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9

ILLEGAL EXPLOITATION OF WILDLIFE

E.J. Milner-Gulland and Nigel Leader-Williams

Utilization of wildlife

Wildlife utilization takes several forms. Legal forms, such as ranching, tourism and community-based development, have been dealt with in other chapters. Here we look at the illegal utilization of wildlife. "Illegality" in most circumstances implies both irregularity and immorality. With regard to the exploitation of wildlife, this may not be the case, for the traditional use of wildlife by subsistence hunters often breaks wildlife laws imposed by outsiders. In terms of the quantity of the resource used and the economic value of the industry, illegal hunting is probably the most important and widespread form of wildlife utilization throughout much of Africa. For example, in the wildlife-rich country of Tanzania it has been estimated that around 60 per cent of wildlife utilization is illegal (ITC/IUCN, 1988).

In broad terms, there are two distinct elements to illegal utilization. First, traditional subsistence hunting, where products are used mostly for local consumption. Second, larger-scale commercial hunting, where products are bartered or sold further afield, often in the international market-place. Both forms have been practised traditionally for centuries, as shown, for example, by remains of animal kills in archaeological sites or the long-standing trade in ivory between Africa and the Far East. The right to practise these forms of utilization went largely unquestioned until this century, when laws establishing protected areas and limiting the use of wildlife were passed.

Wildlife laws in Africa were usually first passed by alien colonial administrators (Graham, 1973; Marks, 1984). Laws often resulted in the enclosure of land in attempts to form pristine areas of wilderness. Local people were evicted to new areas, often without compen-

sation for the loss of property, title and traditional hunting rights. In the eyes of local people, colonial wildlife officers favoured the protection of animals over the welfare of humans living around the newly created protected areas. This problem was particularly acute because, by then, most wildlife remained on marginal agricultural land whose occupants were poorly integrated into the mainstream economy. Such disenfranchisement occurred throughout much of Africa, on the assumption that conservation was equated with land use restrictions, although there were regional differences in the extent of the restrictions. For example, cattle-herding Masaai in East Africa were allowed to continue their traditional use of wildlife land for water and grazing, but local hunters living in tsetse-infested areas of Zambia, where cattle herding is impossible, had their traditional rights more severely curtailed.

This chapter examines both subsistence and commercial illegal hunting and their impact on the wildlife resource. The strategies that are needed to conserve the resource and bring the profits of utilization into the mainstream economy are discussed. We use the hunting of rhinos and elephants in the Luangwa Valley, Zambia, as our case study.

Background – the recent history of the Luangwa Valley

The Luangwa Valley has a fairly typical history among protected areas (PAs) in Africa. The four national parks (NPs), with an area totalling 16,660 sq. km, were originally established as game reserves in the colonial era. The local inhabitants, who had previously used the area's products both for subsistence (meat, firewood, honey) and trade (ivory, rhino horn), were evicted. People were allowed to remain in seven sparsely inhabited hunting areas, totalling around 46,300 sq. km, that border on the reserves, but were subjected to game and gun laws and to licence quotas set to protect wildlife. Both reserves and hunting areas were managed increasingly for the benefit of outsiders, chiefly tourists and safari hunters, and earnings from wildlife went largely to central government and the private sector. Apart from two far-sighted exceptions where revenue-sharing schemes were established, local residents, denied access to resources that were previously under their control, became increasingly impoverished and resentful (Marks, 1984; Abel and Blaikie, 1986).

After independence in 1972, Zambia established NPs over 9 per cent and game management areas (GMAs) over 22 per cent of its surface area. At that time, Luangwa Valley held large populations

of elephant (100,000) and black rhino (between 4,000 and 12,000). However, Zambia's economy then began to decline because of falling copper prices and although central government spent quite heavily on conservation, the amount was low in relation to the vast areas under protection. Consequently, park infrastructure and law enforcement began to collapse. By the late 1970s, Zambia's internal socio-economic problems, coupled with dramatic price increases of ivory and rhino horn on the world market, had resulted in a serious outbreak of poaching in Luangwa Valley (Western and Vigne, 1985; Douglas-Hamilton, 1987).

By the mid-1980s elephant numbers were reduced by 75 per cent to around 25,000 and rhinos to probably a few hundred. Profits from this slaughter went not to the Zambian mainstream economy, but elsewhere – the smallest share to local poachers, a larger share to members of organized gangs who killed and extracted horn and ivory from animals within the parks, and the largest share, including foreign exchange, to middlemen who smuggled the trophies out of Zambia. The slaughter provided little direct benefit to Luangwa residents, because most of the organised poachers came from areas bordering onto, but outside, Luangwa Valley (Leader-Williams, Albon and Berry, 1990).

In late 1979 an anti-poaching operation was set up, funded in part by the Zambian government. The following year an external conservation agency donated a relatively large sum in conservation terms (half a million US dollars over three years) to the operation. The government bought vehicles and mobilized staff into units that undertook regular foot patrols in important areas with the aims of arresting poachers and protecting rhinos and elephants. In spite of this protection, the elephants and rhinos still declined rapidly in numbers. Clearly law enforcement was not adequately deterring poaching.

Illegal exploitation as an economic activity

The effects of law enforcement on poaching rates can be examined in detail for the Luangwa Valley because the anti-poaching patrols kept detailed records of all interactions with poachers, showing the number of hunters and carriers in the gang, the number and type of firearms and trophies with them, and the number arrested. There are also details of the subsequent sentencing of the gang members (Leader-Williams et al., 1990). These data allow the effects of law enforcement to be included accurately in the costs that a poaching gang incurs when hunting. A model of a poaching gang's incentives to hunt was produced using this information. It was used to explore

the effects of changes in the probability of being caught and in the penalty received on a poacher's decision to hunt (Milner-Gulland and Leader-Williams, 1992).

In the Luangwa Valley, the elephant and rhino stocks are now so low that the government's main objective is to prevent further large-scale exploitation. Thus the poachers' incentives must be altered in order to make it uneconomic to poach. This could be done in several ways. First, on an international level, the demand for trophies could be reduced. There is still controversy over whether the best way to achieve this objective is to ban the ivory trade or to promote a more regulated legal trade (ITRG, 1989; Barbier et al., 1990). Second, the cost of poaching could be raised by increasing the wages that an employee could gain elsewhere, either in the economy as a whole or in the Luangwa Valley area. Third, penalties could be made more severe so that hunters must be paid more in order to persuade them to risk capture.

A wildlife authority with a budget to spend on law enforcement has the option to increase the probability that a gang will be caught. It can also press the courts for an increase in the penalty that a captured poacher faces. Both changes feed into the costs of the poaching operation in a rather different way to straightforward increases in the cost of mounting a poaching operation, and it is these two options that we examine in more detail.

The structure of the poaching industry

There is a very clear difference between the types of poacher encountered. On the one hand, there are local people, who use their area of Luangwa Valley for subsistence hunting. For them, meat hunting is a traditional and cultural necessity in an area where domestic stock cannot be herded because of the presence of tsetse fly (Marks, 1976, 1984). They hunt mostly in the GMAs, in small gangs, and stay close to home, usually only going out for one day at a time. They use primitive firearms such as muzzle loading guns, as well as spears, snares and dogs. Although they mainly hunt for meat, they will occasionally kill an elephant or rhino. On the other hand, there are organized poaching gangs that usually contain two professional elephant and rhino hunters with automatic weapons and about six carriers. The gangs penetrate deep into the NPs, and are out for several days. It is this type of gang that can reduce elephant and rhino populations most seriously. The members of the gang come not from within Luangwa Valley, but from above the escarpment to the north and west of the valley, next to the Great North Road, so

that transport is excellent. Their trophies can quickly be removed by middlemen and exported (Leader-Williams et al., 1990).

Any action to reduce incentives to hunt will affect these two gang types very differently. The gang types vary both in the costs and prices they face and in the structure of the industry within which they work. The local gangs are exploiting a tribal resource over which no one now has control, apart from the limited capability of the wildlife authority, so that anyone is free to exploit it. The organized gangs are employed by middlemen, who organize poaching activity along with other similar activities. Ivory and rhino horn are often discovered with other contraband such as drugs, gems and electrical equipment. There are relatively few middlemen, who effectively control the exploitation of the wildlife resource. There is evidence that a single dealer controlled most of the hunting in Luangwa Valley. The organized part of the poaching industry is probably operated by this dealer much like any other business with exclusive rights in its territory.

The incentives to poach

In order to understand how changing rates of detection and penalties affect the poacher, the economic context of the poacher's decision must be taken into account. The two distinct groups of poacher, local and organized gangs, must both be deterred. The local hunters have relatively low hunting costs, since most are self-employed farmers who earn little from their work. However, the price that a trophy fetches is also relatively low, because rather than being employed by a dealer, the hunter must try to sell his trophies to the dealer. By the 1980s, the density of elephants in the GMAs was quite low, and of rhinos was very low indeed, and so the chances of a local hunter coming across either in a hunt specifically intended to kill elephants or rhinos were small. Even if a herd of elephants was encountered, a gang with a single muzzle loading gun could only shoot one and the gun is so unreliable that there would probably only be a 50 per cent chance of killing it (Marks, 1976). Even without the chance of being caught and incurring a penalty, the economics were such that in 1985 the small cost of mounting a special expedition to kill rhinos or elephants outweighed the probable returns. Thus it was not worth hunting elephants and rhinos simply for their trophies. Box 9.1 shows the economic decision faced by a local hunter.

The penalty if caught is significant compared to the low costs and prices obtained by local poachers and so further militates against hunting specifically for trophies. However, a local hunter is

primarily concerned with meat, and if he happened to encounter an elephant or rhino while out hunting other game, it would be worth killing for its large carcass with the added bonus of ivory or horn. Thus the model confirms what is seen in the Luangwa Valley – local gangs are caught primarily with meat, but also with the occasional elephant and rhino trophy.

The story is very different for the organized gangs because the dealer has exclusive rights over the territory and so can control the speed at which the animals in it are harvested. He may want to harvest less today in order to invest in the resource for the future. This decision depends upon two main factors. The first is the growth rate of the asset. Elephant and rhino populations grow rather slowly. An elephant population will grow at up to 6 per cent per year, a rhino population at up to about 11-16 per cent per year. The growth rate is fastest at low population sizes. The second factor is the weight the investor gives to future earnings as compared to earnings today. In Africa, the future is discounted at a high rate due to factors such as political uncertainty and the high lending rate.

A local poacher makes a decision to hunt or not at a particular moment, ignoring the future because the resource may not still be there. Because the dealer has sole control over his assets, he will try to maximize their value over time. The best way to do this is to hunt as hard as possible until the asset, in this case the elephant or rhino population, reaches an optimal level. Then as the population grows, he will remove the increase in population size each year. The optimal level of the population depends on how much present income is preferred to future income. A dealer with no preference for the present over the future will reduce the population until it produces the maximum yield each year. In elephants and rhinos, this is at around 75 per cent of the maximum population size. If the dealer has high preference for the present, he will remove more individuals now, giving a lower sustained harvest later. This investment decision comes on top of the economic decision as to the level of hunting that maximizes short-run profits. Law enforcement affects the decision because the more a gang hunts, the more likely it is to be caught and a penalty imposed.

The dealer's costs and prices are much higher than those for the local hunter, and so law enforcement has less potential effect on his decision making. Elephants and rhinos are also more abundant in the national parks than in the GMAs, and the superior weapons used by the gang mean that most of any herd encountered can be killed. Thus the chances of finding and killing an elephant or rhino on an expedition are far higher for an organized than a local hunter. Longer expeditions and the presence of carriers also mean that a

single expedition can produce a large output. These differences meant that it was profitable for organized gangs to hunt elephants in Luangwa Valley.

Box 9.1: The economic decision faced by a local hunter

All the economic variables are in Zambian Kwacha and are for the situation in 1985. In 1985, K5.7 equalled US$1. A local hunter could earn K270 from the ivory of one elephant. Killing a rhino would earn him K670 for its horn. The cost of going on a hunting expedition was K14. The fine if the gang was caught was K500/hunter, plus the confiscation of the gang's trophies. There were usually two hunters, with one trophy between them. Each time a gang went out, it had a 5 per cent chance of being caught. For a local gang to find and kill an elephant, it had to go hunting on average 20 times, while to find and kill a rhino the gang would need to go out 9,600 times.

From these data, the expected profit from one expedition can be worked out. If the gang were hunting elephants, the expected profit would have been:

$$K270/20 \ K14 \ 0.05 \times (2 \times K500 + K270) = -K64$$
[Price/expeditions - cost - probability of detection x (fines + confiscation) = profit]

Thus a local gang would on average make a loss if it went elephant hunting. The loss if the gang was hunting rhinos would have been even larger. It was not worth a local hunter's while to go hunting specifically for elephants or rhinos. This is true even without the expected cost of law enforcement – the cost of mounting an expedition was K0.5 more that the expected revenue earned from it.

Source: E.J. Milner-Gulland and N. Leader-Williams (1992), "A model of the incentives for illegal exploitation of rhinos and elephants: poaching pays in Luangwa Valley, Zambia". *Journal of Applied Ecology 29.*

At the 1985 parameter values, the fate of Luangwa Valley rhinos was being determined by the incentives to hunt elephants. It was profitable for the organized gangs to go out specifically to hunt elephants, but not rhinos. However, as with the local hunters, if an organized gang happened to encounter a rhino, killing it would be very profitable, particularly since rhino horn is far easier to carry than ivory and so the number of elephants that could be killed would not decrease. The situation in the Luangwa Valley in 1985 was consistent with these findings: organized gangs were usually

found with ivory, but occasionally with rhino horn as well. Thus the profitability of ivory actually contributed to the decline in the rhino population, despite rhinos being too scarce to be worth hunting alone.**Box 9.2

The effects of changing the incentive framework

This case study has shown that illegal exploitation of wildlife can be the result of the predictable reaction of individuals to a given framework of economic incentives. It is important to know by how much the factors affecting a poacher's decision to hunt need to change to produce a marked change in the poacher's behaviour. For the local poacher, elephants and rhinos were scarce enough that the cost of the hunt itself was enough to deter hunting. Even if the price of ivory or horn doubled, it would still not be worth the local hunter's while to mount hunts specifically for elephants and rhinos. The opposite situation held for the organized gangs hunting elephants. Only if both hunting costs doubled and the price per kill was reduced fivefold would it be unprofitable to hunt, and it was only near these levels that the hunters became at all sensitive to changes in costs and prices. The rhino population was so low that their hunting was only incidental to elephant hunting (Milner-Gulland and Leader-Williams, 1992).

Changes in law enforcement were essentially irrelevant to local hunters, since the simple economic calculation would imply a decision not to hunt, although as discussed later, law enforcement has some bearing on whether or not elephants or rhinos are killed in a casual encounter. For the organized elephant hunter, law enforcement could have more impact, but the prices and costs involved in hunting were large enough that changes in the penalty or the risk of incurring it would have to have been very large for any effect to occur at all.

Detection or penalty?

There are two components to law enforcement, but they are rather different in their effects and in their costs of implementation. In the literature on crime in the United States, from which some lessons can be drawn, opinion is divided as to whether the severity of a sentence has a deterrent effect at all. The studies do agree, however, that the penalty level is less of a deterrent than detection rate (Ehrlich, 1973; Avio and Clark, 1978). Taking a severe penalty such as prison, an offender's perception of the severity of the sentence before it is delivered depends on how much he

Box 9.2: The economic decision faced by an organized hunter

All the economic variables are in Zambian Kwacha and are for the situation in 1985. In 1985, K5.7 equalled US$1.

A dealer could earn K2570 from the ivory of one elephant. Killing a rhino would earn him K4390 for its horn. The cost of going on a hunting expedition was K500. The fine if the gang was caught was K500 per hunter, plus the confiscation of the gang's trophies. There were usually two hunters, with one trophy between them. Each time a gang went out, it had a 5 per cent chance of being caught. On average, an organised hunting expedition killed 3.5 elephants, while seven expeditions were needed to kill a rhino.

The optimal population sizes for an organized poacher.

	Population size	
	Optimal	Actual in 1985
Species		
Elephant	8	77
Rhino	42	16

The table shows the optimal population sizes of elephants and rhinos for an organized hunter, based on the information above. These are given as percentages of the maximum populations that the area can hold. The actual population sizes of elephants and rhinos in 1985 are also given as percentages. The gang will hunt as much as possible if the population is above the optimal size, not at all if the population is below optimal and at the population growth rate if the population is at the optimal size. Thus the table shows that the organized gangs would have wanted to hunt elephants as hard as possible in 1985, and not to hunt rhinos at all until the population was larger. The differences in the optimal population sizes for the two species are due to the different expected revenues from an expedition – the expected revenue from a rhino hunting expedition is lower than that from an elephant hunting expedition.

Source: E.J. Milner-Gulland and N. Leader-Williams (1992), "A model of the incentives for illegal exploitation of rhinos and elephants: poaching pays in Luangwa Valley, Zambia", *Journal of Applied Ecology 29.*

values the present over the future and how far into the future he looks.

In Africa, there is a lot of uncertainty about the future, so people tend to value the present more than the future and not look far ahead. Thus a sentence of two years might look much the same as a sentence of five years when the poacher is deciding whether or not to go hunting. The expected number of years spent in prison is the same if a poacher has a 20 per cent chance of one year in prison or a 10 per cent chance of two years in prison. However, if things are valued less the further into the future you look, a 20 per cent chance of one year in prison will appear to be a worse option than a 10 per cent chance of two years in prison (Cook, 1977). Thus increasing the probability of a poacher being caught will probably be a more effective deterrent than increasing the penalty.

There is a further reason why it is appropriate to concentrate on detection rates rather than penalties. The courts are completely separate from the wildlife authority that is attempting to protect the wildlife resource, and do not always set the same priority on elephant and rhino conservation. In Zambia, concern about the loss of elephants and rhinos and ivory and horn trafficking led to the government introducing mandatory 5 to 15 year prison sentences for elephant and rhino offenders in 1982. However, even though magistrates tended to deliver more prison sentences to elephant/rhino offenders, not all received prison sentences after 1982 and they were usually very short. The maximum length given up to 1985 was three years. Magistrates also did not distinguish clearly between elephant/rhino offences and other offences in terms of the severity of sentences. The legislation to increase penalties was slow and difficult to enact and has been incompletely carried out (Leader-Williams et al., 1990).

What kind of penalty is best?

The detection rate is probably the major determinant of poaching activity, but the type of penalty given once the poacher has been caught can also have a major effect on the incentives to poach. The two forms of penalty that are commonly used to deter illegal exploitation of wildlife in African conservation areas are fines and prison sentences (IUCN, 1986). It has been argued that fines are a better form of penalty than prison sentences, because they act as a "tax" on illegal activity and a direct transfer payment from the offender to the victim, in this case the state, which has lost a valuable animal (Becker, 1968). Fines are also easier to administer than prison. In contrast, prison sentences incur large costs both to

the state and society and also to the prisoner, whose powers to earn legitimate wages may be seriously compromised by a spell in gaol. In the Luangwa Valley, the effectiveness of one or other type of penalty depends crucially on who suffers the penalty as opposed to who decides whether or not to hunt.

In the case of the local gangs, the hunters themselves are the decision-makers and also suffer the penalty. Because of this, and because they may have difficulty paying fines they are likely to be deterred by a fine. Local hunters are marginal offenders and so are likely to be easily turned from crime by the threat of a high penalty (cf. Thurow, 1980). If a differential were maintained between the penalty for entering a PA and killing game for meat and that for elephant and rhino hunting, this would deter local poachers from killing elephants and rhinos that they came across. A prison sentence might well be unnecessary, and would be a very severe penalty to a local hunter, having a serious effect on the welfare of his family since most are self-employed farmers.

Deterring organized gangs presents a far more serious problem. The decision-maker is the dealer employing the gang rather than the hunter in the gang, but the hunter is convicted. Confessions and evidence from the sentences delivered to poachers suggest that dealers often bought the acquittal of hunters with small fines while the more disposable and unskilled carriers were sentenced to prison. Therefore small fines for hunters were just part of the economic equation of ivory and horn trading, suggesting that much higher fines for hunters could act as a deterrent for the dealer. However, the size of fines delivered to hunters would require careful adjustment because they would only be effective as long as the dealer paid. If fines were set too high the dealer would allow the hunter to go to prison in default. Equally, delivering a prison sentence to an employed hunter probably would not deter the dealer from funding poaching until he ran out of skilled hunters. There might, however, be an increase in the risk premium needed to attract hunters into organized poaching if the sentences were perceived as severe, particularly if prison were involved. The ideal solution would, of course, be to deliver appropriate sentences to dealers in ivory and rhino horn, rather than to their employees.

There is one simple modification to the law enforcement structure that dramatically reduces the incentive to poach. At present, court records indicate that convicted poachers are penalized only for illegal hunting, not for the number of animals poached. However, if the fine paid were made proportional to the number of animals killed, then the optimal percentage of the population for the organized hunter to kill could have been reduced from

90 per cent to 2 per cent. This modification also penalizes the poachers who kill the most animals and so do most harm to the elephant and rhino populations. Making the fine larger for the more endangered rhino could also act to discourage opportunistic rhino killings.

A shoot-to-kill policy for poachers has been instituted by certain countries with prior political approval, initially Zimbabwe (Tatham, 1988; Tatham and Taylor, 1989) and latterly Kenya. The policy was never politically acceptable in Zambia because most poaching is carried out by Zambians (Leader-Williams et al., 1990). Elsewhere, however, illegal exploitation of rhinos and elephants has been carried out by nationals of other countries – Zambians in Zimbabwe and Somalis in Kenya. Crossing national boundaries with automatic weapons represents a threat to national security that, together with poaching, is deemed to merit such a punishment (Tatham, 1988). Wildlife managers have pushed for shoot-to-kill because it allows them to have sole control over law enforcement, circumventing lack of co-operation between ministries and particularly between neighbouring countries. However, it also sets an unacceptable precedent by imposing summary executions without trial. This undermines justice and human rights in the countries practising the shoot-to-kill policy.

Apart from the considerations of justice, there is evidence that the policy may not work. One disadvantage of a very high penalty is that although it may lower the overall level of crime, there is evidence that the level of serious crime may increase (Stigler, 1970). This suggests that a shoot-to-kill policy should not be applied to all poachers entering a PA, for then there is no incentive just to kill warthog as opposed to elephant or rhino, and no incentive to avoid killing approaching scouts. Thus local poachers may turn to serious crime if the punishment is applied unselectively. But are the serious poachers deterred by the death penalty? As yet no data are available to assess the situation in Kenya. In Zimbabwe, small gangs without carriers hunt for rhino horn, so the policy stands the maximum chance of success because a high proportion of hunters are killed. However nearly 300 rhinos were killed there between 1984 and 1987, despite 29 Zambian poachers being shot (Tatham, 1988; Tatham and Taylor, 1989).

How to achieve adequate detection

Given the importance of raising the probability of being caught as well as of deciding upon the most appropriate penalty, we now consider how the detection rate of offenders could be increased.

The key to effective deterrence remains simple in principle. It requires a wildlife authority that is well-manned and funded with motivated field staff. In Luangwa Valley the anti-poaching units were greatly understaffed, given the levels of illegal activity aimed at rhinos and elephants there in 1979-85. Field staff densities of at least around one per 10 to 20 sq. km of PA are needed to prevent the loss of valuable species in Africa (Leader-Williams et al., 1990). Indeed the highly successful mountain gorilla programme in Rwanda had staff densities of one per 2.5 sq. km (Harcourt 1986). Given that only 56 staff were available for the whole of Luangwa Valley during 1985, at densities of one per 300 sq. km of NP, it is scarcely surprising that very low detection rates were achieved and conservation measures for rhinos and elephants were unsuccessful.

The lesson here is that the infrastructure of PAs must be invested in if countries are to retain their natural resource base. As yet few countries earn enough from their PAs to be able to pay for their protection. In 1980 the total recurrent expenditure on conservation in the whole of Africa was around US$75 million per year, compared with US$167 million in 1979 for the United States alone (Morse, 1980; Bell & Clarke, 1986). Efforts in the USA to apprehend people hunting white-tailed deer in the closed season are sophisticated and have met with considerable success (Glover, 1982). Using an Africa-wide comparison of the success of different countries in conserving their rhinos and elephants, it was shown that a minimum of $200 per sq. km of recurrent expenditure was needed in the 1980s to prevent organized poaching (see Box 3) and with inflation and raised stakes, this has probably risen to $400 per sq. km today.

Such results illustrate a dilemma that will have to be faced increasingly in Africa. Poor countries that do not earn much from their wildlife resource often have large areas of PAs theoretically under protection, yet relatively few staff in national conservation agencies actually to undertake law enforcement duties. In different African countries in 1980, staff: area ratios varied from 1 per 580 sq. km to 1 per 7 sq. km (Cumming, Martin & Taylor, 1984; Bell & Clarke, 1986). In countries with low overall staff densities, such as Zambia, it is necessary for national conservation agencies and external funding bodies to make selective decisions about how much of their PAs and valuable species they can afford to patrol at effective staff densities. Although military tacticians and businessmen find no difficulty in concentrating effort and being selective when resources are short, this policy does not come easily to conservationists (Leader-Williams and Albon, 1988; Parker & Graham, 1989; von Clausewitz, 1976; Kraushar, 1985).

### Box 9.3: The economics of investing in protected areas

Background: Rhinos and elephants have shown marked overall declines throughout Africa. However, their numbers have increased in several countries, especially in the richer countries of Southern Africa. It has been suggested that an important factor in the overall decline in rhino and elephant numbers across Africa was a shortage of manpower and ultimately of resources within national conservation departments.

Results: This suggestion was examined on a local scale in Luangwa Valley. It was shown that effort expended by anti-poaching patrols was directly related to success in conserving elephants and rhinos. On a continental scale, gross population trends of both species vary between countries. There are wide differences between the amounts of money spent by central governments on protected areas. There is a relationship between spending and the rate of rhino population decline in a country (see graph). The countries with high rates of rhino decline spent less than $50 per sq km on their protected areas, while the countries with stable or increasing rhino populations spent at least $200 per sq km. Similar results were found for elephants. The exception to this rule was Kenya, which although it spent nearly $200 per sq km, had a high rate of rhino population decline.

Conclusions: From this evidence, the rate of decline of a species in a particular country seems to be related to the resources available for conservation in that country, although the exception of Kenya suggests that other factors also play a part. It is important to invest adequate funds in law enforcement if species are to be conserved.

Other options to increase patrol coverage within PAs might include reducing patrol size, increasing time spent in the field, or using helicopters or aeroplanes. All these options require increased infrastructural input, the first needing well armed and trained patrols with effective logistical support, the second needing better servicing, provisioning and pay arrangements for staff, and the third needing good vehicular and mechanical support (Bell, 1986; Tatham, 1988). Unfortunately, all three options are less readily affordable or available in poor countries already in a state of infrastructural collapse. Perhaps the most effective option to raise detection rates in Africa is to make more arrests outside PAs (Bell, 1986b; Tatham, 1988). However, this still requires sufficient staff to achieve a balance between gathering intelligence information

Figure 9.1: The relationship between conservation spending and change in black rhino numbers between 1980 and 1984, for various African countries.
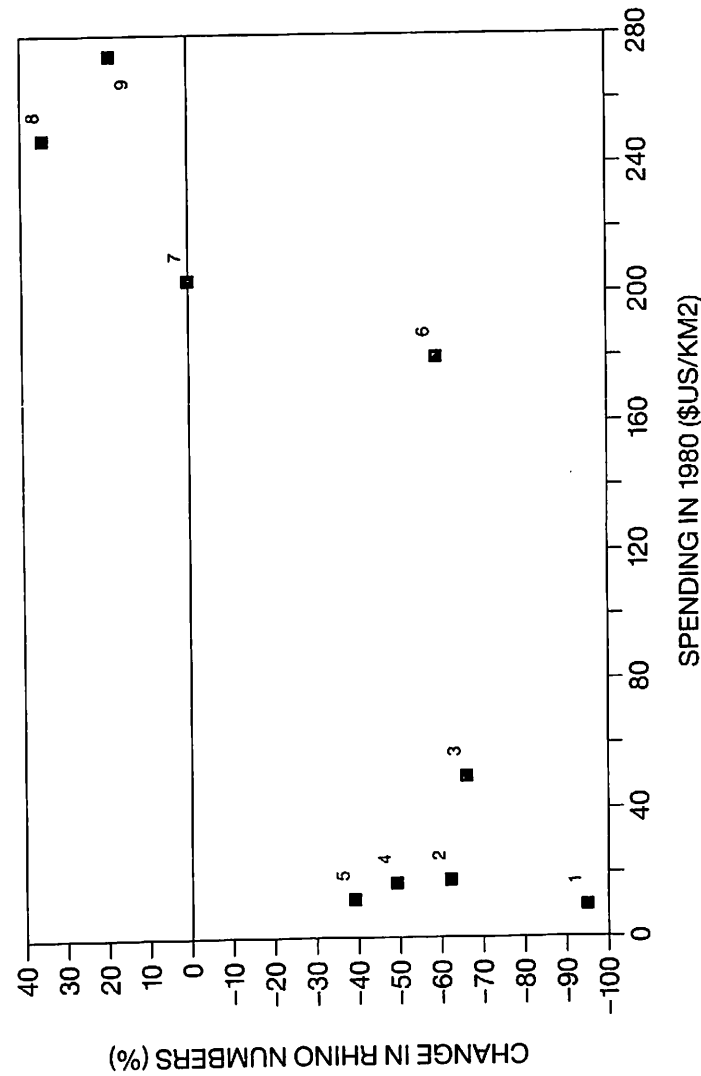
Note: 1 = Central African Republic; 2 = Tanzania; 3 = Somalia; 4 = Mozambique; 5 = Zambia; 6 = Kenya; 7 = South Africa; 8 = Namibia; 9 = Zimbabwe.

Source: N. Leader-Williams and S. Albon 1988. "Allocation of resources for conservation". *Nature* 336, 533-5.

from captures made within PAs and mounting police-style operations, often in conjunction with other law enforcement bodies, to achieve arrests of organized poachers, and possibly even the all-important dealers, outside the PAs. This balance is made very difficult if there is a high level of corruption and little political or local support for conservation.

Local involvement in resource management

Increasing the opportunity cost of poaching through increasing legitimate earning potential within PAs presents a politically appropriate solution that is within the power of an enlightened wildlife management authority, and the most likely to gain popular support for conservation. Local hunters are marginal elephant/rhino offenders, who are hunting meat illegally because meat hunting is a traditional and cultural necessity. If hunting carries a penalty whatever the species, then there is no barrier to elephant and rhino hunting. If meat hunting by locals without a licence were better managed or even legalized, the decision to poach elephants and rhinos would become more clear cut.

Projects that give some responsibility for management decisions, return some of the proceeds of safari hunting and tourism to local people and secure jobs locally have been very successful. The CAMPFIRE project in Zimbabwe is an excellent example (Martin, 1986). A similar project in the GMAs of Luangwa Valley has caused a reported drop in illegal activity, because local people have received revenues from the PA and have been employed to supplement law enforcement efforts. Thus local poachers are no longer helped or tolerated (Lewis, Kaweche and Mwenya, 1990).

Improvements in legitimate earning potential for organized gangs living outside the PAs of Luangwa Valley are harder to achieve because they cannot be included in community-based conservation schemes as easily. Neither can the reduction of economic incentives for hunters to enter a dealer's employment be achieved by increased wages, given Zambia's declining economy. Thus the only chance of increasing the effective wage rate of hunters is to increase the perceived risk of poaching and so impose a large risk premium on the dealer.

How best to reduce poaching?

We have concentrated on the Luangwa Valley but there is a serious poaching problem in many African PAs. For example, buffalo numbers in the Serengeti in Tanzania are now limited by poachers

supplying local meat markets (Dublin, et al., 1990). The themes discussed here are relevant to many areas where the main concern is not traditional subsistence hunting, although it may contribute to the decline of already endangered species, but large-scale commercial hunting.

Local hunters could easily be deterred by fairly small penalties. They are particularly suited to local involvement schemes and the return of some dividend from the resource that was once theirs. Hunting for meat is their main objective when entering PAs and better regulation of legal meat hunting could stop the hunters killing trophy species. Community involvement schemes have shown a reduced poaching rate by locals who feel that they now have some stake in the preservation of the resource.

Organized gangs present a less tractable problem, since the dealer who decides the level of poaching is sheltered from law enforcement, and treats the penalties imposed as simple costs to be borne. Our analysis showed that in Luangwa Valley the profits to be made out of ivory were such that neither the costs of labour nor fines were significant in reducing hunting mortality. This is likely to be true for other wildlife products and other areas. If law enforcement is to be effective, the dealers need to be convicted rather than the gang members. However, a high perceived risk of detection and a serious penalty could make the risk premium added to the hunters' wage high enough for the costs of poaching to rise significantly.

There are other ways of reducing poaching rates such as effective demand reduction by end-users, either nationally or in importing countries, or a well-regulated legal trade lowering the price for illegal trophies. However, until these kinds of system can be instituted, illegal exploitation will continue to be an important form of utilization in most of Africa's PAs, and law enforcement the only means of combatting it. Given that resources for conservation are limited and a high detection rate is the best way to deter commercial poaching under these circumstances, the wildlife manager's best short-term strategy seems to be two-pronged. Local involvement schemes give local people a share in the proceeds from the exploitation of their resource and create a political climate favourable to conservation. At the same time, high levels of law enforcement concentrated on the areas of key biological importance reduce commercial poaching in those areas. Thinly spread patrols have a detection rate low enough to make no difference to the commercial poacher, and are thus a waste of precious resources (Leader-Williams and Albon, 1988).

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ECONOMICS
FOR THE WILDS

Wildlife, Wildlands, Diversity and Development

Edited by Timothy M. Swanson
and
Edward B. Barbier

1992