Effective Enforcement in a Conservation Area
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Effective Enforcement in a Conservation Area

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There are two primary approaches to wildlife conservation, the generation of economic benefits from wildlife to local communities, so that protecting wildlife is in their interest, and the enforcement of protected areas. Outside of protected areas, community-based conservation must be the cornerstone of protection (*1*). However, within protected areas there is debate as to whether enforcement can maintain wildlife and even whether protected areas as wildlife reserves are realistic or morally justified (*2*). Here, we present the history of illegal harvesting in Serengeti National Park (SNP), Tanzania; estimate the amount of antipoaching activity by park staff; and show how the level of funding for antipoaching has affected the trends in abundance of three severely affected species: African buffalo, elephant, and black rhino.

The primary form of poaching in the SNP and surrounding areas is snaring by local villagers (*3*), but targeted trophy hunting for elephants and rhinos occurred in the 1970s and 1980s. Park staff conduct antipoaching patrols by driving on roads and across country and foot patrols. In 1977, Tanzania closed its borders. The Tanzania economy went into a rapid decline, park budgets and resources collapsed, and it is widely acknowledged that poaching increased markedly. Beginning in the late 1980s, park budgets expanded and antipoaching patrols increased greatly, becoming a higher priority in the annual budgets.

We used the capture of poachers per patrol as our index of poaching intensity. The number of poachers arrested per year has been recorded since 1957 (fig. S1A) in the SNP; antipoaching effort, measured as ranger patrols per day was available in some years (Fig. 1A) (*4*, *5*); and the relative poaching effort was estimated by the ratio of arrests to patrols. (Fig. 1B). Poaching was low before 1977, increased between 1977 and 1986, and declined rapidly between 1984 and 1988.

Buffalo (Fig. 1C), elephant (fig. S1C), and black rhino (fig. S1D) abundance all show a rapid decline after 1977, low numbers for several years, and then (for buffalo and elephant) a recent increase. The fitted curves come from a simple population dynamics model (*6*) that assumes the illegal harvest rate is proportional to the intensity of poaching. Buffalo were also affected in 1993 by a severe drought that killed 40% of the population. The model matches closely the census data for buffalo, indicating that the decline and increase in numbers is accounted for by changes in illegal hunting. Both elephants and rhinos were targeted for the high-value ivory and rhino horn trade, and the increase in poaching was probably stimulated by particularly high prices in the late 1970s. The fast increase in elephants in the 1990s was helped by the reduction in the world price of ivory due to a CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora) ban on ivory trading.

All three data sets support the basic contention that poaching after 1977 was severe and caused major declines in abundance, whereas since 1993 poaching has been reduced enough to allow populations to rebuild. Estimates of poaching intensity in recent years depend on the assumption that arrests per patrol are a linear index of poaching intensity. Patrol efficiency may have increased with better training, more resources, and development of informant networks, or, possibly, poachers may be better able to avoid patrols as they developed more experience.

Since 2000, SNP has contributed about U.S.$100,000 per year to community development projects (*7*), augmented by additional funds from nongovernmental agencies. However, the main decline in poaching effort occurred well before the community conservation programs were initiated; hence, the decline in poaching can be attributed primarily to the increase in antipoaching effort. Therefore, we can conclude that antipoaching is effective for the protection of the species of interest if there are sufficient resources for a professional national park service.

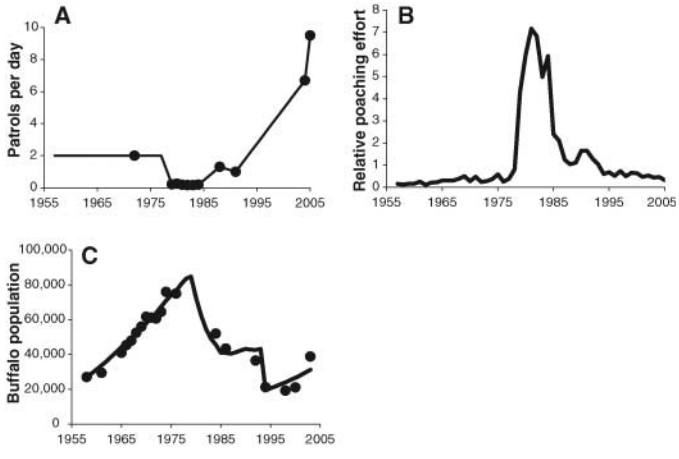

Fig. 1. (**A**) Number of antipoaching patrols per day: dots represent data, and lines represent interpolated values. (**B**) Estimated amount of poaching effort measured as poachers arrested per patrol day. (**C**) Observed abundance of African buffalo (dots) and model predictions (solid line).

References and Notes

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6. Materials and methods, including model descriptions, are available as supporting material on *Science* Online.
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Supporting Online Material

www.sciencemag.org/cgi/content/full/314/5803/1266/DC1
Materials and Methods
SOM Text
Figs. S1 and S2
Table S1

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