecutive weeks now stands at 59.

Report: Sililo Mubiana

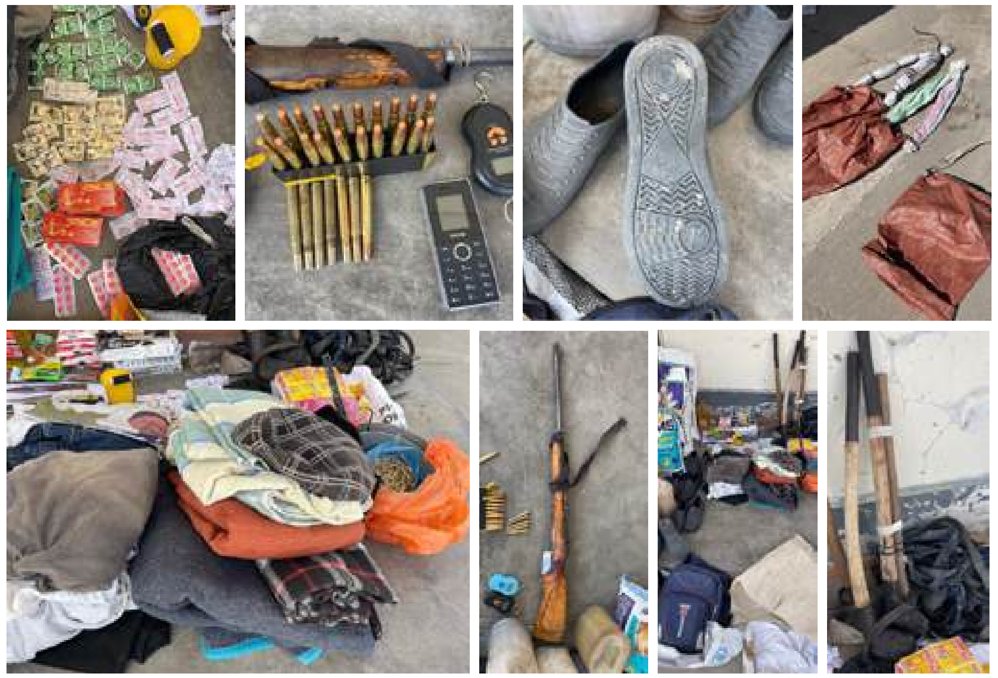
#NBCNews #nbcdigitalnews #nbcDSTV282 #nbcGOtv20 #nbcPlusApp

05 December 2023 – 18 elephant tusks, 7 suspects and a hunting rifle.

27 January 2024 – BDF Interception – Khwai NG18.

08 May 2024 – Namibia interception – 19 tusks.

20 May 2024 – BDF interception in Botswana; approximately six tusks seized.



14 June 2025 – interception as poachers were entering Botswana on their way to poach elephants.

10 September 2025 – the Botswana Defence Force intercepted a group of foreign poachers along the Linyanti River in northern Botswana. The suspects abandoned a cache of thirteen large elephant tusks, later confirmed to have been taken from elephants recently killed within concession NG15.

Economic Costs of Elephant Poaching in Botswana

Elephant poaching is not only a conservation and ecotourism problem but a serious economic threat to Botswana. As diamond revenues decline and the nation seeks to diversify its economy, wildlife and nature-based tourism have become one of Botswana's most reliable sources of sustainable growth, foreign exchange, and rural employment. Elephants, in particular, are the cornerstone of this success, they attract international visitors, sustain community livelihoods, and underpin the country's global reputation as a conservation leader.

Based solely on the poached elephant carcasses documented annually by Elephants Without Borders, a minimum of 120 elephants are illegally killed each year in northern Botswana. These killings are carried out primarily by foreign poaching syndicates, which deliberately target the largest bulls, the same individuals most valuable to tourism, and the genetic health of the population (Kopf et al. 2024).

The ivory they extract, and traffic represents only a fraction of the true loss. Poaching is stealing directly from Batswana: from the communities that have invested in conserving living elephants, from the tourism industry that supports over 100,000 jobs, and from Botswana's long-standing identity as Africa's last great elephant stronghold.

Tourism contributes 10–12 percent of Botswana's GDP and remains a key pillar of employment and rural income (WTTC 2023; World Bank 2022). While estimates differ, several studies suggest that a single living African elephant can generate around USD 1.5 million or more in cumulative tourism and ecosystem-service value during its lifetime (van de Water et al. 2022; Greenfield 2021).

The ivory from a single poached elephant may fetch approximately USD 21,000 on the black market. In stark contrast, a living elephant contributes an estimated USD 1.5 million in lifetime ecotourism revenue and associated economic benefits (see caveat below). This represents a 75 fold greater value alive than dead, highlighting that elephant conservation is not only an ecological imperative but also a sound economic investment.

Using a conservative mean value of USD 1.5 million per elephant, the annual loss of about 120 elephants translates into approximately USD 180 million in foregone tourism and ecosystem potential, equivalent to about BWP 2.51 billion.

This loss is borne both by the state and by the rural communities and tourism operators whose livelihoods depend on living elephants, particularly the charismatic large males. Protecting these tuskers is therefore a strategic economic investment in Botswana's long-term prosperity.

Caveat: Limitations in Estimating the Monetary Value of a Living Elephant

Estimating the full economic value of a living elephant throughout its lifetime is inherently complex and context-dependent. The total value depends on multiple variables, including species (savanna vs. forest elephant), lifespan, regional tourism potential, ecosystem productivity, and the social and economic context in which the elephant occurs. Consequently, any monetary estimate should be interpreted as an approximation based on the best available data, not as an absolute figure.

Several well-established studies provide credible benchmarks. Analyses by the David Sheldrick Wildlife Trust (2014) and the International Fund for Animal Welfare (2013) estimate that a living African elephant contributes approximately USD 1.6–1.7 million in lifetime economic value through ecotourism, employment, and ecosystem services. Similarly, Chami et al. (2020), in an IMF Finance and Development publication, estimate the ecosystem carbon-service value of an African forest elephant at about USD 1.75 million. While these figures originate from different ecological settings, they consistently illustrate the substantial and sustained economic benefits derived from living elephants.

Given the absence of Botswana-specific valuation data, this report conservatively adopts an indicative lifetime value of USD 1.5 million per elephant (approximately BWP 21 million at current exchange rates) as a reasonable benchmark for assessing the economic contribution of elephants to national and local economies.

It is important to note that this valuation:
- Represents a composite estimate combining tourism and ecosystem-service values, not market price;
- Does not account for non-market cultural, ecological, or genetic values, which may be equally or more significant;
- Should therefore be considered conservative, reflecting only the quantifiable, monetized benefits currently recognized in the literature.

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