Serengeti II

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Historical and Present-Day Anti-Poaching Efforts in Serengeti

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Many protected areas around the world are currently under immense pressure due to the illegal exploitation of the plant and animal species within them. Although not restricted to the poorer areas of the world, these pressures are frequently most severe where depressed economic conditions both increase the attractiveness of engaging in illegal harvest and decrease the ability of local authorities to provide sufficient enforcement against it. One emerging conservation ethic addresses the first of these issues by promoting the managed, legal use of wildlife resources in order to enhance local economies and encourage sustained harvest strategies (Western 1982; Bell 1986b, 1987; Lewis, Keweche, and Mwenya 1990; Mbano et al., chap. 28). In tandem with such plans, a few studies have also addressed the efficiency of enforcement techniques and the minimum levels of funding required to protect particular wildlife populations (Bell 1986a; Leader-Williams and Albon 1988; Leader-Williams, Albon, and Berry 1990; Milner-Gulland and Leader-Williams 1992).

In this volume, Mbano et al. (chap. 28) discuss a plan for regional development and the sustained use of wildlife resources in the Serengeti ecosystem, and Campbell and Hofer (chap. 25) explore spatial aspects of illegal meat hunting within Serengeti National Park. As a complement to those chapters, we provide some details of the history of the anti-poaching effort in Serengeti, offer a preliminary analysis of some factors affecting the efficiency of anti-poaching patrols, and explore some possible effects of illegal hunting on ungulate populations. We show that with a small investment in additional effort and organization, routine data collection by anti-poaching patrols could play a key role in the understanding of trends in ungulate populations within the Serengeti-Mara ecosystem and elsewhere.

METHODS

Historical Records

Since its inception as a national park, wardens and rangers in Serengeti have routinely compiled monthly reports on the number of individuals arrested while hunting illegally in the park. Data were also available for a variable fraction of all years on the number of wire snares collected and on the number of elephant, rhinoceros, wildebeest, and zebra carcasses found killed. We use these data to describe some long-term patterns in the anti-poaching effort in relation to ivory prices (Caldwell 1988; cited in Leader-Williams, Albon, and Berry 1990), time of year, the number of visitors to Serengeti, and the total number of rangers employed within the park and their average monthly salary in U.S. dollars (based on the average annual bank rate in Tanzania). Records of annual fuel consumption, available vehicles, and total number of patrols conducted by month or year were unavailable.

We obtained figures on the size of the human population living outside the park from the results of national censuses conducted in 1957, 1967, 1978, and 1988. These data provide a baseline index of the potential for changes in human hunting pressure inside the park due to changes in human population size alone. The data we use here were taken from the areas corresponding to the present boundaries of Tarime, Serengeti, Bunda, Bariadi, and Meatu Districts. These districts border the western edge of Serengeti and are the main regions of origin for hunters arrested in Serengeti (Turner 1988; Magombe and Campbell 1989; Campbell and Hofer, chap. 25; Mbano et al., chap. 28). The best linear fit to the data for 1957–1988 indicated an annual rate of population increase of 2.9% in the area along the western edge of the park, where most hunting takes place. As there was no suggestion of an accelerating rate of growth of the human population from a visual analysis of the data, a constant growth rate was assumed for subsequent analyses.

Surveys of Ranger Patrols

Beginning in June 1991, we distributed questionnaires to ranger posts in Serengeti in order to obtain standardized data on anti-poaching techniques and their success and on the number and species of animals captured by hunters operating illegally within the park. Questionnaires were filled out by the officer in charge upon completion of a patrol and compiled in Seronera. We analyzed data from 149 patrols conducted from June 1991 to February 1992, mainly in the central woodlands and western corridor areas of the park.

Information collected from the questionnaires included: the post of origin, number of rangers, officers, and vehicles on patrol, time of depar-

ture on and return from patrol, number of people observed, number of people arrested, type and number of weapons confiscated, and species and number of animals found killed. For the purpose of analysis, we divided patrols into three types: (1) foot patrols, (2) vehicle patrols, on which rangers spotted people or other signs of illegal activity solely from the vehicle while driving cross-country, and (3) mixed foot and vehicle patrols, on which rangers were transported by vehicle to an area that was subsequently searched on foot (e.g., when bush or watercourses prevented vehicle use).

Analyses

Statistical Analyses. We employed standard parametric techniques in most of our statistical comparisons (Sokal and Rohlf 1982). We tested for normality in the distributions of data using graphical analyses (e.g., probability plots), and we conducted tests using transformed values when data were poorly distributed (e.g., by arcsine—square root in the case of percentages, or by $\log_{10}$ for normalizing distributions of abundance and body mass). For analyses involving percentages, we conducted parallel nonparametric tests (e.g., Kruskal-Wallis ANOVA), but in no case did these yield markedly different levels of statistical significance. We thus present only the results of parametric tests of these data. All graphs are plotted using untransformed data, since these are more easily interpreted. All probability values reported are two-tailed.

Preference Indices and the Probability of Mortality. We used three common preference indices to explore the effect of illegal hunting on wildlife species in relation to their abundance, body size, and main habitats occupied: the "forage ratio," "rank preference index," and "Manly's alpha." These indices are typically used to estimate relative preference for specific food items by individual foragers. We use them to determine relative preference for and success in capturing various wildlife species by illegal hunters in Serengeti. Krebs (1989) describes each of these indices in detail, and he recommends the rank preference index and Manly's alpha in particular for situations in which there are large differences in the abundance of the species being selected. We found that preference scores obtained using these three indices were, nevertheless, very highly correlated (e.g., each of the three simple correlation coefficients between these indices exceeded 0.90; $P < .001$, $N = 13$ in each case). We therefore use only Manly's alpha for statistical analyses, since it is continuously distributed and easily normalized by arcsine—square root transformation.

We tested the sensitivity of Manly's alpha to the inclusion of abundant species that were rarely captured by excluding Thomson's gazelle and recalculating our results. We also repeated this process by excluding

topi, a species of average abundance that was frequently killed. Neither of these alterations substantially influenced our results with respect to preference or to the relative risk of mortality (see below).

To determine whether individual species were killed significantly more or less often than expected given their relative abundances, we also calculated chi-square statistics for single-category goodness of fit tests. We hypothesized that if each species were equally likely to be killed, each should appear in the killed sample in proportions equal to those in the live sample (see also Marks 1976). To obtain the number of individuals of each species expected to have been killed, we multiplied the species' proportional abundance in the cumulative live estimate for all species by the total number of animals of the species recovered by rangers. We then calculated chi-square values for each species by comparing the expected number killed with that observed. Because of the number of tests conducted on these data, we reduced the critical value of alpha to 0.05/13, or 0.004.

We relied on figures from Campbell and Borner (chap. 6) to estimate the relative abundance of nonresident wildlife species in Serengeti (e.g., wildebeest, zebra, Thomson's and Grant's gazelles, ostrich, and eland; see table 6.6 in chap. 6). For residents, we used figures for the central and western portions of the park only (table 6.2 and 6.4 in chap. 6), since these were the areas where all patrols reporting killed animals were undertaken. However, it is unlikely that all species were equally available to hunters throughout the sample period. Many migrants, for example, spend much of the year on the short-grass plains, where they are likely to be immune from hunters using common capture methods (e.g., snares and pits). This difference in availability undoubtedly has an influence on our results that we cannot control with our present data. Another potential problem with our analyses of preference and mortality risk arises because wildlife surveys are prone to bias. This can be due to differences in the detectability of species that vary in size or habitat (Norton-Griffiths 1978; Krebs 1989; Campbell and Borner, chap. 6). Our estimates of preference and relative mortality should therefore be viewed as preliminary.

HISTORICAL PATTERNS OF ANTI-POACHING EFFORTS

Trophy Hunting

Few examples of the illegal exploitation of wildlife are more widely known than the hunting of African elephants and rhinos, whose populations have now collapsed over much of Africa (reviews in Douglas-Hamilton 1987; Leader-Williams 1990; Leader-Williams, Albon, and Berry 1990). Dublin and Douglas-Hamilton (1987) describe elephant populations in Serengeti as undergoing an initial increase in the 1970s, then suffering a decline during the 1980s. Both of these trends were at

least partly attributed to illegal trophy hunting: the increase due to hunting outside the protected area causing immigration, and the decrease due to a rapid increase in the illegal exploitation of elephants within the park.

The near-disappearance of elephants occurred primarily from 1975 to 1986, and the local extinction of black rhinoceros in Serengeti from 1975 to 1980, as indicated by sharp peaks in the number of fresh carcasses found by rangers (fig. 24.1a). Records of rhino and elephant carcasses in Serengeti are unavailable for the period prior to 1975, but Turner (1988) noted that illegal hunting of these species was uncommon during this period. A. R. E. Sinclair (pers. comm.) suggested that elephant carcasses observed during a routine census of the northwest of Serengeti in May 1973 may have signaled the beginning of large-scale trophy hunting for ivory in the park.

Peaks in the number of trophy carcasses discovered in Serengeti corresponded to escalations in the world prices of both ivory and rhino horn (e.g., fig. 24.1b; see also Douglas-Hamilton 1987; Leader-Williams 1990) and to a sudden decline in tourist visits to the park (fig. 24.1b). By 1986, reductions in tourist revenue and operating budgets led to only a single vehicle being available to park staff for anti-poaching patrols. Acting together, these factors created a nearly impossible situation for enforcement and likely combined to exacerbate the decline of elephant and rhino populations in the park.

After a low count of 467 individuals in 1986, the 1989 census indicated that elephants are again increasing in Serengeti (table 6.3 in chap. 6). This may be due to the rebuilding of the enforcement capability in Serengeti since 1986, and more recently to the world ban on ivory trading. Rhinoceros populations remain negligible within Serengeti itself, however, and given the small size of adjacent populations in the Masai Mara National Reserve and Ngorongoro Conservation Area, they appear unlikely to recover in the near future.

Meat Hunting

Since Serengeti was gazetted as a park, the main duty of park rangers has been the curtailment of illegal meat hunting. Although hunting by local people is allowed on public lands outside the park (with hunting permits and firearms only), overexploitation of wildlife (likely due to illegal hunting), the conversion of land to agricultural use, and the relative abundance of ungulates inside the park have led to Serengeti being an attractive hunting area, despite the risk of arrest (Campbell and Hofer, chap. 25; Mbano et al., chap. 28).

Turner (1988) informally documented the early efforts of anti-poaching patrols in Serengeti and provided several examples of the techniques used by hunters to kill, prepare, and transport meat. The main

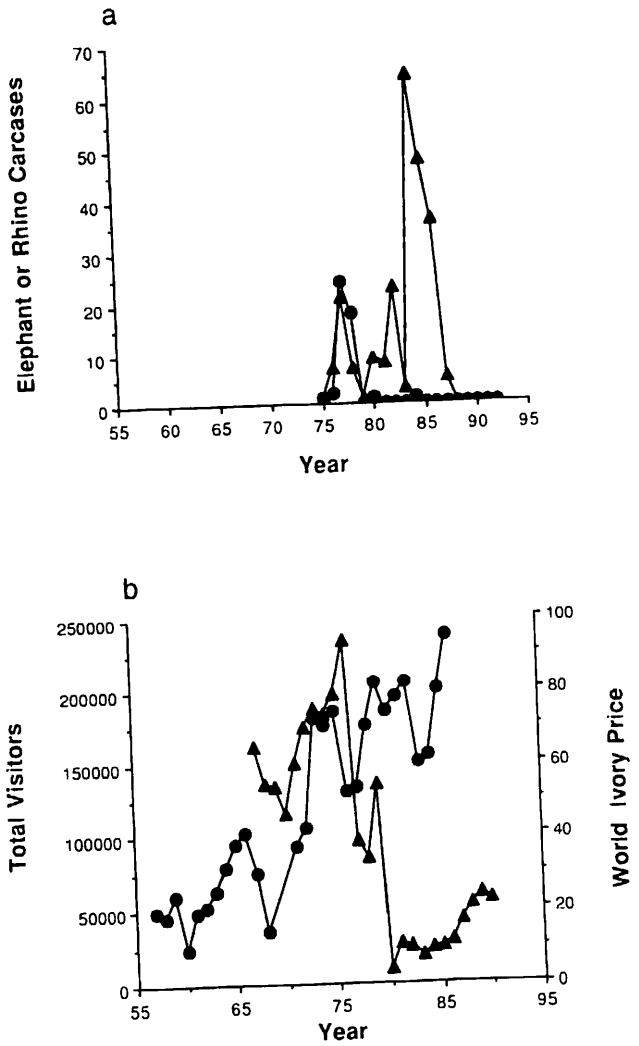

Figure 24.1 (*a*) The number of elephant (triangles) and rhinoceros (circles) killed illegally and found by rangers from 1975 to 1992. (*b*) The total number of visitors to Serengeti (triangles) from 1966 to 1991 and the world price of ivory ($U.S./kg; circles) from 1957 to 1985. (Data on ivory prices are from Caldwell 1988; cited and replotted in Leader-Williams, Albon, and Berry 1990.)

methods have not changed, and include setting wire snares in thickets, occasionally in lines of one hundred or more; digging pitfall traps, often near frequently used river crossings; and less often, the use of muzzle-loading rifles or other firearms. Spears and poison-tipped arrows are typically carried by hunters, but are mainly used to dispatch animals otherwise captured in snares or pitfalls.

Although several factors affect species preference among hunters (e.g., Marks 1976), the overwhelming dominance of the wildebeest population in Serengeti, their tendency to form large herds, and their willingness to enter thickets during migration has made them the focus of hunters, and of rangers deciding where to patrol (e.g., Turner 1988). Illegal hunting of wildebeest may have increased since 1975, as indicated by an approximate fourfold increase in the number of carcasses found killed (fig. 24.2). Although we were unable to statistically correct for variation in patrol effort over this period, we suggest that the upward trend (thought possibly not its magnitude) accurately reflects real changes in illegal wildebeest harvest over this period.

In comparison with wildebeest, the number of zebra carcasses found remained about constant from 1975 to 1992 (fig. 24.2). We note, however, that the wildebeest population increased by about 50% between 1975 and 1990, while zebra numbers remained stable (Sinclair, Dublin, and Borner 1985, Campbell 1989). Thus an alternative interpretation of the data in figure 24.2 is that harvest effort has not changed for wildebeest or zebra, but that the total number of wildebeest carcasses has risen in response to an increase in their abundance. However, this explanation predicts a much smaller increase in the number of wildebeest carcasses found than the one that was observed (e.g., ca. 0.5-fold vs. ca. 4-fold; fig. 24.2).

In contrast to the deleterious effects of illegal hunting on elephant and rhino populations in Serengeti, there is less evidence that hunting has had a significant negative effect on other ungulates in the park. For example, both wildebeest and zebra populations have remained approximately stable since 1977 (Campbell 1989; Campbell and Borner, chap. 6), even though these are two of the species most commonly taken illegally (Turner 1988; Magombe and Campbell 1989).

In contrast, Dublin et al. (1990) attributed 90% and 50% declines in local buffalo populations in the northwestern and western corridor areas of the park, respectively, to illegal hunting after ruling out the effects of disease. Sinclair (1977) described how the herding behavior of buffalo is exploited by hunters to eradicate local herds in cooperative drives into snare lines. Buffalo are also a preferred species among hunters in the northwest of the park (Sinclair 1977; pers. obs.), because of the quality and abundance of their meat and their mystique among local hunters. These factors may have acted together to increase the vulnerability of buffalo to hunting in Serengeti, and they suggest that factors other than commercial value may affect the stability of ungulate populations faced with illegal hunting.

Aside from elephants and rhinos, published evidence that illegal hunting has reduced ungulate populations in protected areas elsewhere

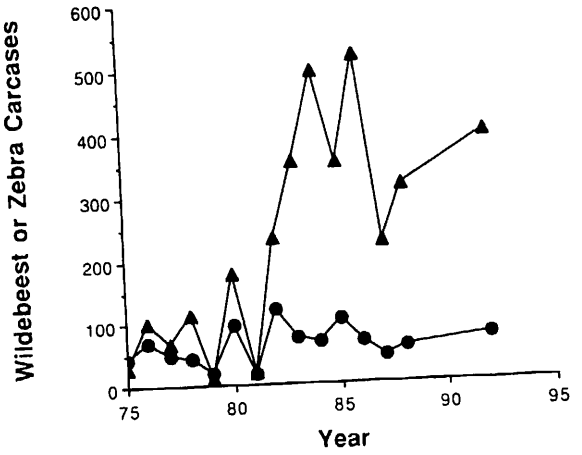

Figure 24.2 The number of zebra (circles) and wildebeest (triangles) killed illegally and found by rangers from 1975 to 1992.

in East Africa is sparse. This may be because early estimates of species abundance are not typically available. However, Edroma and Kenyi (1985) show that, especially in small areas, even small-bodied species such as reedbuck are potentially at risk of local extinction from illegal hunting. In North America, overhunting, which as in Africa is often done illegally, is the leading cause of endangerment and extinction among mammals (Hayes 1991).

Patterns of Arrests

Three main factors influenced the number of arrests made by rangers in Serengeti from 1957 to 1991: season, year, and the number of rangers employed. The number of arrests peaked during August through November, when the migratory wildebeest herds are typically in the northern portion of Serengeti or returning southward to the plains (fig. 24.3). At this time of the year, the mobility of rangers and their vehicles is greatest because it is the dry season, when vehicles can gain access to areas often impassable from December through June, and because grazers and fires remove much of the tall grass.

Arrests were made with about equal frequency in each of the months from January through July, but were lower than in the peak months of August through November (fig. 24.3). This probably occurred because during much of the former period the main wildebeest, zebra, and gazelle herds typically occupy the short-grass plains, where they are relatively immune from hunting. Turner (1988), whose anti-poaching efforts were primarily oriented to protecting the wildebeest herd, stated that once the wildebeest were on the plains, patrols were conducted much less often.