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Chapter 9

Regulation and Protection: Successes and Failures in Rhinoceros Conservation

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LIVING RHINOS AND USES OF THEIR HORNS

There are five living species of rhino, but only just. Three species, Sumatran, Javan and Indian rhinos, occur in Asia while two species, black and white rhinos, occur in Africa. Rhinos are now among the world's most endangered large mammals. Two Asian species, the Javan and Sumatran, and one African species, the black rhino, are critically endangered (Table 9.1). Several sub-species, including both sub-species of Javan rhino, the northern white rhino and the western black rhino, occur at such low numbers that they teeter on the edge of extinction. By contrast, the southern white rhino is currently well conserved in limited areas of its range in southern Africa, as is the Indian rhino in even more limited areas in India and Nepal. However, the total world populations of southern white and Indian rhinos are still only in the low thousands, and their continued long-term survival is by no means guaranteed (Foose and van Strien, 1997; Emslie and Brooks, 1999).

In global terms, the population of all species of rhino has probably declined from some hundreds of thousands in the early 1900s, to perhaps 75,000 in the early 1970s, and to some 13,000 based on the most recent published estimates (Table 9.1).

Historically, rhino numbers have declined for three main reasons. First, much habitat has been lost in the rainforests and flood plains of Asia, and in the grasslands of southern Africa. Second, legal hunting of rhinos, both to clear land and for sport, greatly reduced numbers of Indian, Javan, black and southern white rhinos early in the 20th century. Because of increasing moves to

Table 9.1 Estimates of Numbers of Different Rhino Taxa Alive in the Wild and an Assessment of their Status

Species	Status of species	Sub-species	Number in wild	Status of sub-species
White rhino <i>Ceratotherium simum</i>		<i>C.s. cottoni</i>	25	CR
		<i>C.s. simum</i>	8440	LR (cd)
Black rhino <i>Diceros bicornis</i>	CR	<i>D.b. michaeli</i>	485	CR
		<i>D.b. minor</i>	1365	CR
		<i>D.b. bicornis</i>	740	VU
		<i>D.b. longipes</i>	10	CR
Indian rhino <i>Rhinoceros unicornis</i>	EN		2095	
Javan rhino <i>Rhinoceros sondaicus</i>	CR	<i>R.s. sondaicus</i>	<60	CR
		<i>R.s. annamiticus</i>	<15	CR
Sumatran rhino <i>Dicerorhinus sumatrensis</i>	CR	<i>D.s. sumatrensis</i>	<230	CR
		<i>D.s. lasiotis</i>	?	EX
		<i>D.s. harrisoni</i>	<70	CR

Key to status

CR: critically endangered

EN: endangered

EX: extinct

LR(cd): lower risk (conservation dependent)

VU: vulnerable

Source: Foose and van Strien, 1997; Emslie and Brooks, 1999. Assessment of status according to the IUCN Red List Categories (Hilton-Taylor, 2000).

The Javan rhino sub-species *R.s. inermis* is now almost certainly extinct, and is not included

establish protected areas and to ban the hunting of rhinos, these are not now so important for rhinos in Africa. However, habitat loss is still an important issue for Asian rhinos, given the high human population densities in many areas of the continent. Third, as a result of high demand for rhino horns, unprotected populations of rhinos have been exploited unsustainably. The trade in their horn has largely been responsible for reducing them to their presently threatened status (Leader-Williams, 1992).

The international trade in rhino horn has a long history. The Chinese were recorded as using rhino horn as a medicine between 200 BC and 200 AD (Martin and Martin, 1982). During the Ming and Ching dynasties, the Chinese also carved rhino horns into beautiful cups, plates, bowls and figurines. However, westerners long believed that the main use of rhino horn was as an aphrodisiac, but this myth was debunked in the early 1980s (Martin and Martin, 1982). Some rhino horn might indeed be consumed as an aphrodisiac, but this is limited to use by the Gujaratis in India. Rhino horn has had two far more important uses in terms of volumes traded in recent times.

Horn and other rhino products such as blood, skin and urine, are important constituents in traditional medicines and potions used to reduce fevers,

headaches and other illnesses in the Far East. Such medicines are used primarily by the Chinese, but also by Burmese, Thais and Nepalis. In contrast, the Japanese and Koreans also learned to use rhino horn in medicines through early cultural links with the Chinese, but do not use other rhino products. Rhino horn is generally sold in the Far East in one of two forms, first as 'raw' horn by traditional pharmacists who make up the medicine for individual customers in their shops, and second as a constituent in manufactured medicines. Furthermore, 'Fire' (Asian) horn is believed more efficacious than 'Water' (African) horn and therefore Asian horn is considerably more expensive (Martin and Martin, 1982; Nowell et al, 1992). Thus both African and Asian rhino horn are used widely throughout the Far East both by indigenous people but particularly by the resident Chinese communities found in most Far Eastern countries (Martin, 1983). In addition, confiscations in Los Angeles, San Francisco and Brussels show that Chinese communities use rhino horn in medicines in Western countries.

Yemenis, by contrast, have used African rhino horn since at least the 8th century to make handles for traditional daggers, known as *jambias*. Daggers are important status symbols in the cultural life of Yemeni men. The advantage of rhino horn over other materials used for dagger handles such as water buffalo horn, is that rhino horn improves in appearance and lustre with age (Martin et al, 1997). However, the demand for horn in the Yemen varies greatly depending on the economic status of the country, which in turn is linked to oil prices, and on the availability of substitutes (Vigne and Martin, 2001).

APPROACHES TO CONSERVING RHINOS

Two main approaches have been followed over the past quarter century to prevent rhinos from being killed for their horns. The first approach has been the attempt to close or halt the international trade in rhino horn through regulation. The second approach has been the attempt to improve the protection of rhinos in situ (Foose and van Strien, 1997; Emslie and Brooks, 1999).

REGULATION OF INTERNATIONAL TRADE IN RHINO HORN

When CITES entered into force in 1975, rhinos and their products were among the first species to be placed on the CITES Appendices (Table 9.2). By 1977, all *Rhinocerotidae* were placed on Appendix I, therefore banning international trade in the whole family of rhinos and their products from that date.

Nevertheless, a large illegal trade in rhino horn continued during the 1980s and early 1990s (Leader-Williams, 1992). This is well illustrated for the more accurately estimated and formerly numerous black rhino, which continued to decline following its listing on CITES appendices (Figure 9.1). Indeed, its numbers plummeted from an estimated 65,000 in the 1970s to a low of 2,400

Table 9.2 Changes in Listing of the Rhinos on Appendices I and II

Year	Appendix I	Appendix II
1975	Sumatran rhino, <i>Dicerorhinus sumatrensis</i> Javan rhino, <i>Rhinoceros sondaicus</i> Indian rhino, <i>R. unicornis</i> Northern white rhino, <i>Ceratotherium simum cottoni</i>	Black rhino, <i>Diceros bicornis</i>
1977	Black rhino, <i>Diceros bicornis</i> Southern white rhino, <i>C.s. simum</i>	
1994		Southern white rhino, <i>C.s. simum</i> ¹

Note: 1 South African population for trade in live specimens and in hunting trophies only

over a period of 25 years. During this period, the species became locally extinct within at least 18 range states in Africa. The once numerous and wide-ranging Sumatran rhinoceros has probably undergone no less spectacular a rate of decline, but this has been less well documented due to the difficulty of counting this species in rainforest habitats. Nevertheless, even considering more recent estimates, it is suggested that Sumatran rhinos have declined from an estimated 600–1000 in the early 1990s, to perhaps 300 in 1995 (Foose and van Strien, 1997).

The failure of the Appendix I listing to prevent the decline of the global stock of rhinos stimulated further efforts from the parties through the adoption of resolutions (Wijnstekers, 1995). This series of resolutions (Table 9.3) plots a gradually changing philosophy to the international ban on trade in rhino products. Initial concern centred on the various major markets for rhino horn that occurred in countries such as Taiwan and Yemen that were not parties to CITES (Wijnstekers, 1995). As such, these countries were outside the controls operating on international trade in rhino horn. Furthermore, certain parties continued to sell stocks of rhino horn held by relevant government and parastatal wildlife authorities. Therefore, Resolution Conf 3.11 was approved in 1981 (Table 9.3) and called on nations that were not parties to CITES also to take measures to prevent the international trade in rhino products. Furthermore, the resolution called for a moratorium on the sale of all government and parastatal stocks of rhino horn, and required that any stocks should be recorded in annual reports to the convention. Subsequent to the adoption of this resolution, the illegal killing of black rhinos in Africa, and of Sumatran rhinos in Asia, continued unabated.

The obvious failure of Resolution Conf 3.11 prompted the adoption of Resolution Conf 6.10 in 1987 (Table 9.3). This resolution called for immediate, drastic and even stricter measures to be taken by parties to curb an illegal trade in rhino horn that had no respect for international boundaries. Furthermore, concern was also expressed at stockpiles of rhino horn held by respective authorities, which had stimulated theft and further horn entering illegal markets.

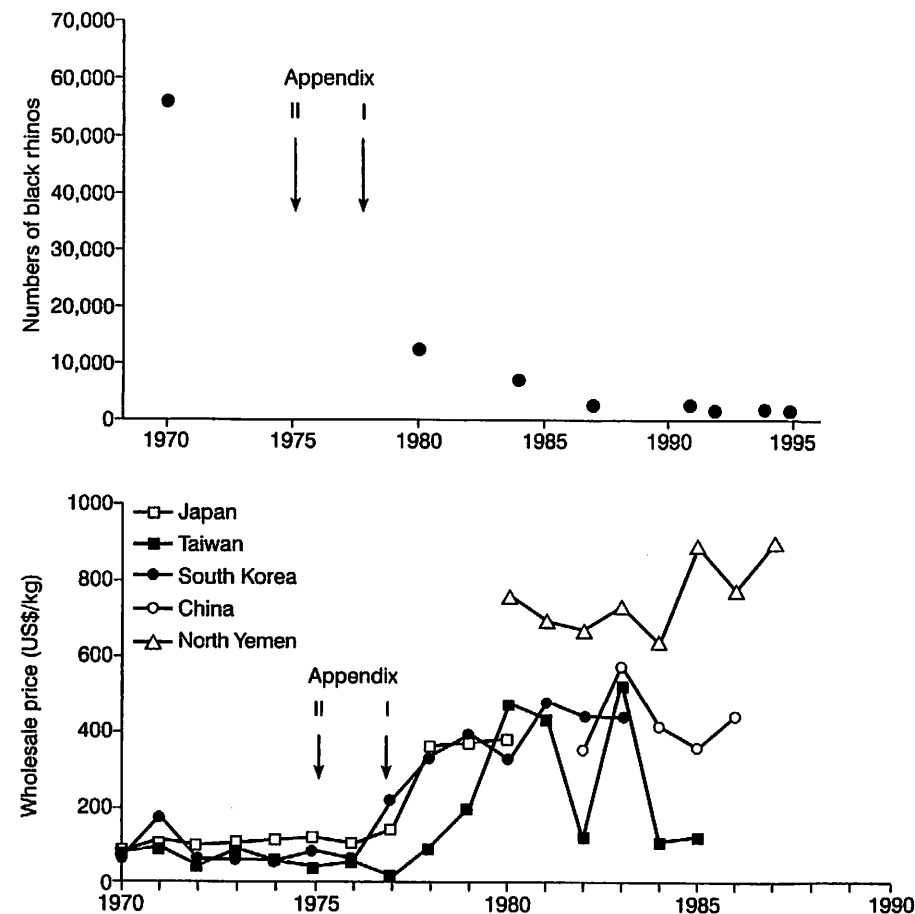


Figure 9.1 Continental Decline of Black Rhinos and Rise in Price of Horn in Consuming Nations

Therefore, Resolution Conf 6.10 urged all parties to completely prohibit all sales and trade, whether internal or international, in rhino parts and derivatives, particularly horn, excluding non-commercial movement of hunting trophies. Furthermore, all parties were urged to destroy all government and parastatal stock of rhino horn with supporting contributory funds from external aid sources to be used for rhino conservation in the state concerned. Other measures that were urged comprised: issuing instructions to all law enforcement agencies to be particularly alert to smuggling of rhino horn; to increase penalties for individuals and companies convicted of relevant offences; and, to take firm action against middlemen and poachers involved in cross-border poaching and trafficking of horn.

Because the 1981 resolution was being ignored by several countries, Resolution Conf 6.10 also recommended that parties use all appropriate means,

Table 9.3 Resolutions Adopted to Prevent further Loss of Rhinos

Resolution	Title
Resolution Conf 3.11	Trade in rhino horn
Resolution Conf 6.10	Trade in rhino products
Resolution Conf 9.14	Conservation of rhino in Asia and Africa

including economic, political and diplomatic, to exert pressure on countries continuing to allow trade in rhino horn. In other words, this resolution broke new ground by urging and recommending actions that were well outside the remit of the convention to regulate international trade. Nevertheless, many range states again ignored Resolution Conf 6.10, and did not destroy their stockpiles of rhino horn. Nor indeed was any compensation forthcoming to promote the destruction of stockpiles. Furthermore, several key consuming nations failed to implement domestic legislation to curb the rhino horn trade. Losses of black rhinos in Africa continued (Milliken et al, 1993), while illegal horn continued to be available in the market place (Leader-Williams, 1992).

By 1992, the governments of South Africa, Zimbabwe and Namibia began to express dissatisfaction with the international ban on trade in rhino products, and concluded that a controlled legal trade in rhino horn might be a better option. Both Zimbabwe and South Africa held considerable stocks of horn attained through seizures from traders, through collection of horn from dead animals, and in the case of Zimbabwe through dehorning operations undertaken to enhance the protection of rhinos. At the 1992 Conference of the Parties, South Africa proposed to down-list its white rhino population to Appendix II and Zimbabwe proposed to down-list both its black and white populations to Appendix II. These proposals were rejected. The dissatisfaction with the Appendix I listings generated further contradictory actions between the 1992 and 1994 Conferences of the Parties, and several major changes in direction at the 1994 Conference of the Parties.

Three main actions were undertaken between the 1992 and 1994 Conference of the Parties. First, the US government threatened four consuming nations with sanctions under a piece of domestic legislation known as the Pelly Amendment. This legislation empowers the US president to suspend any wildlife and fisheries trade between the US and any country considered responsible for diminishing the effectiveness of an international treaty designed to protect any threatened or endangered species. Governments of consumer nations responded to this pressure from the US by passing some domestic laws and intensifying efforts to control illegal trade, but this served only to drive trade further underground and to raise the illegal prices charged for rhino horn (Mills, 1993). The second action was that the United Nations Environment Programme (UNEP) held a meeting in Nairobi in 1993 to raise funds for rhino conservation, there having been no external aid for rhino conservation in response to Resolution Conf 6.10. At this meeting, some US\$60 million was requested in

emergency funds over the next three years, but only some US\$5 million was pledged. At this meeting, South Africa again expressed its belief that a controlled legal trade in rhino horn offered a potential solution, because sales of legally held stockpiles could provide a substantial source of revenue to conservation agencies that the international community was patently unwilling to provide. The third action was that efforts were finally made to seek the views of the traditional Chinese medicine community about how they viewed their healing role relative to the threat posed to rhinos and other endangered species included in their medicines.

At the 1994 Conference of the Parties, South Africa again proposed to down-list its white rhino population to Appendix II. However, even though the down-listing was agreed, an annotation confined this to trade in live specimens and in hunting trophies only (Table 9.2). Therefore, the international ban on trade in rhino horn and other products remained in place, even though one rhino population was down-listed to Appendix II. Nevertheless, a more far-reaching resolution was adopted at this meeting that resulted in the repeal of Resolution Confs 3.11 and 6.10. Resolution Conf 9.14 recognized many of the problems in rhino conservation, and urges the following:

- those parties that have legal stocks of rhino horn to identify, mark, register and secure all such stocks;
- all parties to implement adequate legislation including internal trade restrictions, aimed at reducing illegal trade in rhino products;
- range states to be vigilant in their law enforcement efforts and to place increased emphasis on the prevention of illegal hunting and early detection of offenders;
- that law enforcement cooperation between states be increased in order to curtail trafficking in rhino horn;
- the consumer states to work with traditional-medicine communities and industries to develop strategies for eliminating the use and consumption of rhino parts and derivatives.

Resolution Conf 9.14 also directed the standing committee to continue to pursue actions aimed at reducing illegal trade, ensuring that all such actions are accompanied by evaluations of their effectiveness, through the use of standardized indicators, and that policies guiding interventions are responsive to the outcomes of evaluations and modified accordingly. The resolution also recommends that each range state develop for its rhino population a recovery plan that inter alia: is appropriate for the situation in that country; will not adversely affect rhino conservation in other range states; and, includes provisions for the reinvestment of revenues derived from use of rhinos that is consistent with the convention, in order to offset the high costs of their conservation. Finally, Resolution Conf 9.14 urges potential donors to assist with funding the efforts of range states to implement their recovery plans, and the Global Environment Facility to fund the protection of rhino populations within

the context of broadly-based projects for the conservation of biological diversity.

At the 1997 Conference of the Parties, South Africa yet again attempted to set in motion measures that would lead eventually to a controlled legal trade in rhino horn, but this proposal was again rejected. South Africa, conserving as it does some 70 to 80 per cent of the global population of rhino, remains concerned about incentives for rhino conservation, particularly for private land owners who conserve some 15 per cent of South Africa's rhinos. Meanwhile, black rhino numbers in Africa appear to have stabilized, and indeed to have increased slightly, at a continental population of around 2600 (Table 9.1). Hence, a sense of cautious optimism seems to have pervaded the cause of rhino conservation internationally. Indeed, rhinos hardly featured at the 2000 Conference of the Parties, apart from some revisions that were made to Resolution Conf 9.14 (Rosser et al, 2001). These revisions recognized both ongoing and recent successes, but in particular called for better reporting by the range states, so that the effectiveness of different measures to conserve rhinos could be assessed.

Taken overall, the Appendix I listing has failed to stop either trade or poaching within the rhino family. Indeed, the raised stakes caused by making international trade in rhino horn illegal was evidenced by soaring prices for rhino horn in consumer markets (Figure 9.1). In turn, this may have stimulated poaching in range states where rhinos were inadequately protected and where the incentive structure favoured poachers rather than conservationists (Milner-Gulland and Leader-Williams, 1992). However, even an intuitively obvious comparison of data on population decline and rising prices of horn (Figure 9.1) masks a number of complexities that need to be addressed in evaluating the Appendix I listing for the rhino family. The most obvious question is whether the decline in black rhino numbers, the start of which pre-dated the Appendix listings (Figure 9.1), would have been faster or slower without the listings. This question cannot be adequately answered with the available data. Nevertheless, economists believe that the convention has been responsible for regulating the extinction process in rhinos (Swanson, 1994; t'Sas Rolfes, 1995). Another issue is that certain important consuming nations like Taiwan and Yemen were not parties to the convention at the time many rhinos were being lost in the late-1970s and the 1980s. Hence, the role that this might have played cannot be determined with any certainty.

Whatever the answer to these imponderable questions, the rhino family has certainly played an important role in developing thinking within the workings of the convention. As a result, the convention has extended its mandate to roles other than purely dealing with issues of regulation of international trade. Indeed, the latest resolutions on rhinos consider wider issues of conservation in situ, many of which fall within the purview of responsibility of the range states rather than of the convention.

IN SITU PROTECTION OF RHINOS

The in situ protection of rhinos has almost been a game played on two fronts, one of failure and the other of success. On the failure front, high priority was given in the 1980s to protecting large populations of rhinos within extensive protected areas. As noted already, it has been hard to monitor the situation accurately for the widely distributed Sumatran rhino in its rainforest habitats. However, the fate of the black rhino is better known (Figure 9.1). The focus of poaching moved from Kenya and northern Tanzania in the 1970s, southwards to southern Tanzania and Zambia in the early 1980s and thence to Zimbabwe in the late 1980s and early 1990s. A shortage of resources and political commitment, resulting in de facto open access, saw large populations of black rhinos decline rapidly in one country after another. Under this ongoing illegal regime, with its increasingly high rewards, the costs of poaching escalated. The bows and arrows that were used in Kenya in the 1970s were replaced by automatic rifles. Poachers increasingly risked death through shoot-to-kill policies, while the costs of effective policing rose considerably in real terms.

Nevertheless, there have been considerable successes in rhino conservation in both Africa and Asia. Over the course of the 20th century, numbers of southern white rhinos have increased dramatically in Southern Africa, as to a more limited extent have Indian rhinos in India and Nepal (Foose and van Strien, 1997; Emslie and Brooks, 1999). Indian rhinos have increased from the low hundreds in the early 1900s to 2500 today (Table 9.1). Southern white rhinos have likewise increased from the low hundreds in the 1900s to more than 10,000 today. Equally, these increases continue trends that had been set in motion in the early 1900s, when small and well-protected reserves were established in India and South Africa to prevent the then remnant populations from going extinct. Hence, these spectacular successes are quite unrelated to actions taken under the convention. Nevertheless, the down-listing of South Africa's white rhinos to Appendix II (Table 9.2) provides international recognition of a national success with that sub-species. Furthermore, the spectacular increase of southern white rhinos has occurred where limited use is allowed, through sport hunting and live sales, in a system whose regulation has now been reduced from an Appendix I to an Appendix II listing. In turn, this change in listing has removed the requirement that the prior grant of an import permit is required before a hunting trophy or a live sale can be exported internationally. Southern white rhinos continue to increase, largely through incentives to private land owners as carrying capacity has been reached in state protected areas (Emslie and Brooks, 1999).

WHICH DIRECTIONS IN FUTURE?

As noted already, a sense of cautious optimism now pervades the cause of rhino conservation. Black rhinos have begun to recover in Kenya, South Africa and

Namibia. This has been largely achieved by following a similar formula to the ongoing successes with Indian and southern white rhinos, of providing good protection, usually in small areas attracting high protection budgets. In the case of the black and southern white rhinos, this has included protection on both state and private land, and strong biological management through monitoring, translocation and the seeding of new populations. Furthermore, with southern white rhinos, an incentive-based and slightly deregulated system is firmly in place to underpin the most impressive success of all. This all amounts to better news than for many a year.

Is this sense of cautious optimism justified? The revised Resolution Conf 9.14 concludes that the decline of all rhino populations has not been halted. The Sumatran rhino appears to be continuing its slide towards extinction. Furthermore, only small remnant populations remain of Javan rhino in two locations, one in Java and another in Vietnam. Likewise, northern white rhinos remain in only one location in the Democratic Republic of Congo, while western black rhinos remain in only one location in Cameroon. In addition, Indian rhinos are no longer increasing as rapidly because carrying capacity has been reached in the available state-protected areas.

Different approaches are being explored in the conservation of particular populations and species of rhinos in situ (Foose and van Strien, 1997; Emslie and Brooks, 1999). Tactics include translocation to unoccupied habitats in areas of former range; concentration of resources and conventional law enforcement efforts in small areas; use of fencing; involvement of local communities in conserving rhinos on communal land; and, more recently, the dehorning of rhinos to reduce their attractiveness to poachers. To offset the costs of rhino conservation some countries have investigated tourist viewing and consumptive activities, such as live sales and limited trophy hunting of surplus males, as sources of income. By realizing the full economic potential of rhinos some countries hope to encourage further cooperation of both the private sector and local communities in conserving rhinos. As the plight of some taxa of rhinos has worsened and the cost of policing has risen, conservation organizations have received increasing demands on their limited funds.

The revised Resolution Conf 9.14 recognizes that the illegal trade in rhino horn remains a global law enforcement problem. A key question remains, and that is whether the horn trade should be deregulated and legalized. A considerable diversity of opinion exists as to the most effective approach. On the one hand, even when horn trade was legal, rhinos lost ground in terms of their distribution, and presumably of their numbers. Furthermore, much trade in horn was not legally declared in customs statistics. Equally, a number of interlinked issues still remain, including:

- How best to deal with stockpiled horn?
- How best to reduce rewards for poaching illegal products?
- How best to reduce policing costs, particularly on state land?

- How best to reduce abuse of human rights?
- How best to provide incentives to ensure that strong ownership remains or is encouraged on communal and private land outside state-protected areas?

These issues require serious consideration over the next few years, as the fate of Sumatran, Javan and northern white rhinos continues to hang in the balance. There are five living species of rhino, but even after all the effort spent on regulation and protection, still only just.

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Chapter 10

Elephant Poaching and Resource Allocation for Law Enforcement

Hugo Jachmann

INTRODUCTION

After a long period of illegal unsustainable off-take, the African elephant (*Loxodonta africana*) was transferred to Appendix I of CITES, leading to the international ivory trade ban that came into effect in early 1990. Since 1990, two attempts have been made to assess the impact of the ban on illegal off-take of elephant (Dublin and Jachmann, 1992; Dublin et al, 1995). The results of these studies, however, were for the most part statistically inconclusive due to a lack of reliable data from the majority of sites in the six target countries covered.

This chapter focuses on the enforcement of elephant conservation legislation in Zambia and considers this in relation to the Appendix I listing. The relationship between the levels of resources allocated to law enforcement in the Luangwa Valley, eastern Zambia, and the numbers of elephants killed illegally between 1979 and 1995 (Jachmann and Billiouw, 1997; Jachmann, 1998) is identified. It is shown that variation in poaching levels can be attributed to differences in resource allocation alone.

METHODS

The South Luangwa Area Management Unit (SLAMU), formerly known as the Luangwa Integrated Resource Development Project (LIRDIP), operated in the South Luangwa National Park (9050 km²) and the Lupande Game Management Area (4950 km²), situated in the central Luangwa Valley. The project area contained more than half of Zambia's national elephant population. From its inception in 1988 to 1995, LIRDIP collected accurate in-depth information on

elephant trends, law enforcement input and levels of illegal activity. This information is supplemented by some additional information from the period from 1979 to 1986 when the Save the Rhino Trust (SRT) was operating in the area.

In the LIRDIP area, conventional aerial sample counts were carried out from the early 1970s to 1995 (Caughley and Goddard, 1975; Leader-Williams et al, 1990; Bell et al, 1992; Jachmann, 1995; Jachmann et al, 1995; Jachmann, 1998). For the period from 1973 to 1988, numbers of elephants killed illegally were estimated from carcasses observed during aerial counts and a modelling procedure (Bell et al, 1992). For the LIRDIP operational period from 1988 to 1995, nearly all of the elephants found killed illegally were detected by foot patrols, although some were reported by tour operators and later confirmed by wildlife personnel. A series of aerial surveys carried out during this period detected no unknown fresh carcasses (Jachmann, 1998).

For the period from 1979 to 1986, resource allocation, in terms of patrol days and financial input, relate to SRT operations alone.

Law-enforcement methods used under LIRDIP fell into two classes: conventional foot patrols within the project area, and investigation operations following up information supplied through a system of informers outside the project area. Foot patrols from each of the scout camps covered the entire project area, divided into six patrol sectors, on a regular basis. A patrol consisted of between six and ten scouts, while patrol duration was usually around ten days. Total patrol time was made up of 'placement days', that is days spent moving between base and the location where the patrol started or finished, and 'effective patrol days', that is days spent actively in pursuit of illegal activity (Bell, 1985). For the SRT period (1979–1986), only information on total patrol days was available, which includes 'placement time'. For the LIRDIP period (1988–1995), information on both total patrol days and 'effective patrol days' was available. Up to 1994, for each patrol, most of the equipment was hauled by permanent carriers. In 1995, however, financial constraints forced the project to dismiss most of the permanent carriers, leaving a fluctuating small number of temporary carriers. Investigation operations were mainly carried out in the towns and villages surrounding the project area, while operation time was also made up of 'placement days' and 'effective days'. An essential feature of the law-enforcement programme was the bonus system, providing cash rewards for information obtained from informers or scouts that eventually led to an arrest or the confiscation of a firearm or a trophy.

Because the resource data for the period prior to 1988 is incomplete, it will be subjected to a crude analysis only, using elephant trends and projected elephant mortality as a measure of illegal activity, and total patrol days as a measure of resource allocation (Jachmann, 1998). The resource data from the LIRDIP period are far more detailed and accurate, and modelling procedures will be used to investigate the relationship between resource allocation and illegal off-take of elephants (Jachmann and Billiouw, 1997; Jachmann, 1998). The

number of elephants killed illegally was not corrected for numbers of live elephants, as poachers may focus on areas of known high elephant density, because this was found to have a minor, non-significant impact on the outcome of the analysis (Jachmann, 1998).

To investigate the relationship between resource allocation and illegal off-take for the LIRD P period, the logarithmic link function, specifying Poisson errors, in the GLIM statistical modelling package was used (Crawley, 1993). In our model, the *response variable* (Y) is the number of elephants found killed illegally per annum, while the *predictor variables* (X_1 to X_9), are the total law-enforcement budget per km² (US\$), personal emoluments per scout per month (US\$), transport expenditure per km², km² per scout, km² per carrier, effective patrol days per km², effective investigation days, numbers of bonuses paid, and the average bonus rates (US\$). For a detailed description of the analysis procedure the reader is referred to Jachmann and Billiow (1997), and Jachmann (1998). The ultimate goal was to produce a minimal adequate model with the easiest possible interpretation and the least number of terms, explaining the temporary variation in elephant poaching in the study area between 1988 and 1995.

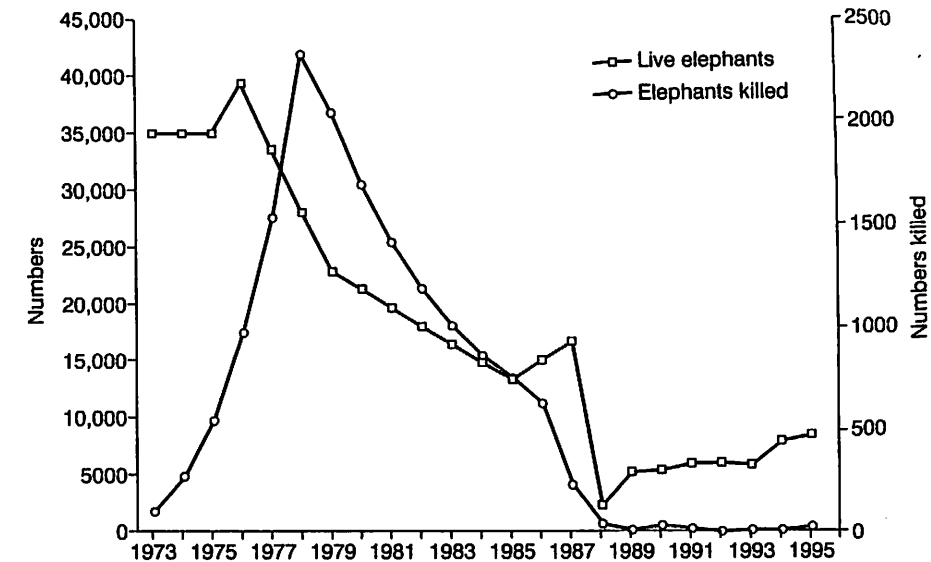
RESULTS

Elephant trends

In the early 1970s, the elephant population in the central Luangwa Valley was more or less stable at about 35,000 elephants. Elephant numbers began to decline sharply from about 1976 as a result of the wave of illegal off-take that spread southwards through Africa during the second half of the 1970s, peaking in Zambia in about 1977 (Figure 10.1). The wave of illegal off-take was caused by a number of factors acting in concert, starting with the collapse of the purchasing power of currencies and wages in many African countries. This led to the search for economic opportunities outside the formal economy, including commercialization of illegal hunting for ivory and rhino horn. As a result, elephant numbers dropped to about 15,000 in 1987 (Figure 10.1). In 1988, the population further declined to 2400, partly due to illegal off-take, and partly due to movement of elephants away from the project area (Jachmann, 1998). With the onset of an effective law-enforcement programme of LIRD P in 1988, illegal hunting of elephants dropped dramatically, and, mainly as a result of elephants moving back to the project area, the population increased to 5400 by 1989. From 1989 to 1995, elephant numbers gradually increased to about 9000 (Figure 10.1).

Resource allocation and elephant poaching

In the early 1970s, there may have been as many as 60 wildlife scouts stationed in the central Luangwa Valley. However, these scouts were not supported with allowances, transport, operational support or supervision, and consequently the



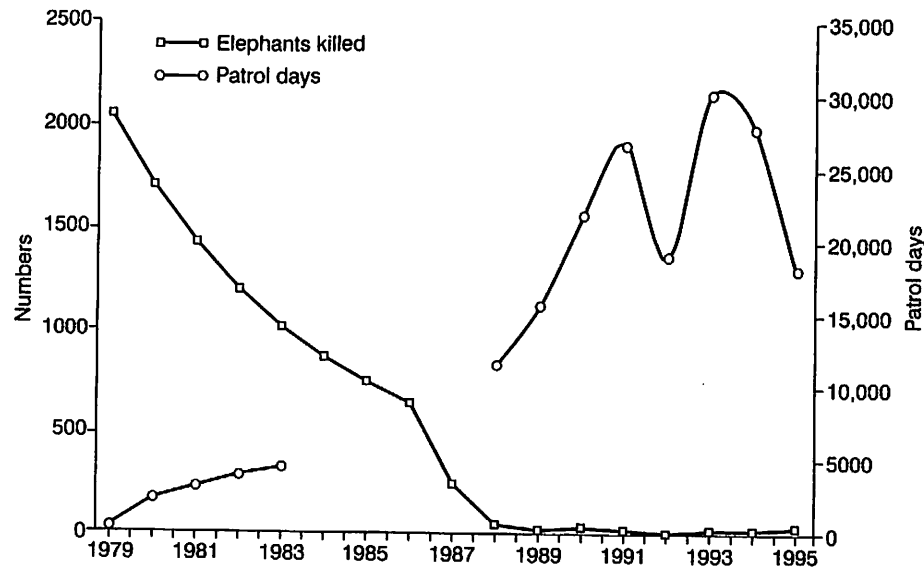
Source: Jachmann, 1998

Figure 10.1 Elephant Population Estimates and Projected Elephants Killed for the LIRD P Area (1973-1995)

law-enforcement effort of this scout force was negligible. As a result, illegal hunting of elephants was proceeding at will at a very high rate of approximately six elephants killed per day. For the period from 1979 to 1986, the numbers of effective wildlife personnel were confined to 22 SRT scouts. Total patrol days under SRT increased from 363 in 1979 to 4484 in 1983 (Leader-Williams et al, 1990). For the period from 1984 to 1987, information on total patrol days was lacking. The improved enforcement effort under SRT, even on a small scale, evidently had a major impact in reducing illegal off-take (Figure 10.2). With the initiation of LIRD P in 1988, effective scout numbers increased to 133, with a further increase to 286 in 1991, gradually declining to about 214 in 1995. Total patrol days increased from 11,462 in 1988 to about 30,000 in 1992, declining to about 10,000 in 1995. The vastly improved manpower input under LIRD P resulted in a massive reduction in elephant poaching two years before the international ivory ban came into effect (Figure 10.2).

The operational law-enforcement budget fluctuated between US\$15 and \$22 per km² per year between 1979 and 1988, which includes the operational budget for SRT of approximately US\$11 per km² per year, increasing to nearly US\$52 in 1991, declining to about US\$24 in 1995.

During the LIRD P operational period (1988-1995), numbers of elephants found killed illegally declined from 39 in 1988 to 7 in 1992, and gradually increased to 23 in 1995 (Figure 10.3).



Source: Jachmann, 1998

Figure 10.2 Projected Numbers of Elephants Killed and the Total Numbers of Patrol Days for the LIRDPA Area (1979–1983 and 1988–1995)

Resource allocation for this period follows the opposite pattern, with both financial and manpower input increasing to its highest level for the period in 1991–1992, then gradually declining to lower levels in 1995 (Table 10.1).

Univariate (Poisson) regressions show that all of the manpower predictor variables (Table 10.1) and two of the budgetary predictor variables (expenditure and emoluments), significantly influenced the numbers of elephants found killed illegally (Jachmann and Billiouw, 1997). However, the most important factor that influenced elephant poaching during this period was the incentive system (that is the predictor variable 'numbers of bonus claims paid'). Two-variable Poisson regression models, using log numbers of bonus claims paid and each of the other variables, showed that only one model was adequate and biologically plausible. The predictor variables bonus claims paid and effective investigation days together explained more than 95 per cent of the temporal variation in elephants found killed illegally between 1988 and 1995 (Fig 10.4). However, as a result of correlation between all the manpower variables and bonus claims paid, the latter incorporates the influence of the numbers of scouts and carriers employed as well as the numbers of effective patrol days (that is the entire manpower input).

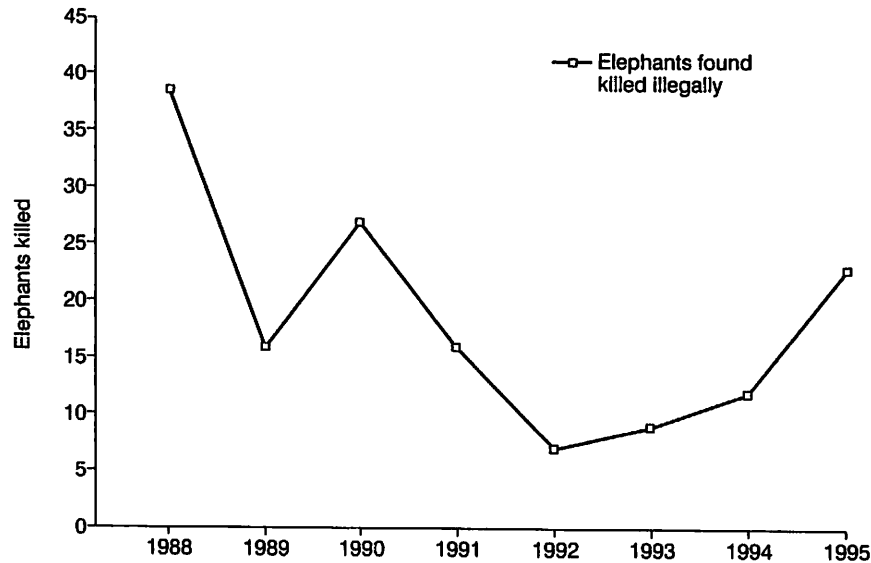
Table 10.1 The Response Variable, Numbers of Elephants found Killed, and Predictor Variables Relating to the Law-enforcement Input of LIRDPA, used for the Modelling Procedure (1988–1995)

Year	1988	1989	1990	1991	1992	1993	1994	1995
<i>Response variable</i>								
Elephants killed	39	16	27	16	7	9	12	23
<i>Predictor variables Budget (US\$)</i>								
Expenditure/km ²	3.11	21.78	48.84	51.47	47.66	31.41	36.98	23.73
Emoluments/scout/month	13.08	51.54	89.53	96.38	127.71	78.06	117.94	83.16
Transport expenditure/km ²	0.46	0.79	2.01	10.45	5.25	4.55	6.43	5.34
Average bonus rates	2.26	1.81	2.03	5.84	1.95	0.60	0.53	0.44
# Bonus claims paid	54	372	1189	2692	22537	9823	3483	557
<i>Manpower</i>								
km ² /scout	105.26	81.40	63.06	48.95	48.95	58.33	60.34	63.93
km ² /carrier	2000	2000	225.81	104.48	104.48	245.61	245.61	411.76
Effective patrol days/km ²	0.61	0.96	1.31	1.60	1.03	1.75	1.63	1.15
Effective investigation days	331	1554	250	2769	3110	661	1152	232

Source: Jachmann and Billiouw, 1997

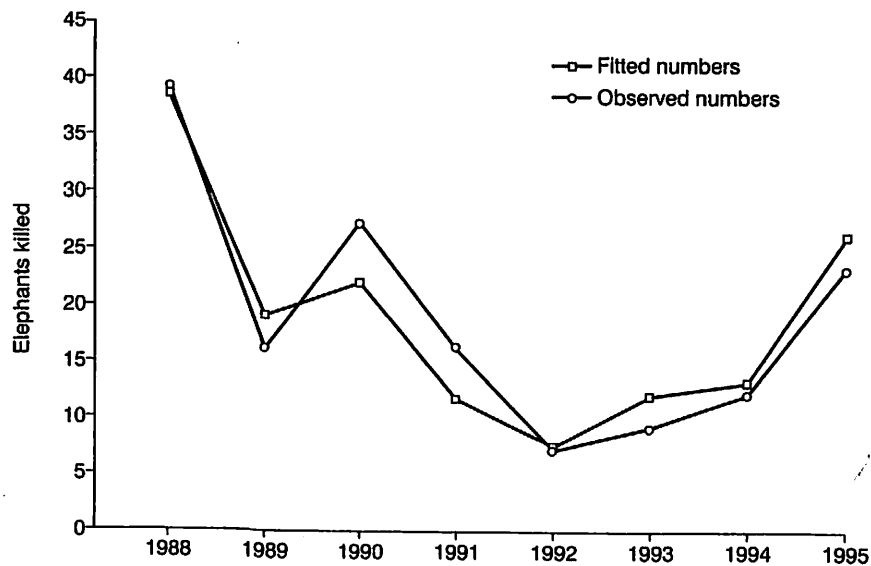
DISCUSSION

In this case study it has been shown that the minor improvement in local enforcement during the SRT period (1979–1986) had a significant impact in reducing elephant poaching, while the effective law-enforcement programme of LIRDPA reduced illegal off-take to acceptable levels in 1988, two years before the ivory ban came into effect. Furthermore, the analyses show that the temporal variation observed in the numbers of elephants found killed illegally between 1988 and 1995 can be explained by variation in resource allocation alone, without any contribution of external factors, which includes the international ivory ban. The success of LIRDPA enforcement was due largely to a steep rise in the overall budget, an increase in manpower, but above all, the introduction of investigation operations and the incentive system. These were found to be the most important factors contributing to elephant conservation in the central Luangwa Valley. Thus, in the central Luangwa Valley, it was local enforcement effort, and not international regulation that was crucial to elephant conservation. As an example, during the early 1990s, the elephant population in the LIRDPA area nearly doubled, whereas the population in the Kafue system in



Source: Jachmann and Billiouw, 1997

Figure 10.3 Numbers of Elephants found Killed Illegally in the LIRDPA Area (1988–1995)



Source: Jachmann and Billiouw, 1997

Figure 10.4 Minimal Adequate Model, Explaining the Variation in Numbers of Elephants found Killed Illegally in the LIRDPA Area (1988–1995)

Zambia (56,600 km²) was nearly halved (Jachmann, 1998). The only difference between the two areas was investment in local enforcement – about US\$4 per km² per annum in the Kafue area compared to about US\$30–50 per km² per annum in the central Luangwa Valley.

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The late Richard H V Bell introduced me to the subject of monitoring of law enforcement and of illegal activity when working in Malawi in the late 1970s. Richard was also instrumental in setting up the monitoring system in the central Luangwa Valley, when working as co-director for LIRDPA. His sharp intellect and his friendship will be sadly missed.

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THE TRADE IN WILDLIFE

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