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The impact of game meat hunting on target and non-target species in the Serengeti

Heribert Hofer, Kenneth L.I. Campbell, Marion L. East and Sally A. Huish

SYNOPSIS

In the Serengeti National Park (SNP), illegal game meat hunting is largely carried out using snares in the south-western, western and north-western areas. Game meat hunting provides cash income and protein to communities outside the SNP. The economic benefits of game meat hunting have drawn people to villages close to the park boundary, causing a rise in human population density well above the regional average. Game meat hunting has already drastically reduced populations of Cape buffalo and must in the long term be considered unsustainable for a number of other herbivore species. In this chapter an estimate of the current wildlife offtake from the National Park is made and the impact of unselective hunting methods on carnivore species, the most common non-target species, is considered. The analysis demonstrates that game meat hunting poses a threat to both target and non-target species of the Serengeti wildlife community. Optimality models, commonly used in behavioural ecology and economics, are introduced to assess a hunter's profit in relation to hunting effort (costs) and to ask whether unchecked illegal hunting is likely to be sustainable in the long term. A review of studies on African systems demonstrates that whenever costs are reduced, the impact on wildlife due to illegal hunting is dramatically increased and reaches unsustainable levels. Proposals to limit wildlife offtake to sustainable levels, including limited legalization of game meat hunting in areas adjacent to SNP and the development of alternative sources of income and protein for local communities, are considered. The evaluation of these proposals suggests that the situation in the Serengeti does not meet the pre-conditions and assumptions of programmes developed elsewhere for maximizing economic returns from wildlife utilization as an incentive to preserve wildlife; hence such programmes are unlikely to be successful here. This is because the Serengeti is a wildlife system dominated by migratory herbivores, exacerbating the problem of assigning unambiguous ownership of wildlife outside the protected area to a given local community – a pre-condition for any successful privatization or commercialization scheme. Also, if future community conservation services are focused only on those communities that currently benefit most from illegal exploitation, i.e. communities adjacent to the

Table 9.1 Wildlife hunted inside Serengeti National Park (SNP) in 1992–1993 and total population sizes in SNP plus adjacent game reserves (Protected Area, PA) in the Tanzanian portion of the Serengeti ecosystem in 1991

Species	Status	Population size in PA 1991	Animals in hunting camps 1992–1993	Estimated total offtake by hunters	Offtake as % of estimated population size	Body mass (kg)[i]	% usable meat	Offtake in meat (tonnes)
Wildebeest	migratory	1 278 603[a,n]	932	87 476	6.8	123	60[j]	6 455.73
Zebra	migratory	146 867[b]	202	18 959	12.9	200	55[k]	2 085.49
Eland	migratory	9 416[b]	18	1 689	17.9	340	65[k]	373.27
Thomson's gazelle	migratory	325 769[a]	38	3 567	1.1	15	64[j]	34.24
Grant's gazelle	resident	25 483[b]	11	1 032	4.0	40	64[j]	26.42
Cape buffalo	resident	40 735[b,c]	27	2 534	6.2	450	60[k]	684.18
Giraffe	resident	7 853[b]	16	1 502	19.1	750	55[l]	619.58
Impala	resident	79 098[b]	123	11 545	14.6	40	65[k]	300.17
Kongoni	resident	11 716[b]	11	1 032	8.8	125	60[m]	77.40
Topi	resident	95 037[b]	175	16 425	17.3	100	60[m]	985.50
Warthog	resident	7 151[b]	71	6 664	–	45	65[k]	134.95
Waterbuck	resident	2 466[b]	21	1 971	–	160	55[k]	73.45
Bohor reedbuck[f]	resident	–	24	2 253	–	–	–	–
Spotted hyaena	commuter	5 214[d]	4	375	8.0[e]	–	–	–
Lion	resident	–	12	–	–	–	–	–
Cheetah	resident	–	2	–	–	–	–	–
Silver-backed jackal[g]	resident	–	4	–	–	–	–	–
Porcupine	resident	–	1	–	–	–	–	–
Ostrich[h]	resident	4 317[a,n]	11	–	–	–	–	–

[a] Campbell and Borner (1995); [b] Campbell and Hofer (1995); [c] counts from 1992; [d] Hofer and East (1995); [e] Hofer *et al.* (1993); [f] *Redunca redunca*; [g] *Canis mesomelas*; [h] *Struthio camelus*; [i] Sinclair and Norton-Griffiths (1979); [j] Blumenschine and Caro (1986); [k] Marks (1973); [l] conservative guess based on lowest estimate; [m] assumed to be identical to wildebeest; [n] merged estimates from the 1989 and 1991 censuses.

1989b, 1990) and carnivore populations (Hofer and East, 1995). Migratory and resident mammalian herbivores are the target for game meat hunting (Table 9.1) and the terms 'wildlife' and 'offtake' below usually refer to them.

9.3 LOCAL COMMUNITIES

In seven Districts west of SNP the human population has grown continuously since 1957, reaching a total of 1 777 620 in 1988 (Figure 9.1; data sources in Campbell and Hofer, 1995, updated). Following Campbell and Hofer (1995), a 'source area' for game meat hunters is defined here as a belt 45 km wide around the western edge of the PA. In 1988 this source area contained 454 villages with a total population of 1 161 749 living in households with an average of seven persons. In the 5 km belt adjacent to the PA boundary alone there were 122 023 people. In some areas, settlements have been established on the boundary of the PA.

The average annual rate of population increase in villages close to the PA boundary (< 10 km) between the two national censuses of 1978 and 1988 was substantially higher than the national average of 2.9%, indicating that migration contributed to this increase (Figure 9.2). There was a significantly lower average annual population increase (2.2%) in areas 10–25 km from the boundary, compared with those that were close (< 10 km, 3.5%) or further away (> 25 km, 3.0%; Kruskal-Wallis analysis of variance, $H = 6.24$, $df = 2$, $P = 0.04$), suggesting that the high growth of villages close to the PA was due in part to migration from villages located at intermediate distances of 10–25 km.

9.4 HUNTERS

Although game meat hunting was the most common illegal activity (79%) inside SNP in 1992–1993, local communities extracted other natural resources through firewood collection, livestock grazing, tree cutting for building poles, cultivation and other activities (Table 9.2). Standardized questionnaires (Campbell and Hofer, 1995) completed by SNP rangers between February 1992 and December 1993 indicated that the 452 people arrested for hunting activities belonged to hunting parties consisting of 705 people. More than 75% of arrested hunting personnel (hunters and porters) originated from villages within 15 km of the PA boundary (Hofer *et al.*, submitted). This information was used to derive an estimate of the total number of hunting personnel operating inside SNP. On the basis of the 1988 National Census data this produced an estimate of 17 856 hunting personnel.
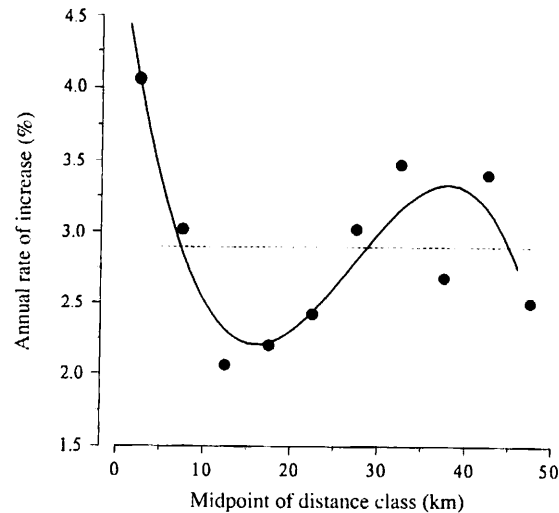
Figure 9.2 Average annual rate of increase (1978–1988) of village populations in 5 km distance classes from the boundary of the Protected Area. -- National and regional average. The solid line is the 3rd order polynomial fit ($y = 4.95 - 0.397x + 0.018x^2 - 0.00022x^3$, $r^2 = 0.80$).

9.5 HUNTING PATTERNS AND WILDLIFE OFFTAKE

Hunting is primarily done by snares; other infrequently used methods and weapons include pit traps, poisoned arrows and firearms (Turner, 1987). The most common type of snare is wire (telephone wire, mining wire or wire extracted from the treads of burnt tyres). Hunters establish camps as a base for their hunting operations. Snares are set along game tracks, around watering holes and along rivers, or snare lines are created by laying fences made from thorn bushes (Turner, 1987). At intervals along these thorn fences gaps are left in which snares are set. Resident and migratory herbivores either wander into snares, or are driven towards the fences, attempt to move through the openings and are caught by the snares, usually around the neck. Game meat is sun dried at the camp; porters are employed to assist in transporting the dried meat out of the PA.

Wildlife located in hunting camps by law enforcement patrols in 1992–1993 are listed in Table 9.1. Other species known to have been killed by hunters since at least 1986 but not found in camps between 1992 and 1993 include elephant (*Loxodonta africana*), black rhinoceros (*Diceros bicornis*), hippopotamus (*Hippopotamus amphibius*), bushbuck (*Tragelaphus scriptus*), dikdik (*Madoqua kirkii*), hare (*Lepus capensis*), aardvark

Table 9.2 Recorded activities, inside the Protected Area, of people arrested by law enforcement patrols of the Serengeti National Park Authority between February 1992 and December 1993

Activity	Frequency	Percentage
Hunting	403	70.6
Carrying meat out (porter)	24	4.2
Hunting and carrying meat out	22	3.9
Buying meat rather than hunting	1	0.2
Hunting and tree cutting	2	0.4
Tree cutting (building poles)	15	2.6
Firewood collecting	37	6.5
Grass cutting (for thatching)	2	0.4
Livestock grazing	33	5.8
Honey gathering	2	0.4
Cultivation inside Park	9	1.6
Stealing livestock	13	2.3
Fishing	1	0.2
Digging for gold	2	0.4
Banditry (attacking/robbing people)	5	0.9
Total	571	

(*Orycteropus afer*), aardwolf (*Proteles cristatus*), honey badger (*Mellivora capensis*), crocodile (*Crocodylus niloticus*) and monitor lizard (*Varanus niloticus*).

The hunting parties from which people were arrested had killed a total of 1703 wild animals (Table 9.1), i.e. 2.42 carcasses per hunting personnel. Prior to their arrest, these hunting parties had spent on average 3.5 ± 0.2 ($n = 417$) days in the Park. Those arrested admitted to 3.7 ± 0.3 (range 1–36, $n = 233$) hunting trips per year.

9.5.1 Wildlife offtake

The number of hunting trips per year multiplied by the number of wildlife killed per trip gave a total of 8.95 kills per hunting personnel per year. Of these, 2.52 were resident and 6.25 migratory mammalian herbivores, and 0.18 represented other species. Total wildlife offtake by all villages in the source area can be estimated as the number of hunting personnel multiplied by the average annual offtake per hunting personnel. This gave an estimated total annual offtake of 159 811 wildlife, including 44 958 resident and 111 691 migratory mammalian herbivores, equivalent to a minimum of 11 950 tons of meat (Table 9.1).

Table 9.3 Summary of the impact of illegal activities inside the Serengeti National Park plus adjacent game reserves (Protected Area, PA)

Demonstrated phenomenon	Reference
1. Arrests have increased over the past 30 years at an annual rate of 5%.	Arcese *et al.*, 1995
2. · Hunters come from a 'source area' populated by *c.* one million people.	Campbell and Hofer, 1995
3. Mean annual rate of population increase in villages less than 10 km away from the PA boundary substantially exceeds the national and regional average, while rates in areas 10–25 km away are significantly lower and below this average.	This study
4. Hunters appear not to select particular species as targets, but are more likely to catch species whose habitat preferences coincide with hunting areas.	Arcese *et al.*, 1995; Campbell and Hofer, 1995
5. Species whose density in an area is low where suitability for hunting is predicted to be high are under-represented in wildlife killed by hunters.	Campbell and Hofer, 1995
6. The more suitable an area is predicted to be for hunting, the fewer its resident wildlife.	Campbell and Hofer, 1995
7. Density of animal tracks increases with distance to the nearest village after variation in vegetation, rainfall and relief are taken into account.	Campbell and Hofer, 1995
8. Density of kongoni increases with distance to the nearest village after variation in woody canopy cover is taken into account.	Campbell and Hofer, 1995
9. Unregulated trophy hunting significantly reduced elephant populations between 1973 and 1987 and effectively exterminated black rhinoceros populations between 1975 and 1980.	Makacha *et al.*, 1982; Dublin and Douglas-Hamilton, 1987; Arcese *et al.*, 1995
10. Hunting caused a population decline of 50–90% in Cape buffalo over parts of its Serengeti range between 1970 and 1992.	Dublin *et al.*, 1990; Campbell and Borner, 1995
11. Hunting is suspected to have driven the population of roan antelope to near extinction.	Turner, 1987; McNaughton, 1989a
12. Declines in giraffe and waterbuck in parts of their Serengeti range may be due to unsustainable hunting pressure.	Campbell, 1989
13. Zoning the Serengeti on the basis of modelled profitability (suitability for hunting × wildlife density) reliably predicts areas where resident wildlife populations declined between 1989 and 1991.	Campbell and Hofer, 1995

(continued)

Table 9.3 *continued*

Demonstrated phenomenon	Reference
14. Incidental killing by hunters significantly changed population dynamics and age structure of spotted hyaenas and is responsible for an annual population decline of 2.4%.	Hofer *et al.*, 1993; Hofer and East, 1995
15. Hunting is not restricted to the periphery of the PA.	This study
16. Hunter activity declines towards the interior of the PA with distance of a grid cell to the boundary.	This study
17. Hunter activity in an area can be predicted from estimates of the suitability for hunting in an area.	Hofer *et al.*, submitted
18. Hunters preferentially operate in highly profitable areas.	Hofer *et al.*, submitted
19. Hunter activity and predicted offtake in an area are positively correlated even after resident wildlife density and suitability for hunting are taken into account.	Hofer *et al.*, submitted

profitable for hunters – typically easily accessible areas close to the western PA boundary – were the main areas in which resident wildlife populations declined precipitously between 1989 and 1991 (Campbell and Hofer, 1995). Density of animal tracks and the density of kongoni significantly increased towards the interior of the PA even after habitat variation was accounted for (Campbell and Hofer, 1995). Species, such as Grant's and Thomson's gazelle, with a preference for habitats that predominantly occur in the less accessible eastern part of the PA (Campbell and Hofer, 1995), experienced a smaller estimated relative offtake than other species (Table 9.1). Thus, current habitat choice and geographical distribution in the Serengeti may already be influenced by past illegal exploitation and may in turn influence a species' current exposure to hunters (Table 9.3).

Estimated offtake as a percentage of total population size diverged widely between species (Table 9.1). In several resident species, including giraffe, impala and topi, offtake must be considered high. Past exploitation has significantly reduced Cape buffalo by 50–90% in parts of their Serengeti range (Dublin *et al.*, 1990), and local declines in waterbuck and giraffe populations may also be due to overhunting (Campbell, 1989). It is possible that roan antelope (*Hippotragus equinus*), never very common in the Serengeti, has been virtually exterminated by overhunting (Turner, 1987; McNaughton, 1989a). In some species (for