Cambridge Studies in Applied Ecology and Resource Management

The rationale underlying much recent ecological research has been the necessity to understand the dynamics of species and ecosystems in order to predict and minimise the possible consequences of human activities. As the social and economic pressures for development rise, such studies become increasingly relevant, and ecological considerations have come to play a more important role in the management of natural resources. The objective of this series is to demonstrate how ecological research should be applied in the formation of rational management programmes for natural resources, particularly where social, economic or conservation issues are involved. The subject matter will range from single species where conservation or commercial considerations are important to whole ecosystems where massive perturbations like hydro-electric schemes or changes in land-use are proposed. The prime criterion for inclusion will be the relevance of the ecological research to elucidate specific, clearly defined management problems, particularly where development programmes generate problems of incompatibility between conservation and commercial interests.

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MAASAILAND ECOLOGY

Pastoralist development and wildlife conservation in Ngorongoro, Tanzania

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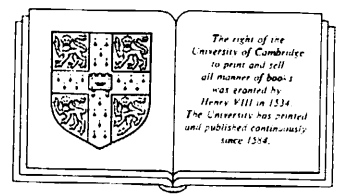

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East African rangeland by mid Serengeti. The flat hill tops often have an open shrub cover of *A. drepanolobium* over short grass. The transition zone between plains and hill slopes carries a denser grass cover of up to 50 cm high, with species from both communities.

(f) Wildlife resources

To the layman and the conservationist it is the wildlife resource that is the most well known and probably the most valuable component of NCA. This section briefly describes the resource; further aspects of wildlife ecology, conservation and management are discussed in chapter 7.

It is the Crater populations that have captured public imagination but there are many other wildlife values in NCA. The Serengeti migratory wildebeest population (currently some one million animals) spends much of the rainy season on the plains of west NCA, outside Serengeti National Park. The wildlife resources of NCA are best described in terms of five distinct communities:

1. The forest wildlife of Oldeani and Northern Highlands Forest Reserve.
2. The arid-land populations of south Natron and Lake Eyasi.
3. The Ngorongoro Crater populations, which may intermingle with:
4. The highland grassland populations, which may join into:
5. The migratory plains game populations, which use the NCA in the rainy season and move westwards and northwards in the dry season.

1. The NCA forest fauna, like the flora, is poor compared with those of older block mountain forests such as the Usambaras or Ulugurus (Rodgers, Owen and Homewood 1983), particularly in terms of forest primates, small mammals and birds. The fauna of the montane forests of the wetter eastern slopes of Ngorongoro and Oldeani is nevertheless of conservation value for its conspicuous large herbivores: buffalo, rhino, elephant and bushbuck. No detailed studies have been undertaken on wildlife in this or any other similar forest in East Africa, though preliminary accounts of the mammals and avifauna of Kilimanjaro forests appeared in a special edition of Tanzania Notes and Records (1965, reprinted 1974).

2. The arid lowlands surrounding Lake Natron have small populations of wildebeest and zebra, but also the more typically dry country Grant's gazelle, oryx and lesser kudu. Rhino and elephant populations were hunted out years ago. Lake Eyasi escarpment and the bushlands of Maswa and Endulen still have a greater kudu population, although all animal species are subject to illegal hunting (chapters 7, 11; Makacha, Msingwa and Frame 1982).

3. Populations of herbivores in Ngorongoro Crater have been briefly described by Estes and Small (1981) and more recently by Hanby and Bygott (1989) and Boshe (1988). Large mammal species are listed in chapter 7 together with estimates of population size. Other than for Grant's gazelle, giraffe, eland and impala, the Crater holds the majority of NCA dry season wild ungulate populations (Table 2.4). All herbivore populations are subject to some fluctuation, whether with seasonal migrations (wildebeest, zebra – Estes 1966, 1969, Boshe 1988) or longer-term factors (buffalo – Rose 1975). Rhinoceros populations were studied intensively in the mid-1960s (Goddard 1967). Poaching has eliminated rhino in many areas of northern Tanzania since 1976 and has severely reduced the Crater population (see chapter 7). The predator populations of the Crater have been studied mostly as part of intensive programmes on the predators of the entire Serengeti (from Schaller 1972 through to Pusey and Packer 1987 on lions; Kruuk 1972 – hyaena; Estes and Goddard 1967 – wild dog). The Crater has a very high density lion population, reflecting the highest resident biomass in Africa of their preferred prey (van Orsdol 1981). The lion population is currently very stable. Following their recovery from a disease-related crash in the 1960s (*Stomoxys* fly outbreak – Fosbrooke 1962) the lions reached their present population size in 1975. Since then a high proportion of subadults emigrate permanently each year; no immigration has been recorded in the last decade (Pusey and Packer 1987). Other species may have permanent resident populations (e.g. serval – Geertsema 1985), but some predator species (wild dog, cheetah) are present only intermittently as the result of periodic recolonisation of the Crater.

4. The highland grasslands populations include animals permanently resident in Empakaai and Olmoti craters and surrounds, and seasonal emergents from the forest and Ngorongoro Crater. Livestock are common in this zone; wildlife by contrast are not numerous (Frame 1976, 1982). Zebra are the commonest wild ungulates and are often seen near domestic herds. Eland, reedbuck and steinbok are frequently encountered. Wildebeest and gazelle are more common on the western slopes and Malanja depression above the Serengeti Plains.

5. The migrant plains game populations of the Serengeti invade the western Ngorongoro plains (Serengeti, Salei, Gol) during the rainy season, December to March/April, when over two million migrants (mainly wildebeest, but some zebra and gazelle) use this area. One survey estimated that over 75% of the wet season grazing by the Serengeti migratory herds took place outside the SNP boundary, the great majority being in NCA (Watson and Kerfoot 1964). Table 2.4 shows the main species. NCA, which comprises 8% of Arusha Region, accounted for 86% of the plains wildlife and 67% of all wildlife for the Region.

Table 2.4 *Main large ungulates of NCA*

Species	NCA count[a] 1980	Arusha region[a] 1980	95% limits[a] for regional estimate	1987 census of NCA[b] Wet season	Dry season	Dry season Crater only
Wildebeest	830 800	1 067 575	28%	1 109 011	8 318	7 415
Thomson's gazelle	373 800	144 504	20%	149 715	6 161	4 677
Zebra	69 700	389 543	7%	62 959	7 187	4 332
Buffalo	10 200	21 800	13%	3 102	3 484	2 855
Grant's gazelle	10 000	30 782	11%	10 303	7 587	1 135
Eland	2 900	30 679	12%	5 436	168	7
Giraffe	2 719	24 145	14%	1 666	1 226	
Impala	1 800	90 083	13%	3 301	452	
Coke's hartebeest	1 000	15 405	10%	345	160	112

Notes:

[a] Ecosystems Ltd. 1980: pp. 57, 62;

[b] Boshe 1989: p. 5, combining ground survey estimates for the Crater with aerial estimates for the rest of NCA.

A large proportion of the total is made up of migrants. Changing patterns of the duration and intensity of use of the NCA by migratory ungulates are explored later (see chapter 7).

Archaeological and palaeontological resources

The NCA is particularly rich in archaeological remains which are not only of scientific value, but of considerable tourist interest. Olduvai Gorge cuts through some two million years of deposits (Reck 1933, Leakey, L 1965, Leakey, M. 1971; see Poirier 1987:136–9 for a brief up-to-date summary of the importance of Olduvai). Louis and Mary Leakey carried out their famous studies at Olduvai from 1931 until late 1983. There are many archaeological sites of significance in and near NCA which together span a period of human evolution of some 3.5 million years (Mturi 1981). Laetoli, above Lake Lagarja (Ndutu) at the western foot of Lemagrut, is the site of well-investigated beds spanning 300 000 years to 3.5–3.8 million years BP (Leakey and Harris 1987).

As well as providing hominid bones these beds have yielded a vast array of other vertebrate remains, many of which still await full description (see Leakey, L. 1965, Leakey, M. 1971, Leakey and Harris 1987). These, together with studies of pollen grains and of the nature of sediments at Olduvai and Laetoli, have allowed the description of past climates and vegetation types. Palaeontologists present a picture of a dynamic mosaic of savanna grassland and woodland types (Andrews 1989). The distribution and relative extent of different vegetation types has changed throughout the last few million years with changes in climate and volcanic activity (particularly of Ol Doinyo Lengai, whose windblown ash conditions vegetation growth on the short grass plains). The Laetoli Pleistocene fauna resembles that of modern Serengeti woodland habitats in distribution of body sizes, locomotor types and dietary adaptation (Andrews 1989). Harris (1985) presents a picture of open grassland with scattered trees, with evidence of migration into or through Laetoli of a great diversity of species at the onset of the Pleistocene rainy season. Different ash layers have preserved what he tentatively interprets as traces of a resident dry season fauna (lagomorphs, guinea fowl and rhinos) with other layers perhaps corresponding to a wet season influx (larger bovids, equids, and elephants). The Olduvai Pleistocene faunas differ more markedly from those of present day Serengeti grassland and woodland habitats, especially in the dearth of species in the 10–45 kg range, in the relatively high proportion of small mammals with locomotor adaptations for low vegetation and ground-dwelling niches, and in the high proportions with insectivorous and grazing dietary adaptations (Andrews 1989). The distinctive Olduvai faunas may indicate a different and as yet poorly understood habitat, or represent some bias in preservation and recovery of fossil material.

vation. Wildlife legislation dealing largely with the hunting of game animals, and providing for their protection, was laid down in outline in Tanzania in 1921 (Serengeti Committee of Enquiry 1957; Kitomari 1985). In 1928 a Complete Game Reserve was declared comprising the Ngorongoro Crater as defined by the rim, but excluding two German settlers' farms on the Crater floor. All hunting except that especially prescribed was prohibited in the Reserve. In 1929 part of the Western Serengeti was added to this closed reserve and the boundaries were greatly extended in 1930. In 1937 all hunting of lion, cheetah, leopard, giraffe, rhinoceros, buffalo, roan antelope, hyaena and wild dog was prohibited (Serengeti Committee of Enquiry 1957). The boundaries were redefined in 1939 to include Serengeti, Loliondo areas and most of present day NCA, apart from the forests. Initially gazetted by the Germans, the Forest Reserve was ratified and demarcated by the British and administered under a separate ordinance.

The initial hunting bans together with minor restrictions on settlement construction, stock movements and range management had little impact on the Maasai of the Serengeti–Ngorongoro area at the time (Legislative Council of Tanganyika 1956, Ole Saibull 1978, Arhem 1985a, b). However, later they formed the basis of major curtailment of human activities.

In 1940 the Game Ordinance replaced the earlier Game Preservation Ordinance. This empowered the Government to create National Parks. The entire Serengeti Closed Reserve of that time, which included most of NCA, was declared a National Park (without any consultation with traditional residents). This legislation restricted entry to and residence in the park area, but excepted those born there or with 'traditional rights' from such restriction. In 1948 a new National Park Ordinance was passed, and in 1951 the Serengeti/Ngorongoro area became a park, with much stricter legislation. For example, burning 'either wilfully or negligently' became a criminal offence (though this proved impossible to police), and an amendment in 1954 withdrew the right to cultivate.

Attempts to enforce the ban on cultivation brought about the first major overt conflict between wildlife conservation and human interests. Relative to the scale of pastoralist activities there was little cultivation within the Ngorongoro/Serengeti area. However, because of the dependence of pastoralists on dry season dietary supplements (see chapter 10) those few inhabitants who were primarily cultivators and suppliers of grain found support from the pastoralist majority (who were also part-time cultivators of subsistence crops). The residents of the Park wanted cultivation to be allowed, subject to control of its extent by the pastoralists themselves, and further wanted guarantees of unrestricted grazing access throughout the Ngorongoro highlands.

Increasingly strict conceptions of what a national park should be, and the incongruity of a growing and developing human community in Tanzania's only park, led the administration to conclude that 'the continued presence of the Maasai and their stock within a National Park was irreconcilable with the purpose of the Park' (Fosbrooke 1962). In 1956 the Tanganyika Government proposed a modification of the park boundaries, releasing much of the Ngorongoro area from the Park. This created a furore among European conservationists and Professor Pearsall was commissioned to report on the area for the Fauna Preservation Society of London (Pearsall 1957). Ensuing discussions decided that all Maasai rights in the Western Serengeti should be extinguished and that the eastern area, including the Crater Highlands, should be excluded from the park and administered by a separate Conservation Unit of the Government.

During and after the enquiry, the demands of the cultivator and pastoralist residents were taken up by TANU as a grievance against the colonial administration represented by the Park Trustees. In 1959 a compromise was reached with the Ngorongoro Conservation Area Ordinance. This separated the 12 000 km^2 Serengeti National Park from the 8292 km^2 Ngorongoro Conservation Area (NCA). The NCA was to be administered by the Ngorongoro Conservation Unit, charged with conserving and developing the natural resources as well as allowing for human use compatible with wildlife conservation. This provided for extensive but controlled Maasai grazing rights, settlement and small scale cultivation at the discretion of the Conservation Unit. Meanwhile, the 1959 National Parks Ordinance forbade human interests in the Serengeti. Current boundaries do not correspond with the zones censused by Grant (1954), and this census was preoccupied with distinguishing between families that had been resident prior to 1940 from later immigrants. However, using a minimum estimate (Grant 1954:13; Western Serengeti zone) it is possible to deduce that around 1000 Maasai inhabiting the Serengeti at the time were forced to move, together with over 25 000 cattle and 23 000 small stock and donkeys. This represented about one-tenth of the Maasai population of the Serengeti/Ngorongoro area. They were offered rights and services within NCA as compensation.

(b) Ngorongoro Conservation Area: 1960–1989

Ngorongoro Conservation Area Authority received grants for the construction of compensatory water developments to accommodate Maasai vacating the western Serengeti. A management plan was formulated in 1960 and revised in 1962. This management plan drew its direction from a speech of

must lead to adverse effects on the wildlife. The most obvious example of a specific crisis is the near-extinction of black rhino in the area. The NCAA accuse the Maasai of organised poaching. Conversely the Maasai accuse the NCAA employees of using their antipoaching patrols, arms and vehicles as opportunity and equipment to poach rhinos and dispose of the currently highly valuable rhino horn. The issue is discussed in detail in chapter 7. A second conservation crisis as perceived by the Authority is the decline of woodland and forest areas (Kaihula 1983, Kikula 1981) which is seen as an outcome of Maasai activity. On the other hand, vegetation ecologists invoke long-term change from causes other than human activity, for example senescence of single-age stands, changing groundwater levels, and growing wild ungulate numbers. If anything there is a phase of bushland invasion with regeneration of woody species in many edge areas of the plains (NEMP 1989, Chamshama *et al.* 1989), perhaps attributable to lower elephant numbers, and less fire, as much as to changing livestock pressure. These issues are analysed in detail in chapter 6.

The NCAA attitude overall is that the presence of the Maasai is detrimental to NCA environment and wildlife populations. The original official description of the Serengeti National Park and Ngorongoro Conservation Area (Legislative Council of Tanganyika, 1956) stated clearly that Maasai interests were to be excluded from the Park not on the basis of any supposed damage, but because of the political problems envisaged in a multiple land use future, and because of the possible eventual incompatibility of Maasai and conservation interests. However, the subsequent Serengeti Committee of Enquiry (1957) took a different tone. Professor Frank Pearsall together with Pasture Research Officer T. Robson gave subjective evidence to the effect that serious damage to the environment was already being caused by the Maasai through burning, overgrazing, trampling around water points, and tree cutting. It was felt that human and stock numbers would inevitably rise, that damage by Maasai would increase, and competition for grazing and water would intensify. The original decision to exclude Maasai from the 12 000 km² Serengeti National Park and to place substantial restrictions on their use of NCA was justified on these grounds. The ecological damage argument is regularly repeated (Ole Saibull 1978; Ole Kuwai 1981; Chausi 1985; Makacha and Frame 1986). There are rare statements against this conventional wisdom (e.g. Branagan 1974). In NCA, as for most sub-Saharan semi-arid areas, longitudinal quantitative data are few, and primary productivity fluctuates from year to year in a way likely to mask any long-term trend. Subsequent chapters discuss the problems of assessing trends in vegetation and environment, and evaluate the statements of the 1957 Serengeti Committee of Enquiry and later authors on Maasai impacts on NCA environment and wildlife.

Background to research

When NCA was declared a World Heritage Site UNESCO commissioned a new management plan, to be drafted by relevant departments of the University of Dar es Salaam. A wealth of descriptive material on the natural resources of NCA together with detailed ecological studies of vegetation and wildlife studies were already available, but there was virtually no baseline information on the pastoralist inhabitants. In order to evaluate the different perceptions of subsistence and conservation problems outlined above and to make a useful contribution to future policy and management we needed an understanding of the ecology of the Maasai and their livestock in NCA. While our initial brief was to collect baseline ecological data, specific questions emerged. Firstly, what could ecological studies tell us about the sustainability of Maasai pastoralism in NCA? What was the impact of pastoralism on conservation values, in terms of environment, of wildlife populations and of 'naturalness'? Secondly, what could such studies reveal about the problems of pastoral subsistence in NCA? To what extent were such problems a result of 'natural' ecological factors of the physical and biotic environment, a result of poorly adapted methods of land use and stock management, or a result of imposed management constraints? The next six chapters outline our choice of research methods and review our own and others' studies of range, wildlife, livestock and human subsistence ecology in the light of these questions. This will form a basis for our concluding chapters which discuss possible management alternatives and their likely outcomes.

woodland areas. Several woodland areas in NCA have shown a decline in canopy cover, a decrease in total woodland extent, and or a failure of regeneration over the last few decades. Anthropogenic impacts (e.g. pre-1975 clearing for cultivation in the Endulen/Kakesio zone) and the effects of changing groundwater levels (e.g. for the *Acacia xanthophloea* Lerai Forest in the Crater) are both involved. However, wild herbivores also play a large part in woodland change. The 'elephant problem' – large scale damage to woodland by high density elephant populations, and their control through culling – became a major management controversy in the 1960s and 1970s (Laws 1970, Eltringham 1980, Field 1971, Owen-Smith 1983). With the rise in elephant poaching in the 1970s the woodland damage aspect of the elephant problem lost urgency. However, NCA is sandwiched between two areas where large mammal damage to woodland has been studied in detail: the Seronera woodlands (Croze 1974 a,b, Pellew 1983) and Manyara (Mwalyosi 1977, 1981). Although not studied in depth in NCA, elephant, giraffe and other herbivore

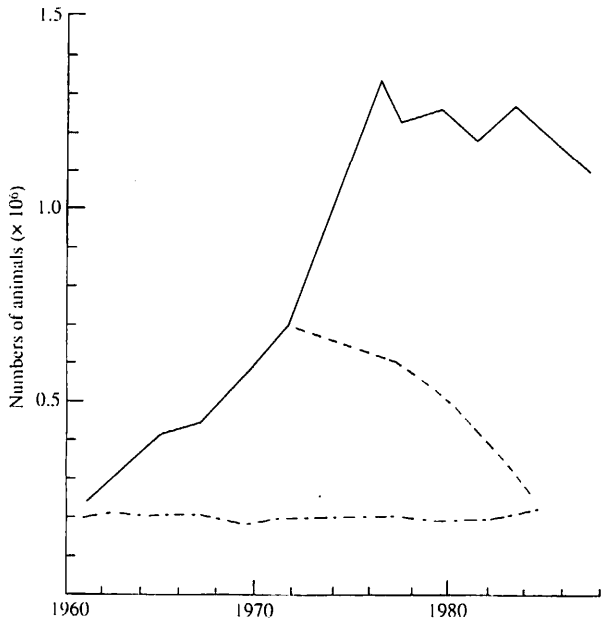

Fig. 7.2. Changes in main large wild herbivore populations of the Serengeti Ecological Unit including NCA (after Malpas and Perkin 1986). —— wildebeest, – – – Thomson's gazelle, ·—· zebra.

damage is implicated in the decline of woodland around Olduvai and Lake Ndutu (where wildebeest cause considerable damage to young acacias), and in Lerai, Loitoktok Springs and Laiyani in the Crater (Kaihula 1983).

Pellew (1983) has modelled woodland dynamics in the Seronera area, and his discussion of the main factors, including both wildlife and past Maasai livestock effects, is relevant to NCA. The woodlands of Serengeti and by extension of NCA are seen as 'a fluctuating mosaic of change, in which each constituent cell of the mosaic will be in a different stage of the cycle'. Changes in wildlife populations make for major extrinsic perturbations. For example the system has been influenced by rinderpest decimating giraffe; ivory hunting decimating elephants; and low grazing pressure together with high rainfall allowing high standing grass biomass and exacerbating fire effects. Size class frequency data and tree girth increment rates suggest Lerai may have had a period of intensive regeneration at the turn of the century when elephant were heavily hunted for ivory (Spinage 1973, Kaihula 1983). The current crash in rhino numbers due to poaching is probably associated with a concurrent reduction in elephant in the 1970s and 1980s (see below). This would tie in with the possibility of a current period of woodland regeneration in NCA, as happened for example in Tsavo and in Uganda, and as is suggested for NCA by current analyses of aerial photographs and satellite imagery (see chapter 6). Pellew (1983) tentatively attributes the existence of older (pre-1888) stands in the Serengeti to the pre-Park and pre-rinderpest Maasai presence. He suggests that before the Maasai were excluded, higher grazing pressure in times of greater cattle numbers may have suppressed fire, encouraged bush encroachment and allowed a period of woodland regeneration. Again, similar effects of a pastoralist presence may apply in NCA at the moment. In addition to the large mammal impacts reviewed by Pellew, Belsky (1984) presents experimental evidence to suggest that the smaller browsers (Thomson's and Grant's gazelle, dikdik, impala) slow the growth of the smaller size classes of woody plants. Pellew (1983) stresses that the dynamic mosaic of successional stages of regeneration and mature woodland does not allow for the maintenance of any one specific equilibrium state, despite conservation management's desire to do so. Changing plant–herbivore equilibria in NCA/Serengeti do not indicate a need for control of the herbivore populations involved.

Forest wildlife populations

The forest and its wildlife are in a national and international context biologically less outstanding than the NCA grassland communities. However, they make an important contribution to the diversity and conservation values of the NCA as a whole, and the watershed protection role of the forest is vital

not only for NCA water supply but also for the comparatively densely settled and farmed Mbulu areas to the east.

The NCA forest wildlife is species-poor (chapter 2) and has not been well studied. What little is known, apart from a basic species list, derives from observations on the forest margins and adjacent habitats. Of the large mammals, buffalo, rhino, elephant and bushbuck are present and waterbuck are found in the larger clearings. Giant forest hog are rumoured to exist in the Oldeani bamboo (an unconfirmed sighting in 1975; also Child 1965:89) – if these records are correct, this is their only locality in Tanzania. The persistent doubt is symptomatic of the lack of knowledge on NCA forests. Black and white colobus are mentioned by Fosbrooke (1972) but do not exist in NCA. A common guenon (Sykes or blue monkey) may be seen. The forest buffalo and elephant populations also use the Crater walls and floor (Rose 1975; Kiwia, Kabigumila pers. commun.). The forest wildlife populations come into contact with subsistence and commercial farming along the eastern and southern borders from Mangola/Oldeani/Karatu/Mbulumbulu to Lositete (Fig. 7.3). They cause local crop damage, and compensation or crop protection measures must be considered, especially where illegal hunting, pole cutting or firewood collection are to be discouraged.

It is likely that there was originally continuous forest cover from the Ngorongoro forest to Lake Manyara (Douglas-Hamilton 1972) allowing elephant to move between two dry season concentration areas. Tsetse clearing and subsequent Mbulu settlement in the 1940s cut this corridor and today only a fragmented forest strip remains from Kitete and Lositete down the Rift wall to tiny isolated groundwater patches north of Mto wa Mbu (Makacha and Frame 1977a,b). NCAA is not well equipped to conserve forest habitats effectively. There are plans for larger-scale irrigated agriculture in this area. Together with the notorious difficulties of trying to maintain isolated elephant groups amid other developments, these factors preclude rehabilitation of this migratory route (Fig. 7.3 and Rodgers 1981a). The NCA elephants are thus an isolated population, as settlement around Mangola has effectively severed the past southern linkage around Lake Eyasi to Yaida Chini.

Management policies and problems

(a) Wildlife administration

The wildlife resources of Tanzania belong to the government irrespective of whether they are on public or private land. Their management is entrusted to the Wildlife Division of the Ministry of Natural Resources. It controls two parastatals (Tanzania National Parks Authority and NCAA) each with its own ordinances and governing body. It also has the civil service

staff administering Game Reserves (in which there is no settlement or cultivation, and limited wildlife exploitation is strictly controlled) and Game Controlled Areas (in which settlement and cultivation are allowed, but hunting is controlled). The wildlife of the Serengeti/NCA ecological unit while ostensibly under a single Ministry is controlled in practice by three distinct organisations each with its own legislation. It covers three separate regions, each with different wildlife policies and priorities (Arusha/NCA; Musoma/SNP and Shinyanga/Maswa GR); and when animals migrate to Kenya they come under the control of another country. Each organisation involved maintains its own infrastructure and administration, and so while in terms of GNP or per capita income expenditure on the management of the resource is high, there is often considerable overlap and wastage. In real terms, and with deteriorating national economies and inflation, actual expenditure on wildlife has greatly decreased during the 1980s. Boshe (1988), in a brief overview of wildlife status

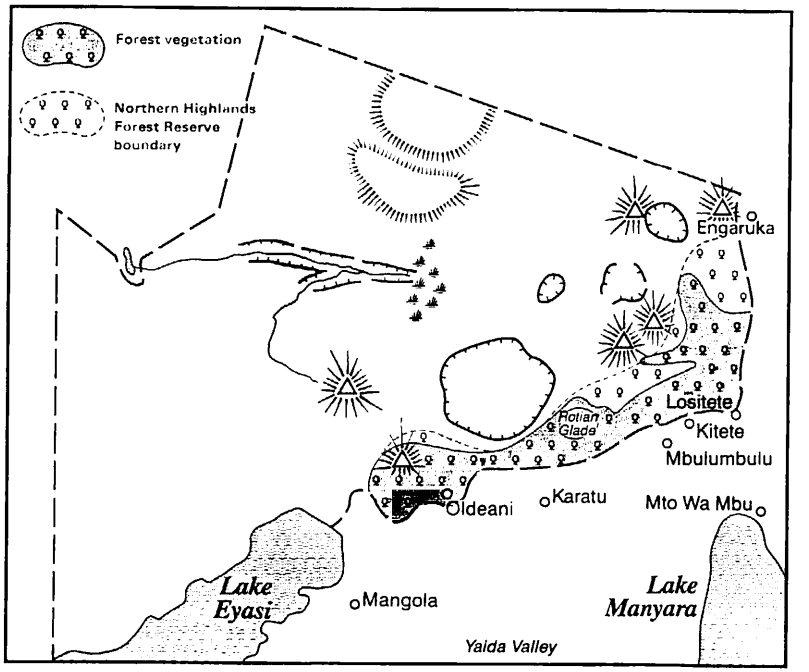

Fig. 7.3. Settlement along the borders of the Northern Highlands Forest Reserve.

for the IUCN study, was unable to identify any wildlife situation or species causing concern to management or biologists. This is in part due to the absence of any management objectives.

(b) Naturalness and change

The well-documented changes in plant and animal communities this century are viewed in different ways by different people. Some changes, such as the sixfold increase in wildebeest, are seen as desirable in wildlife management terms; others, such as the overall decline in woodland, as deleterious. The welfare of the wildlife resources of the NCA continues to be the main focus of attention of management authorities and conservationists in general. However, with NCA's history of incomplete management studies and unconfirmed management plans, there is a lack of accepted and clearly defined objectives for wildlife management. It is thus difficult to evaluate resource status, let alone suggest causal factors that may be threatening environment or wildlife conditions.

Shepherd and Caughley (1987) give a concise and entertaining review of the range and sequence of successive fashions in conservation philosophy and management, summarised below in approximate chronological order:

1. Preservation of scenery and 'nice' animals (and elimination of 'ugly species' – e.g. past shooting of wild dog and hyena in NCA)
2. Conservation of soil and plants (post-1930s US dustbowl)
3. Preservation of a single specific physical or biological state of the area (usually as first observed by Europeans)
4. Conservation of representative plant and animal associations
5. Conservation of biological diversity – species richness and variety of community types
6. Conservation of genetic variability
7. Conservation of biological processes – 'the resource is *wildness*'

New objectives are often added onto the old rather than replacing them. These conservation objectives differ in kind: most are about conserving states, but the last is about processes. The objectives may not be mutually compatible.

These various aims and the contradictions they enshrine are apparant in NCA conservation policies. The East African policy of non-interventionist or laissez-faire management prefers to monitor rather than regulate natural changes over large areas (Sinclair 1983b). This is in contrast to South African policies of fine-tuning manipulative management involving culling and reintroductions (Pienaar 1983). NCA wildlife management now involves a compromise between actively conserving species and physical components that

could be radically affected by natural processes, and valuing the area's changing states as a demonstration of such natural processes. This compromise makes it necessary to define the range of states which are acceptable, and to keep enough control to prevent unacceptable extremes which otherwise natural processes might bring. A changing mosaic of forest, woodland and grassland should be tolerated, even where the relative proportions of the communities alter noticeably; near or complete loss of a vegetation formation would not be acceptable.

With a growing scientific understanding and acceptance of the way herbivore populations wax and wane, and of plant–herbivore interactions, there is less management pressure now to stabilise vegetation states and herbivore populations, or to recreate systems as seen at some previous date. However, there is still extensive debate about related management issues, for example carrying capacity and stocking levels, particularly where both wildlife and domestic stock are involved (Shepherd and Caughley 1987, Homewood and Rodgers 1987). For arid and semi-arid areas the variability of rainfall and of primary production is such that carrying capacity derived from their long-term means is not a useful concept, while their patterns of variability may be fundamental to understanding the system. Linked to the debate over carrying capacity is the persistent idea that reducing a herbivore population must mean a healthier population and a healthier environment. With culling, while surviving individuals may grow larger, suffer lower natural mortality, and show higher fecundity, and the sward carry a higher standing crop, the system tends to lose resilience and becomes more vulnerable (Shepherd and Caughley 1987). It is also no longer 'wild'.

Once the decision has been made that conservation of natural biological processes is among the main objectives, and that change is expected and tolerated, a whole series of potential management interventions become unnecessary and even undesirable. For example, elephant culling has been proposed as a way to reduce woodland damage (see Kaihula 1983 for a recent mention) but rejected by others (e.g. Pellew 1983). Capture and dehorning of rhino was suggested as one way to reduce their attraction to poachers. Other interventions which have recently been considered in NCA are reducing buffalo numbers in the Crater and cropping wildebeest to reduce impacts on the ecosystem. None of these measures has been approved or implemented. Water resources have not been developed specifically for wildlife use, though wildlife benefit from some sources that have been developed for pastoralists. Wildlife control is occasionally carried out when stock (or crops in neighbouring areas) are lost; the raiding animals, or others nearby, are then likely to be shot.

(c) Managing the craters

The exception to the overall policy of tolerating natural change within very broad limits may be the management of Ngorongoro Crater itself (Fig 7.4). Ngorongoro Conservation Area to most people means the Crater. It is the Crater that most visitors want to see, and it is the Crater (together with its buffer forest areas and access to Serengeti), that most conservationists want placed under National Park style management. This 250 km² area is a microcosm of the great variety of habitat types, species and to some extent the processes of the Serengeti/NCA system.

Despite the apparent ease of study of the tame populations in a restricted area, neither individual wildlife species nor community interactions in the Crater have received much research attention. Though existing at very high density, the Crater wildlife populations are small compared to those of the rest of the Ngorongoro/Serengeti system (Tables 2.4, 7.1), and are not self contained. There is evidence that wildebeest, zebra, elephant and buffalo migrate in and out of the Crater (Table 7.2, Estes and Small 1981; Kabigumila

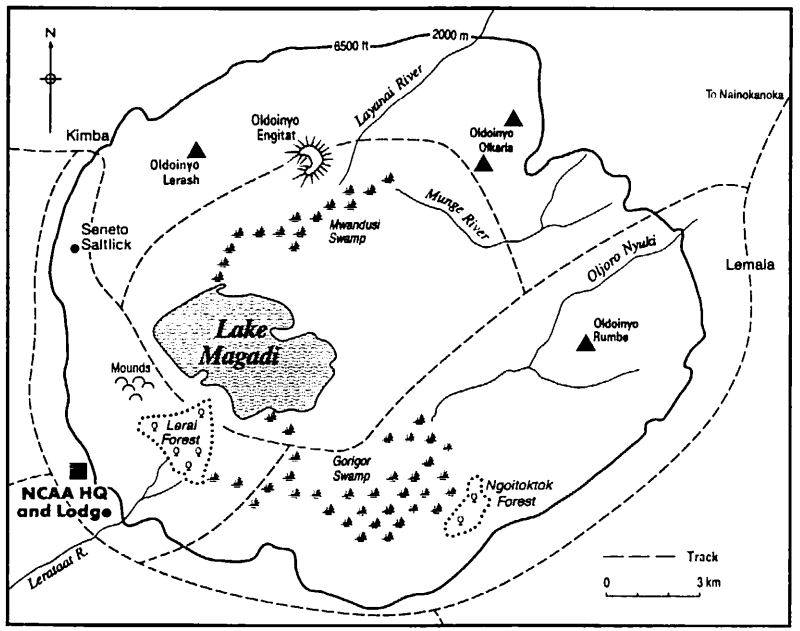

Fig. 7.4. Ngorongoro Crater.

Table 7.2 *The wildlife populations of Ngorongoro Crater (after Estes and Small 1981 and NCAA 1987)*

Species	Year										
	1964 Feb.	1968 March	1970 Dec.	1971 Aug.	1973 Jan.	1976 April	1977 Sept.	1978 Feb.	1986 July	1987 April	
Elephant	28	11	20	7	56	42	5	17			
Rhinoceros	27	3	25	8	39	34	16	21	2		9
Zebra	5038	3058	2596	5523	3286	5306	3312	3005	4297		3127
Hippopotamus	23	2	0	26	0	33	25	47			
Buffalo	11	25	18	0	1279	1508	109	1164	1455		2714
Eland	342	355	240	98	499	574	176	177	59		64
Waterbuck	35	26	63	20	49	20	6	29			
Hartebeest	49	19	136	154	150	249	176	129	72		70
Wildebeest	14922	14417	17597	16797	13422	10059	14451	13376[a]	11847		9011
Grant's gazelle	2310	1376[a]	1376	1492	1833	2346	1507	1361	2136[b]		
Thomson's gazelle		4269[a]	2860	5166	2778	3407	2827	3125	3312[c]		
Ostrich	37	30	32	13	37	45	23	31	26		23

Notes:

[a] Gazelle data from September 1968.

[b] Gazelle data from strip sample.

[c] Another count in February 1978 gave 9587 wildebeest.

1988; Rose 1975 etc). However, the greater part of the 10 000–20 000 wildebeest are probably resident. Dry season counts 1964–1978 average some 3000 head more than wet season ones, indicating relatively minor seasonal movement (Estes and Small 1981). Some carnivores (cheetah, wild dog) are only present intermittently. The lion population is one of the most dense in Africa (reflecting the exceptionally high year-round preferred prey density) and maintains stable numbers through the emigration of a high proportion of subadults, with no immigration recorded for the last decade. The Crater lion population thus represents an isolated population (van Orsdol 1981, Pusey and Packer 1987). A few species have been studied in some detail in the Crater (wildebeest and gazelle: Estes 1966, 1967, 1969; rhino: Goddard 1967, 1968, Kiwia 1983; elephant: Kabigumila 1988; serval: Geertsema 1985). Many others have been the subject of brief comparative studies by SRI scientists (see Sinclair and Norton-Griffiths 1979). Herbivore populations in the Crater appear to be partly limited by grazing resources (see below), predation (judging by the relatively high numbers of lion and clan-hunting hyaena – Kruuk 1972,1975) and to some extent by net emigration (Estes and Small 1981).

With the possible exception of rhino (and maybe lion) the Crater populations are not of prime importance in biological terms (Table 7.1; section below on rhino). Also, while some components are particularly easily observed (e.g. lions), some of the major processes that make the rest of NCA so interesting are less evident (e.g. the mass migrations) or missing altogether (e.g. the juxtaposition of wildlife and pastoralist stock). The Crater is, however, of enormous importance for wildlife viewing and thus for conservation education and awareness as well as for generating revenue. The variety of habitats, the concentration of large wildlife, and the spectacular scenery make the Crater a tremendously important showcase and symbol: so, while it lasts, does the Crater rhino population. All these factors suggest that the Crater may be a candidate for more intensive and more interventionist management while the rest of the NCA wildlife area is better left to more natural processes.

Fire management is one example. In NCA as a whole, fire management could to a large extent be left to pastoralist range management, with the proviso that forest edges must be protected against grassland encroachment. In the Crater, the exclusion of pastoralists and changing policy has meant that few if any fires took place on the Crater floor from the late 1960s to 1982, while the Crater walls burnt frequently with some loss of forest cover. On the Crater floor the coarse ungrazed and unburnt grass was avoided by wildebeest and gazelle (for example around Korigor Swamp) and tick numbers rose dramatically. Estes and Small (1981) commented that the average total 14 000 wildebeest of the Crater used only the short grass communities limited to under 40% of the area.

In 1982 no-burn policies were relaxed and controlled fires set, and wildebeest and zebra used the post-burn flushes. All burning then stopped again and the NEMP (1989) report the accumulation of rank unpalatable and tick-infested forage, with adverse results for the herbivore populations. A severe wildfire briefly threatening crater rim lodges has led to the reintroduction of fire breaks and of a fire control labour force. NCAA staff say a controlled fire policy must await more research and more equipment. There is also a case for special measures protecting particular habitats (for example encouraging regeneration and maintenance of Lerai Forest) or species (e.g. rhino) and reintroducing or restocking others (again rhino, if the Crater population can be better guarded in future). Intervention is likely to become necessary in the near future controlling tourist access to and impacts on the Crater, as it could rapidly deteriorate under current pressures and with the current lack of regulation (chapter 11).

Similar intensive management might be in order for the spectacular but remote Empakaai Crater (Frame 1982). Olmoti Crater like the other craters has in the past been an important dry season grazing and watering area of Maasai livestock. It is little used by wildlife. Pastoralist livestock were originally banned because of feared *Eleusine* encroachment, but the tussock grass is spreading despite two decades without livestock grazing. Unlike the other craters there is little reason to continue to restrict access to Olmoti and strong reason to open it again to Maasai use.

(d) Subsistence hunting

The Maasai traditionally have little interest in hunting wildlife; they may eat certain species of wild herbivore only in times of severe famine, and value few trophies other than those from rare hand to hand combat with lions, or occasionally elephant and rhino (Makacha, Msingwa and Frame 1982 quoting Fosbrooke 1972). The Dorobo hunters of Maasailand have dwindled to virtual extinction (chapter 3). To the north, west and southwest NCA borders on the Serengeti Park, Loliondo GCA and Maswa GR (Fig. 2.1). The extreme southwest corner faces Sukumaland in the Kakesio/Maswa area. WaSukuma and Walkoma people are hunters and poaching is common in this zone. Meat poaching is increasingly big business, leading to organised destruction of ranger camps. Some observers suggest that wildebeest snaring in the west may be beginning to affect population size. The eastern and southeast borders of NCA adjoin areas of Mbulu cultivation and settlement. The WaMbulu are separated from the major wildlife concentrations by the Northern Highlands Forest reserve, but again they are traditionally hunters and meat eaters, and the forest fringes are reportedly heavily hunted for

buffalo, bushpig, and bushbuck. There is considerable concern among conservationists over poaching in NCA, mostly on the Maswa GR border, elephant and rhino in the forest, and rhino poaching in the Crater (Makacha, Msingwa and Frame 1982). There are, however, two different classes of poaching, with quite different implications for conservation, which should be managed in completely different ways. These are firstly small-scale hunting (mainly for antelope meat and skins) and secondly commercial poaching (particularly of rhinos but also for elephant).

The original purpose of wildlife protected areas in Maasailand such as the Serengeti Closed Area and the Southern Reserve in Kenya was to control increasing trophy and meat hunting by settlers and tourists. Following excision of NCA from the Serengeti National Park, planned trophy offtake continued. NCA comprised two hunting blocks with set annual quotas (Table 7.3; Rodgers and Nicholson 1973). The full quota was not taken for many species, although there was concern that blackmaned lions were being enticed from the adjacent park by baiting. In 1973 all sport hunting in Tanzania was stopped. It is interesting to compare current estimates of subsistence poaching offtakes in the Endulen Zone of NCA (Makacha, Msingwa and Frame 1982) with the

Table 7.3 *Current poaching offtakes compared to 1970s set quotas for tourist hunting for NCA*

Species	Oct. 1978	Oct. 1979	Tourist quota per block[a]
Buffalo	2	1	20
Dikdik	1	1	?
Duiker	—	—	++
Eland	4	2	5
Giraffe	1	3	—
Grant's gazelle	—	—	24
Hartebeest	—	—	12
Impala	5	—	20
Leopard	—	—	4
Lion	—	—	4
Steenbok	—	—	++
Thomson's gazelle	—	—	36
Warthog, etc.	—	—	++
Zebra	8	5	30
Fischer's lovebirds	—	60	—

[a]*Source:* from Rodgers and Nicholson 1973; ++ = hunting permitted, no set quota; — indicates none found poached (columns 1 and 2), hunting not licensed (column 3).

earlier set quotas for Ngorongoro Hunting Block II (equivalent to the Endulen Zone - Rodgers and Nicholson 1973; table 7.3).

The recent survey was unable to quantify rates of offtake: the carcasses found probably represent individuals taken during a period of several months, and are unlikely to cover all poaching that had taken place. Smaller animals will be particularly under-represented as they may be removed whole leaving no carcass. However, the results indicate that elephant and rhino apart (see below), offtake by local hunters is either similar to or considerably less than those originally designated as sustainable quotas.

The whole issue of subsistence hunting, its conservation implications and its classification as poaching is coming under review in Africa (chapter 11) and in the Serengeti/NCA region (Malpas and Perkin 1986). Conservation in Africa may be viable in the long term only if conservation resources can be used by the local community, which commonly bears many of the costs of wildlife conservation, but few of the benefits (Bell 1987). Subsistence hunting in NCA carries little threat to conservation values, but could represent substantial cultural and economic benefits to several groups. A number of projects elsewhere in Africa are trying to devolve responsibility for controlled wildlife exploitation (as well as for wildlife conservation) to local communities (Martin 1986, Abel and Blaikie 1986). A recent IUCN study of East African antelopes suggest this sort of wildlife exploitation should become more general as part of an integrated and long-term conservation approach (East 1988). Possible future developments along these lines are discussed in greater detail in chapter 11.

(e) Commercial poaching: rhino and elephant

Aerial survey recorded a live elephant:carcass ratio 1.8:1 over the whole Arusha Region in 1979 (i.e. 36% sightings were of dead animals – Ecosystems Ltd 1980:57). Similar surveys in Serengeti suggests 13% dead in 1977 and 38% dead in 1984 (Dublin and Douglas-Hamilton 1987). These figures suggest extremely high poaching mortality (Douglas-Hamilton and Hillman 1981). The inference of high poaching pressures is borne out by the 1970–1980s crash in rhino numbers. While the NCA forest provides some refuge for elephant, it has not been properly monitored or patrolled and it is likely that the NCA population has suffered a proportional decrease similar to that of neighbouring areas.

During their two surveys Makacha, Msingwa and Frame (1982) found a cumulative total of eight elephant and four rhino carcasses in the Endulen zone of NCA. By contrast, during the same surveys 41 rhino and 12 elephant carcasses were found in the adjacent eastern half of the Maswa Game reserve.

The Maswa Reserve has more wildlife that the Endulen zone and poachers are evidently more active there. However, conservationist concern has focused on the future of rhino in NCA where their decline embodies events throughout the species range.

Ngorongoro at one time had two of the densest black rhino populations in Africa: around Olduvai Gorge, and in the Crater itself (Goddard 1967) as well as throughout the forest, higher bushland, Ndutu, Eyasi scarp and the woodland fringes of the plains. Poaching in the 1970s reduced the population of some 300 animals to a present-day total of about 50 in the whole NCA, with none at Olduvai or in the plains. In the Crater where once there were 110 animals there are now 29.

Episodes of rhino poaching are not new in NCA. Conservancy–pastoralist confrontation led to 31 rhinos being speared in NCA in 18 months 1959–60, and a further 12 in 1961. These figures should be compared to the total of 17 taken over the preceding seven years 1952–1959 and (after the 1959–61 outburst) three per year 1962–1967. It was after this that Goddard counted 110 animals using the Crater floor, including some 70 permanent residents and 25 using Lerai Forest alone.

In the 1970s political and economic instability throughout Africa and the search for exportable forms of wealth led to a dramatic rise in the price of ivory and rhino horn. There was an upsurge in ivory and rhino poaching throughout Africa (Bradley-Martin 1979; Hillman 1981, Western and Vigne 1984). Borner (1981), Makacha, Mollel and Rwezaura (1979), and Makacha, Msingwa and Frame (1982) give detailed analyses for Tanzania and the Crater rhino respectively. In 1978 at least 25 were shot by non-Maasai commercial poachers (Borner 1981). Kiwia found five of his animals poached during his study of Crater rhino home range patterns 1980–1982, and estimated 25 rhino left alive in the Crater at the end of his project. The 1987 NEMP aerial survey counted nine in the Crater, suggesting a corrected figure of some 15–20 animals (Borner 1981). In 1989, 16 animals using the Crater floor and walls can be individually recognised.

Fosbrooke (1972) believed the NCA Maasai deterred such poaching by providing information, acting as informal patrols and helping in pursuit. They probably also limited agricultural encroachment and subsistence hunting, although outside the NCA Maasai presence has not deterred the growth of large-scale commercial poaching over the last 30 years (e.g. in Longido and Natron areas – Rodgers 1981a). Within NCA, conservancy – pastoralist tensions have reduced former anti-poaching cooperation. More importantly, the enormous rise in value of ivory and rhino horn means poachers are no longer local and subsistence level. They are now sophisticated operators,

armed with modern automatic weapons, working in large gangs across international borders. A number of field staff in northern Tanzania including NCAA have been killed in encounters with such groups. Some Maasai may have become involved with poaching gangs as guides and hunters. There are on the other hand frequent suspicions that NCAA staff may also have been involved. It is certainly the case that what in early times had been a disciplined, highly motivated and well-equipped ranger force in NCA has deteriorated as have infrastructure, roads, patrol posts and the tradition of regular foot patrols. Injections of equipment and funds have done nothing to improve this. Continuous telescopic watch with radio contact from the Crater rim and round-the-clock vehicle patrols on the Crater floor have not prevented rhino being taken in daylight.

The NCA rhino population is still biologically significant. With the adjacent forest there may be a total of around 30 – perhaps the largest single population in northern Tanzania. Rhinos appear to be genetically rather homogeneous: the white rhinos of Southern Africa are all descended from fewer than a dozen individuals at the beginning of this century and NCA still has a potentially viable breeding population. However, the current economic incentive to poach, together with the prevalent ill-will between NCAA and pastoralists, and the inefficient ranger force, makes the future of the rhinos and elephant doubtful at best. New policies of cash reward for poaching convictions may stimulate effective anti-poaching. They may also generate cases of false evidence, and further alienate local people. Currently (in September 1990) poaching is said to be on the decline. Rhino numbers using the Crater are up to 29; elephant are to be seen in the Crater, in the forest and at Lake Ndutu. Anti-poaching inputs must develop alongside education and extension services to be effective. Chapter 11 discusses some of the more radical solutions that have been proposed for systems of conservation elsewhere in Africa – such as licensing of ivory hunting and its regulation by the local community (Bell 1987; chapter 11) – despite international agreements designed to terminate the ivory trade.

Summary and Conclusion

The world-famous wildlife community of the NCA/Serengeti rangelands is dominated by migratory ungulates. Their populations have fluctuated over the last few decades and in some cases shown dramatic increases. In the long term, wildlife population impacts interact with changes in pastoralist herd presence to contribute to natural fluctuations in woody vegetation cover that are as or more important than purely anthropogenic effects.

Management of the wildlife resource is still purely *ad hoc*. There are no wildlife management plans, or overall policies. All inputs are directed towards

should be acknowledged and enlisted in support of conserving wilderness areas, not denied so as to generate anti-conservation feeling and action.

Current illegal subsistence hunting in NCA carries no threat to conservation values (chapter 7). In theory it should be possible to legalise, license and thus control subsistence hunting in a number of peripheral zones in NCA. Bell (1987) and Martin (1986) discuss projects of this sort designed to bring both conservation and wildlife utilisation back to community level in Malawi and Zimbabwe, and the Tanzanian Government is preparing detailed plans for similar schemes in village lands around wildlife areas such as the Selous Game Reserve. While some zones of NCA should remain sacrosanct (such as the Crater and plains) other parts such as the Endulen–Kakesio zone and the Forest Reserve might benefit from the higher level of patrols, and from Maasai cooperation in control of licensed hunting. This would only follow if the NCA Maasai perceive genuine gains from the issue or use of hunting licences, but it could mark a return to the kind of anti-poaching cooperation described by Fosbrooke as operating between Maasai and NCAA in earlier times.

(c) Trophy hunting

Bell (1987:93) feels that not only subsistence hunting, but also ivory hunting should become the legal preserve of the local community. He calculates that by making the trade legal both the hunters and the conservation agency benefit economically, and the local community has a strong incentive to police the area. With their tradition of roving *murran* groups the Maasai could patrol very effectively, while the rangers (with current low pay, low prestige and low morale) do not. However, given the conservation status and symbolic value of rhino and elephant it is perhaps unlikely that such a system could or should be operated in NCA. New Convention on International Trade in Endangered Species (CITES) agreements governing exploitation and trade preclude organised ivory hunting. Trophy hunting for other species should nonetheless be given consideration, and the Malawi parallels described by Bell (1987) should be monitored and evaluated carefully. The future of conservation areas throughout Africa generally will come to depend more and more on the extent to which the local communities can enjoy both tangible and intangible values associated with the area (Bell 1987), and NCA is no exception.

Integrating land use in NCA

Several forms of land use in NCA have now been considered. The demands made on resources by pastoralism, wildlife viewing by foreign and local people, commercial and subsistence harvesting of wildlife for meat, and ivory hunting have all beeen described, as have their potential economic and ecological results. Some forms of land use are clearly incompatible with successful conservation in NCA, most notably large-scale cultivation (see chapters 9, 10) and current levels of ivory poaching. However, of the range of land uses that NCA can support, what is the best combination and compromise? Which are likely to be mutually compatible, or even to reinforce one another's success?

Wildlife viewing is generally accepted as fully compatible with conservation. However, foreign tourism may not be sufficiently reliable in NCA to justify exclusion of other forms of land use from areas other than the craters. Local tourism is vital for conservation awareness and must be developed, but has been severely limited by constraints of finance, transport, accommodation and traditions of leisure pastimes. Money is now available in NCAA to establish a base for Tanzanian tourism and conservation education. Wildlife harvesting for meat is not practicable or desirable on a commercial scale. However, subsistence hunting for meat if regulated could be not only compatible with but even a potential incentive for wilderness conservation and anti-poaching vigilance by the Maasai. Trophy hunting could be feasible in some areas, for example Endulen. Pastoralism is highly compatible with wildlife and wilderness conservation. Small scale cultivation of boma scars by pastoralists if regulated could be both compatible and desirable in terms of easing dry season subsistence. Large-scale cultivation by contrast excludes wildlife completely as well as bringing about quasi-permanent loss of natural vegetation, especially woodlands, and must be prohibited.

The conclusion that emerges is that wildlife conservation and pastoralism must continue to coexist as the central forms of land use in NCA. Despite areas of conflict they complement and reinforce one another's claim to NCA resources. Conservation has long-term and global-scale worth; wildlife tourism has short-term financial profit; pastoralism has both immediate and lasting local returns. All three dictate – and justify – the exclusion of large-scale cultivation. Hunting and cultivation on subsistence scales could and perhaps should be planned for buffer zones in consultation with the pastoralist community. Given that pastoralism must remain a central form of land use in NCA, and that NCA Maasai do currently face considerable subsistence problems, the next chapter goes on to look at possible technical interventions that might be both compatible with conservation and desirable in terms of raising productivity and easing subsistence.

Conclusion

With the synthesis of NCA conservation aims, Maasai land use and more general development processes that this book sets out, it is unthinkable