

Supporting Information

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SI Materials and Methods

Individual-Based Monitoring Data and Calculation of Mortality in Samburu. Individually based demographic data on the Samburu elephant population were collected through an individual identification study of ~1,000 elephants inhabiting the semiarid, 220-km² Samburu and Buffalo Springs National Reserves complex in northern Kenya (0.3–0.8°N, 37–38°E) (1, 2). Annual mortality and natality data used in this analysis were collected during weekly travel along five established transects (each of which was ~20 km long) from January 1998 through December 2012 from resident (3) elephants in the national reserves (4). Outside the protected areas, the elephants are at risk for illegal killing (5), and wounded animals enter the reserves and die (poaching in the park was rare, occurring for the first time in 2011 during the 15-y study). Carcasses found during daily monitoring within the reserves and via investigation of reports of dead elephants in the wider ecosystem were used in analyses of the impact of poaching on the known elephant population. For carcasses found outside the reserves, only those of known individuals were used in analysis (1).

Inferring Natural and Illegally Caused Mortality from Carcass Counts. During years when no illegally killed carcasses or carcasses from unknown fates (e.g., those that were decomposed beyond recognition) were observed in the Samburu study area, the proportion and variance of illegal killing were assumed to equal zero. During years when illegally killed carcasses were found, we assumed the number of poached elephants found was a binomial random variable (the number of illegally killed elephants arises from an underlying probability of being illegally killed, given a certain number of dead elephants). As such, for years when illegally killed carcasses were found and the cause of death of all carcasses could be determined (i.e., illegally killed or natural mortality), the estimated proportion illegally killed and corresponding variance (var_p) was calculated as the binomial sample proportion and variance from the observed carcasses (as stated in *Materials and Methods*):

$$p_p = \frac{c_p}{c_t} \quad \text{and} \quad \text{var}_p = \frac{p_p(1-p_p)}{c_t} \quad [\text{S1}]$$

Where carcasses originated from unknown causes of mortality, uncertainty in the proportion illegally killed and its variance are inflated. We accounted for this uncertainty by using Monte Carlo simulation to integrate across the uncertainty of the fate of the unknown carcasses. We assumed the probability of an animal being illegally killed when its cause of death is unknown is given by the true proportion and variance in the population, i.e., it is binomially distributed with parameters c_u (the total number of carcasses of unknown fate) and $p = p_{est_p}$ (the underlying probability of being illegally killed); where p_{est_p} was drawn from a beta distribution with shape parameters calculated via moment matching using the sample proportion and variance from the identifiable carcasses. The estimation procedure is as follows:

$$p_p = \frac{c_p + c_{p_{unk}}}{c_t}$$

$$c_{p_{unk}} \sim \text{Binomial}(c_u, p_{est_p})$$

$$p_{est_p} \sim \text{Beta}(\alpha, \beta)$$

$$\alpha = \frac{\mu^2 - \mu^3 - \mu\sigma^2}{\sigma^2}$$

$$\beta = \frac{\mu - 2\mu^2 + \mu^3 - \sigma^2 + \mu\sigma^2}{\sigma^2}$$

$$\mu = \frac{c_p}{c_{t_{known}}}$$

$$\sigma^2 = \frac{\mu(1-\mu)}{c_{t_{known}}} \quad [\text{S2}]$$

where $c_{p_{unk}}$ is the estimated number of carcasses of unknown fate that were illegally killed, and $c_{t_{known}}$ is the total number of carcasses for which the cause of death could be definitively determined as poaching or natural mortality.

The above method accounts for uncertainty in the underlying probability of being poached that gives rise to the observed proportion of identifiable carcasses that were illegally killed (as the binomial in Eq. S1), and for uncertainty arising from the unidentifiable carcasses, although still allowing the identifiable carcasses to inform the unidentifiable carcasses (via moment matching of the beta distribution). We repeated this process 10,000 times to derive the mean and variance of the proportion of animals illegally killed. Expanding the model to account for age structure among carcasses would introduce uncertainty and, therefore, was not attempted.

Modeling Continental Levels of Mortality. The Monte Carlo simulation approach outlined for partitioning known mortality into illegal or natural rates was adjusted to model mortality rates in populations for which carcass data were being collected as part of the Monitoring the Illegal Killing of Elephants (MIKE) program (MIKE sites) or non-MIKE populations for which the proportion of illegally killed elephants (PIKE) was estimated using a predictive model (6, 7). For each MIKE site, the proportion of illegally killed carcasses and variance was estimated using carcass counts, as described in *Inferring Natural and Illegally Caused Mortality from Carcass Counts*. For non-MIKE sites, this proportion and variance were derived directly from the predictive model output. Because all unknown carcasses were assigned as natural in MIKE sites, the correction for unknown carcasses was not implemented (potential deflation of PIKE as a result is discussed below).

To estimate the illegal killing rate, for each iteration of the Monte Carlo simulation the known (i.e., the empirical approach) or modeled (i.e., the model approach) proportion of illegally killed carcasses at each site was multiplied by a single random draw from a moment matched beta distribution representing an annual natural mortality of 3.2% (variance = 0.015%) derived from the seven published metrics on the species (1) (Table S1). The deterministic intrinsic growth rate (λ) was estimated by combining derived mortality with natality drawn from a beta distribution representing the published, 4-y average natality of the species (7.4%, SD = 1.4%; where the 4-y average spans the average intercalving interval for the species and mitigates the high degree of stochasticity in annual rates of this parameter) (8):

$$\lambda = 1 - m_p - m_n + R$$

$$m_p = \frac{p_p}{1 - p_p} \times m_n$$

$$m_n \sim \text{Beta}(\alpha_n, \beta_n)$$

$$\alpha_n = \frac{\mu_n^2 - \mu_n^3 - \mu_n \sigma_n^2}{\sigma_n^2}$$

$$\beta_n = \frac{\mu_n - 2\mu_n^2 + \mu_n^3 - \sigma_n^2 + \mu_n \sigma_n^2}{\sigma_n^2}$$

$$R \sim \text{Beta}(\alpha_R, \beta_R)$$

$$\alpha_R = \frac{\mu_R^2 - \mu_R^3 - \mu_R \sigma_R^2}{\sigma_R^2}$$

$$\beta_R = \frac{\mu_R - 2\mu_R^2 + \mu_R^3 - \sigma_R^2 + \mu_R \sigma_R^2}{\sigma_R^2} \quad [\text{S3}]$$

where μ_n and σ_n^2 are the sample proportion and variance of natural mortalities, p_p is the proportion of illegally killed elephants (PIKE, where the mean and variance is calculated for each site using carcass counts as described in *Inferring Natural and Illegally Caused Mortality from Carcass Counts* or pulled from a site base model of PIKE) and R is the 4-y running average of recruitment with μ_R and σ_R^2 representing the mean and variance of biologically plausible natality. Values of lambda were estimated using Monte Carlo simulation over 30,000 iterations, from which the median and interquartile ranges for the annual population growth rate were derived. Runs for which PIKE exceeded 0.9, the combined mortality from natural causes and poaching ($m_p + m_n$) equaled or exceeded 1, or where $\lambda < 0$, were discarded and values were discarded to ensure the biological integrity of the simulation (see discussion of assumptions in *SI Text*). The distribution of lambda then was used to estimate the median and interquartile population size and number of elephants illegally killed for each year, using the latest population count for each population (African Elephant Specialist Group 2013) and extrapolating forward or backward. In this procedure the population estimate was assumed to have been collected at the end of the year coinciding with the carcass figure totals for that year (i.e., $N_{t+1} = N_t \times \lambda_{t+1}$). In the absence of illegal killing (i.e., 0 illegally killed carcasses found), our model estimated an average population increase of 4.2% per y.

Assessment of Methods Using Simulated Data. The outlined methods are potentially sensitive to the sample size of carcasses found (sampled) and to the different underlying levels of poaching. Assuming a theoretical sample of 1,000 dead elephants, we examined the sensitivity of our estimated poaching rate to (i) the total number of simulated carcasses found and (ii) the proportion of simulated carcasses poached.

To assess the sensitivity to the sample size of carcasses found, we randomly assigned each of the 1,000 elephants as poached or naturally dead with a probability of 0.5. We set the natural mortality rate of 0.032 (thus the poaching rate was also 0.032), and simulated finding different numbers of carcasses (350, 300, 250, 200, 150, 100, 90, 80, 70, 60, 50, 40, 30, 20, 10, and 5 carcasses; these values represent the full range of annual values for carcasses found at MIKE sites across the continent throughout the study period). We used the Monte Carlo simulation procedure de-

scribed above with no unknowns to estimate the proportion of poached elephants. We repeated this process 10,000 times and examined the mean and 95% quantiles of the resulting estimates of the proportion of animals poached relative to the number of carcasses sampled. The variation in the estimated poaching rate declines as the number of carcasses increases, with the most rapid decrease occurring around 20 carcasses (Fig. S1).

To examine the sensitivity of our model to the underlying poaching rate, we varied the probability of a carcass being poached between 0 and 1, keeping the natural mortality rate fixed at 0.032 (thus the poaching rate varied with the proportion of poached animals in the overall population). We then randomly sampled 20 carcasses (our cutoff for inclusion in the empirical model), and estimated the poaching rate using the Monte Carlo simulation described above. We repeated this process 10,000 times, and examined the mean and 95% quantiles of the resulting estimates of the proportion of animals poached relative to the true underlying proportion of poached animals (Fig. S2). Our model closely reflected the true poaching rate.

Lastly, because our empirical results were based on the estimation of lambda, we examined the influence of the proportion of illegally killed elephants in the carcass sample on lambda. We again simulated a population of 1,000 carcasses and set the number of found carcasses at 20. We varied the true underlying proportion of poached elephants in the sample of 1,000 carcasses from 0 to 1 and estimated lambda as for the empirical analysis above. We calculated the mean and 95% quantiles of lambda following the described Monte Carlo simulation and examined where these values equaled 0 change in the population. Based on our model, populations for which PIKE > 0.54 (i.e., 5.4 of 10 carcasses found were poached) are likely declining (Fig. 4). Due to the high degree of variability in natural mortality and natality, we were 95% confident that populations with PIKE < 0.08 were increasing and populations with PIKE > 0.88 were decreasing.

Estimating Population and Illegal Killing Trends Across MIKE Sites.

MIKE data have been collected across 50 sites in Africa (45 officially recognized). However, the reported simulation results indicated that the number of carcasses surveyed at most of these sites precluded robust inference at the site level (i.e., most had less than 20 carcasses found per y). As a result, we compared two approaches to model population status based on the proportion of mortality caused by illegal killing as described in the *Results and Materials and Methods*. The first simply restricted sites used in analyses to those with adequate carcass samples for robust site-level inference (i.e., the empirical approach). The second used all carcass monitoring data to model PIKE across the continent using site, regional, and global covariates that predicted PIKE among known sites (i.e., the model approach) (7). For the empirical approach, results were calculated for populations averaging 20 or more carcasses per y during the monitoring period ($n = 12$; Table S2), the cutoff indicating the major reduction in variance introduced by sampling defined through simulations (Fig. S1). For the model approach, we applied the published quasibinomial generalized linear model (7) to derive predictions of PIKE (and their variances) for 306 surveyed sites in Africa using covariates available for all sites of infant mortality rate (9), farming (10), site area (log transformed), Transparency International Corruption Perception Index (11), World Bank's China household consumption expenditure index (12), and the 3-y running average mass of large ivory seizures (7). Model selection was used to derive the best predictive model as detailed elsewhere (6, 7).

As a result of our population estimation procedure (i.e., poaching rates calculated as a function of relative cause of death from sampled carcasses and natural rates), years with illegally killed carcass proportions >0.968 resulted in estimates of total population extermination on account of the assumption that

natural mortality averaged 3.2% per y (maximum PIKE under this assumption can only reach 0.968). The proportion of illegally killed elephant values >0.968 were predominantly found in forested populations and likely result from biases in carcass sampling in high-density vegetative areas (see discussion in *SI Text*). As a result, excessively high PIKE values were truncated as mentioned previously, where Monte Carlo runs for which PIKE values >0.9 were discarded and redrawn. This effectively capped maximum annual mortality at 28.8% for each population. Among the 12 sites used in the empirical approach, truncation was applied almost exclusively to forested sites in central Africa, with 13% of the total site years being over this threshold among this sample. Across all 50 sites used in the model approach, 23% of site years were truncated.

The poaching rate and lambda could not be estimated for years in which no carcasses were reported. Among the 12 sites that averaged 20 or greater carcasses per y, three (Niassa, Mozambique; Odzala, Republic of Congo; and Selous, Tanzania) lacked carcass data during 1 or 2 successive years (7). During years that lacked carcass data, we assumed no population change (i.e., $\lambda = 1$).

Population growth rates (λ) and illegal killing rates were amalgamated to derive regional (Central, East, and Southern Africa) and continental rates. For the empirical approach, changes across the sum of the estimated annual site population sizes per region were used to derive regional growth rates, where outputs from each Monte Carlo run were combined to derive the rate distributions. Similarly, the illegal killing rates were amalgamated across the 12 sites by summing the estimated number of poached elephants (illegal killing rate multiplied by estimated population size) across each region and dividing by corresponding regional population sizes. Regional rates were similarly adjusted to estimate continental rates. As such, the empirical-based regional and continental trends are only representative of those populations for which adequate, unbiased data were available. For the model-based analysis, the rates of changes for the regions and continent were calculated directly using the model output for 306 sites for which estimates of the elephant population were available. Because West Africa was not represented in the empirical approach (due to small carcass samples), we present estimates for the combined Central, East, and Southern Africa regions which contain $\sim 98\%$ of extant elephants (Table 1 and Table S3).

We also derived estimates of regional and continental poaching rates, population trends, and numbers of elephants killed using 19 populations for which ≥ 10 carcasses were found on average per y (22 total sites met this criteria, but 3 were deemed unreliable and excluded on account of having PIKE = 1 in $\geq 50\%$ of surveyed years). This provides the advantage of increasing the number of sites used for regional estimates, but comes at the cost of reduced precision in estimates (Fig. S1). Illegal killing rates derived from these 19 sites exceeded those from the other two approaches, indicating greater population declines than those reported in *Results* (Table S4).

Comparing Carcass-Modeled to Census-Estimated Population Change.

Of the 22 sites that averaged 10 or more carcasses per y, 19 were subject to population surveys (aerial-, dung-, or individual-based census) at least twice over the 11-y period during which MIKE data were collected (13). This allowed direct comparison between survey-based and our PIKE-based modeled estimates of population change. Although variation in population estimates can be large depending on the census approach, we focused on changes in mean estimates between consecutive censuses. Annual population changes experienced between successive counts were calculated and compared with those estimated during the same period by our Monte Carlo simulation approach (Fig. 4). It is notable that 95% confidence envelopes of estimated lambda encapsulated nearly all census-based calculations of mean an-

nual population changes, indicating our underlying model generally captures the variation manifested in natural populations. Including all 19 populations (comprising 39 estimates of population change between censuses), modeled and surveyed estimates of annual changes in population sizes were significantly correlated (Spearman's $\rho = 0.685$, $P < 0.001$), with the PIKE-based method estimating an average rate of growth 0.33% slower than that calculated from sequential surveys (Fig. S3).

SI Text

It is critical to summarize the assumptions underlying the presented results and discuss the approaches used to assess or minimize their influence where possible. We first summarize the assumptions regarding the demographic parameterization of our model:

- i) The baseline mortality and natality rates derived from the published literature (1) that were used in our models represent conditions in relatively well protected savanna populations. All but one of the seven populations from which parameters were derived are recovering or expanding populations (most likely experiencing density-independent conditions), in contrast to populations demonstrating compensatory reductions in growth related to age structure or density (1). Therefore, the assumed average annual growth rate of 4.2% in the absence of poaching, which likely reflects healthy growth for this species. Published rates did not differ between region (Southern versus East Africa), as such we simply used the average across all studies (Table S1). Unfortunately, no demographic parameters have been published for forest elephants, but it is known that reproductive rates are much slower in the Dzanga forest system than those used in our model (14). As such, this rate of growth is likely overestimated for forest systems that are subject to the highest PIKE among MIKE sites (potentially resulting in greater declines than those estimated here).
- ii) We did not incorporate the potential effect of density dependence in our model. This was both practical, as there is no logical way to determine carrying capacity for the myriad of sites in different ecosystems represented in our analysis, and ensured our model provided a conservative scenario for population decline.
- iii) We also did not adjust underlying demographic data to account for possible influences of illegal killing (e.g., compensatory influences reducing natural mortality or reductions in fecundity). No evidence for a compensatory relationship between natural mortality and illegal killing rates was found in the Samburu study system, with a positive correlation between annual rates of these two types of mortality ($r_s = 0.581$, $P = 0.023$; Fig. S4).

In addition to these demographic assumptions, our model is dependent on the accuracy of the underlying carcass data. We have attempted to limit the influence of stochastic variation induced by (i) small sample size and (ii) annual variability in natural mortality rates on the empirical approach by excluding sites averaging less than 20 carcasses per y and smoothing carcass counts (averaging PIKE) through amalgamation over a 3-y period. The latter effectively mitigates against stochastic variation in natural mortality (years with very little natural death) that can induce exceptionally high PIKE (as discussed previously in relation to truncation). For our model-based approach, we incorporate uncertainty due to small carcass samples in the quasibinomial generalized linear model in the response variable. Other potential sources of bias that may affect our results include the following:

- i) Where carcasses were found primarily through acoustic identification of gunshots (e.g., gunshots heard and investigated leading to discovery of a poached carcass) or following

poacher trails, lower detection of natural (independent of human sign) carcasses will result in biasing PIKE estimates high. This is particularly a concern in forested sites where sampling is notoriously difficult (15). Unfortunately, we lack any information on patrolling and carcass sampling. To ameliorate the most egregious and likely inaccurate PIKE estimates, we excluded high PIKE values ≥ 0.9 (see previous discussion regarding actual number of site years truncated per analysis). While it is possible to get high PIKE values, particularly in years with low natural mortality, truncation ensured population decrease as estimated in our model could not exceed $\sim 25\%$ during any given year.

- ii) Spatial bias in patrolling relative to elephant distribution or mortality can result in misrepresentative carcass data. Unfortunately, detailed patrol data were not available for any MIKE sites.
- iii) The model presented was not age structured because the reliability of age estimates from carcass data was not known, although it is known that survivorship is age dependent (1, 16). Using a population average mortality, as done here, was assumed to be representative of mortality across the age classes represented in the carcasses surveyed.
- iv) There are factors that may lead to bias in assessment of carcass causes of death. Mortalities of dependents resulting from the illegal killing of adults (1) may not have been found or assigned as natural (i.e., carcasses without human induced wounds are assumed to be from natural causes), when in fact

they are a function of the illegal killing. Similarly, poisoning of elephants may be difficult to diagnose from carcass encounters. Should poisoned elephants have their tusks at the time of detection, the carcass will likely be assigned natural causes. Elephants killed by gunshots that die lying on the side of the gunshot wound may also be misclassified as resulting from natural causes. In contrast, natural deaths from which ivory was harvested before detection may be erroneously assigned as caused by poaching. In the MIKE site carcass data analyzed here, carcasses assigned unknown cause of death were assumed to be from natural causes given that no evidence of illegal killing was found. This is the most conservative assessment, but potentially leads to underestimation of true illegal killing rates.

Although we have attempted to explicitly state and control for the assumptions and potential sources of bias influencing this analysis, the results presented in this paper represent our best estimate of the levels and trends in poaching and resulting population changes. Unfortunately, we could not assess the probability of any of these sources of bias in the data compiled by the MIKE program (7), a function of the large scale of this monitoring program and the importance of its implementation in areas with little research or forensic capacity. Our comparison between modeled and survey-derived trends provides some validation (Fig. 4). Future efforts should expand metadata related to each carcass record, to allow for more detailed inspection of these assumptions.

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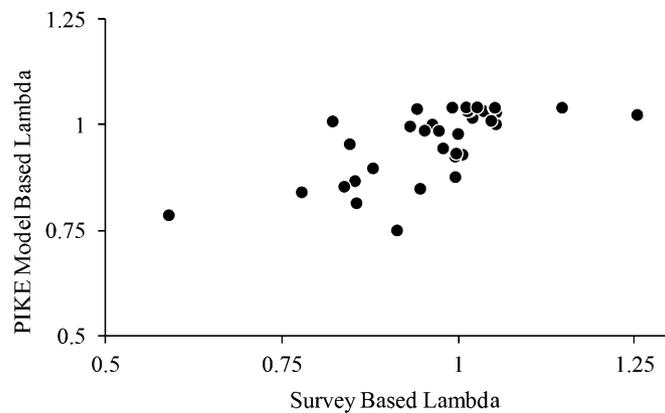


Fig. S3. PIKE-based modeled and surveyed estimates of annual changes in population sizes from 19 MIKE sites were positively correlated, although PIKE-based estimates were lower on the high end and higher on the low end of survey-based estimates due to the parameterization that bounded the population change between 0.75 and 1.042.

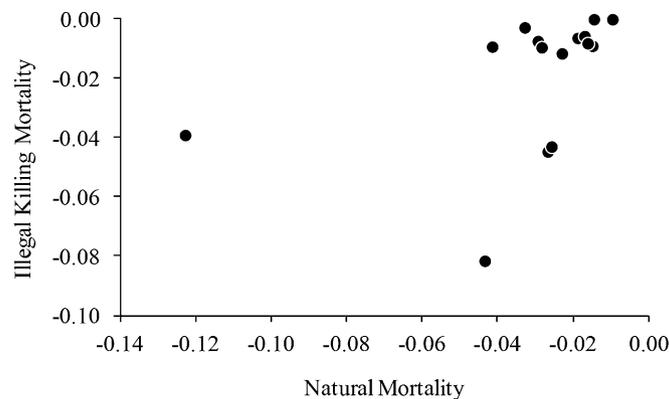


Fig. S4. Annual natural and illegal killing mortality did not demonstrate a compensatory relationship, with a positive correlation between the two in the Samburu study site over a 15 y period.

Table S1. Summary of published elephant demographic parameters on which estimates of poaching rates and population changes were based

Population	Mean mortality	Variance mortality	Mean natality	Variance natality, 4 y	Ref(s).
Addo National Park, South Africa	0.0157	0.00016	0.0665	0.00008	(1)
Amboseli National Park, Kenya	0.0415		0.0614		(2, 3)
Etosha National Park, Namibia	0.0500		0.0500		(4)
Kruger National Park, South Africa	0.0320		0.0980		(5)
Lake Manyara National Park, Tanzania	0.0350		0.0720		(6)
Samburu National Reserve, Kenya	0.0310	0.00010	0.0724	0.00014	(7)
Tarangire National Park, Tanzania	0.0186	0.00018	0.0996	0.00037	(8)
Average	0.032	0.00015	0.0743	0.00020	

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Table S2. Carcass information and estimated demographic rates and number of elephants poached for 2010–2012 for the 12 sites with the largest carcass samples used in the empirical approach

Region of Africa	Country	Site	Average annual carcasses	Years of data	Estimated average annual λ 2010–12	Estimated average annual m_p 2010–12	Estimated no. poached 2010–12
Central	Chad	Zakouma	50.2	10	0.92	0.10	163
Central	Odzala	Congo	37.7	9	0.79	0.25	5,942
Central	DRC	Garamba	53.2	9	0.85	0.20	1,439
East	Kenya	Meru	46.1	7	0.98	0.06	130
East	Kenya	Samburu/Laikipia	189.8	11	1.00	0.05	882
East	Kenya	Tsavo	120.3	10	1.01	0.04	1,294
East	Tanzania	Ruaha	21.4	10	0.96	0.08	5,616
East	Tanzania	Selous Mikumi	111.0	9	1.00	0.04	4,931
Southern	Botswana	Chobe	116.0	10	1.04	>0.01	353
Southern	Mozambique	Niassa	52.0	6	0.81	0.23	10,279
Southern	South Africa	Kruger	21.2	11	1.04	>0.01	29
Southern	Zimbabwe	Chewore	23.3	11	0.99	0.05	794

Table S3. Regional and total estimates, illegal killing rates, and number of elephants poached with inter-quartile ranges for 2010–2012

Region	2010	2011	2012
Empirical method			
Africa			
Population growth rate	0.978 (0.962–0.991)	0.976 (0.961–0.989)	0.977 (0.966–0.988)
Poaching rate	0.063 (0.053–0.077)	0.083 (0.072–0.095)	0.065 (0.057–0.073)
No. poached	29,124 (24,310–35,234)	41,044 (35,843–47,200)	31,616 (28,055–35,364)
Central Africa			
Population growth rate	0.979 (0.965–0.989)	0.795 (0.727–0.853)	0.790 (0.719–0.850)
Poaching rate	0.142 (0.104–0.193)	0.248 (0.196–0.308)	0.235 (0.175–0.306)
No. poached	11,228 (8,207–15,266)	21,148 (16,751–26,272)	16,148 (12,851–19,412)
East Africa			
Population growth rate	0.988 (0.970–1.003)	0.988 (0.973–1.002)	0.983 (0.967–0.997)
Poaching rate	0.054 (0.044–0.067)	0.054 (0.046–0.063)	0.059 (0.051–0.070)
No. poached	7,187 (5,832–8,884)	7,763 (6,603–9,093)	8,695 (7,462–10,071)
Southern Africa			
Population growth rate	0.978 (0.950–0.999)	0.974 (0.946–0.995)	0.980 (0.961–0.996)
Poaching rate	0.064 (0.046–0.088)	0.068 (0.050–0.093)	0.062 (0.049–0.077)
No. poached	15,800 (11,459–21,913)	18,176 (13,336–24,875)	16,583 (13,318–20,197)
Model-based method			
Africa			
Population growth rate	1.001 (0.994–1.006)	0.971 (0.961–0.980)	0.979 (0.969–0.987)
Poaching rate	0.045 (0.029–0.069)	0.077 (0.052–0.111)	0.077 (0.051–0.114)
No. poached	21,477 (13,633–32,850)	39,692 (26,757–56,861)	38,828 (26,277–55,265)
Central Africa			
Population growth rate	0.969 (0.955–0.981)	0.926 (0.907–0.942)	0.932 (0.914–0.949)
Poaching rate	0.100 (0.057–0.179)	0.160 (0.101–0.256)	0.177 (0.108–0.289)
No. poached	7,871 (4,499–14,170)	13,649 (8,637–21,824)	13,607 (8,919–19,686)
East Africa			
Population growth rate	0.994 (0.983–1.004)	0.960 (0.943–0.975)	0.979 (0.966–0.991)
Poaching rate	0.044 (0.026–0.069)	0.074 (0.045–0.123)	0.060 (0.035–0.104)
No. poached	5,645 (3,523–9,182)	10,630 (6,484–17,733)	8,515 (5,196–14,104)
Southern Africa			
Population growth rate	1.019 (1.012–1.026)	0.996 (0.986–1.004)	0.996 (0.986–1.005)
Poaching rate	0.024 (0.018–0.032)	0.047 (0.034–0.066)	0.031 (0.021–0.045)
No. poached	5,740 (3,636–8,995)	12,285 (7,940–18,497)	13,303 (8,582–20,192)

The data presented is calculated using 12 sites in the empirical approach or from 306 sites using the modeling approach. Interquartile ranges of population change are shown in parentheses.

Table S4. Regional and total estimates, illegal killing rates, and number of elephants poached for 2010–2012

Region	2010	2011	2012
Africa			
Population growth rate	0.964 (0.949–0.976)	0.951 (0.936–0.963)	0.974 (0.963–0.984)
Poaching rate	0.080 (0.052–0.133)	0.092 (0.065–0.139)	0.069 (0.050–0.096)
No. poached	36,765 (23,917–61,185)	45,955 (32,296–69,292)	33,570 (24,841–44,311)
Central Africa			
Population growth rate	0.921 (0.882–0.951)	0.809 (0.758–0.853)	0.906 (0.862–0.941)
Poaching rate	0.179 (0.080–0.377)	0.233 (0.133–0.382)	0.136 (0.067–0.279)
No. poached	14,108 (6,294–29,798)	19,871 (11,336–32,608)	9,583 (5,337–15,759)
East Africa			
Population growth rate	0.978 (0.961–0.993)	0.982 (0.968–0.995)	0.978 (0.964–0.992)
Poaching rate	0.066 (0.040–0.114)	0.062 (0.041–0.093)	0.066 (0.043–0.099)
No. poached	8,758 (5,273–15,197)	8,931 (5,844–13,357)	9,571 (6,338–13,831)
Southern Africa			
Population growth rate	0.976 (0.952–0.995)	0.979 (0.954–0.998)	0.985 (0.969–0.999)
Poaching rate	0.060 (0.024–0.027)	0.063 (0.027–0.160)	0.057 (0.029–0.102)
No. poached	14,861 (6,052–39,713)	16,754 (7,141–42,740)	15,247 (8,044–24,666)

The data presented is calculated using the empirical approach on the 19 sites averaging ≥ 10 carcasses. Interquartile ranges of population change are shown in parentheses.