Wildlife economics: a study of direct use values in Botswana’s wildlife sector

by

Jonathan Ian Barnes

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Department of Economics

University College London
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Wildlife economics: a study of direct use values in Botswana’s wildlife sector

by: Jonathan Ian Barnes
Supervisor: Professor D.W. Pearce

Abstract

The wildlife resources in Botswana were studied to determine their direct use values. Cost-benefit analysis was applied to develop models for wildlife viewing, safari hunting, community-based wildlife use, game ranching, ostrich farming, crocodile farming and ranching, elephant utilisation and wildlife product processing. Various planning and policy options were analysed within the wildlife sector. Contingent valuation was used to estimate economic characteristics of demand for wildlife-viewing tourism. A linear programming model, which optimises the contribution of use activities to national income, within a framework of policy and other constraints, was developed for the whole sector.

The findings confirm that wildlife in Botswana can contribute positively and sustainably to national income, and that this can happen without loss in biological diversity. Wildlife’s potential contribution will not likely exceed four percent of gross domestic product. The likely flow of positive use values from the wildlife sector justifies anticipated public expenditures in it. In expansion of wildlife use, emphasis should be placed on wildlife viewing, and, to a lesser extent, ostrich production, crocodile production, and community wildlife use in high value areas. Later, as capital, labour and management resources become more abundant, the sector should be diversified to develop all uses fully. A ban on consumptive uses of wildlife would result in 16 percent less gross value added from wildlife in the sector, and would involve use of 75 percent less land. Even with consumptive use, some 88 percent of the wildlife estate can only generate very low direct use value from wildlife. The survival of wildlife in Botswana depends largely on its ability to generate economic value. This can happen through an array of uses yielding direct use values, within a framework of land use zoning which precludes loss of indirect use and non-use values, which should also be captured where possible.
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Preface

Since I am trained in both ecology and economics, one could expect this thesis to carry elements of both disciplines. In some ways this is true. In carrying out this work, I have strived to determine and secure efficiency of resource use, the central focus of economics; but the approach is singularly empirical, a feature of almost all ecology; and the study is done within a public policy framework which implies that wildlife resources and their values cannot easily be substituted, a conviction typical of biologists. Another characteristic of this study reflecting a biologist’s influence is in the nature of the linear programming model, which incorporates linear relationships instead of the non-linear price-scale convexities much loved by economists.

The literature on wildlife economics from north America, where most work on this subject has taken place, is replete with attempts to value the demand for wildlife and wildlife use. Study of the links between investment in wildlife as a resource and these values have been almost non-existent. In this thesis, to value investment in wildlife use, cost-benefit analysis has been applied, with (to a lesser extent) demand analysis. The value of use is measured from both the private (financial) perspective and the societal or national (economic) perspective. Within the context of the whole wildlife estate, and the policy commitments that go with it, the resource allocation which maximises direct economic use value is determined, without the loss of non-use and indirect use values.

This thesis is one of the very few which primarily involves valuation of the supply of wildlife values, through investment analysis, rather than valuation of demand. This makes much sense, because the allocation of land for wildlife in Africa carries opportunity costs in terms of livestock and crop production, and these activities are traditionally valued using investment analysis. The thesis is one of the first in which an attempt is made to analyse the economic efficiency of, and the allocation of resources within, a nation’s whole wildlife sector. In this way the thesis contributes to scientific knowledge and the development of a new methodological approach to valuing wildlife in Africa.
Part I
Background
Chapter 1

Introduction

1.1 Background

Botswana has relatively well-preserved wildlife resources. Land designated for wildlife occupies some 27 percent of the country’s land surface (Ministry of Finance and Development Planning, 1991) but wildlife utilisation was estimated, in 1986, to constitute less than 1.5 percent of the gross domestic product (FGU-Kronberg, 1988b). Government’s efforts to promote national development have tended to focus on minerals, livestock production, industry and agriculture. Some of these, especially livestock keeping, threaten to displace wildlife.

Within Botswana, public sentiment favours the gradual replacement of wildlife by other land uses, while, internationally, there are powerful forces advocating the preservation of wildlife. In effect, the subject of this thesis is an investigation of the potential role of the utilisation of wildlife in contributing to a satisfactory compromise between these two opposing views. The potential for wildlife to provide economic use values which can contribute to the development process (sustainable rural development) in Botswana is examined.

The central theme is to determine the economic profitability of investment in wildlife use and, further, to determine the best combination and spatial array of wildlife use enterprises which will maximise economic use value without reducing existing non-use values. The study provides an economic rationale for land-use zoning in Botswana. The study is undertaken within a framework of public policy constraints which forms its motivational basis and which is described in more detail in chapter 2.
The hypothesis is that wildlife in Botswana can contribute positively and sustainably to national income, and that this can happen without loss of biological diversity.

The thesis consists of four parts, as described below.

Part I: The background provides an introduction, a description of the physical and economic setting in Botswana, and a review of literature and background theory. The review is concentrated on African case studies.

Part II: The micro-economics of specific wildlife uses is examined here. Wildlife viewing tourism, safari hunting tourism, small-scale wildlife harvesting or cropping, wildlife ranching, ostrich farming, crocodile farming, elephant utilisation and wildlife product processing are dealt with. Enterprise budgeting with conventional cost-benefit analysis is the primary technique used.

Part III: The development of the whole wildlife sector is analysed. Aggregate values for the sector are calculated. Within the framework imposed by policy makers in Botswana, the most economically appropriate allocation of wildlife use activities on wildlife land is determined. The extent to which central government investment in the sector is both necessary and feasible, is investigated. The use of zoning to assist in maximisation of use values and retention of non-use values is discussed. The effect of policy regarding consumptive use on economic values is determined.

Part IV: This part contains the more important conclusions of the thesis, particularly as they relate to policy.

Note: Throughout this thesis, values are given in Botswana pula (P). At the time of the study P1.00 was equal to US$0.47 and £0.28. A list of abbreviations and acronyms used in the thesis is presented in Appendix 1.1.
1.2 The resource base

The physical resources

General features

Botswana is situated in the centre of the southern African subcontinent, bounded in the south and east by South Africa, in the north-east by Zimbabwe, and in the north and west by Namibia. The country is 582,000 square kilometres in extent.

Topography is generally very flat with rare, small groups of inselbergs, mainly in the east. In the east, the landscape is drained by the Limpopo system; the Limpopo river forms part of the eastern border. In the south there is weak drainage towards the Molopo and Nossob river courses both of which form part of the national border. In the northern half of the country the landscape is dominated by the combined endoreic drainage system of the Okavango delta and Makgadikgadi pans, which is weakly linked to the Zambezi system to the east. The Okavango delta is a significant seasonally flooded area of swamps, channels and floodplains. The Makgadikgadi pans are extensive, flat, occasionally flooded saline and/or sodic pans.

Geologically, the western part (some 80 percent) of the country is covered by a mantle of Kalahari beds, typically aeolian Kalahari sand. Only in the east, in the Limpopo basin, are rock formations, primarily of the Basement Complex, exposed. Soils of the Kalahari sand areas are almost all of very light texture and infertile. In the Limpopo basin, soils are variable but mostly medium textured and derived from granite.

The mean annual rainfall varies broadly from 650 millimetres in the extreme north, at Kasane, to less than 250 millimetres in the extreme south-west, at Bokspits. In the eastern sector it also varies from more than 550 millimetres in the south-east to less than 350 millimetres in the low-lying extreme east. The country falls within the broad summer rainfall zone of southern Africa which has been shown to experience wet cycle/drought cycle oscillations (Tyson, 1979). The wet and dry periods, within which the tendency is for relatively wet and dry years, respectively, each average about nine years in duration. The 1980s were dominated by a severe drought cycle.
The average daily maximum temperature is generally about 33°C in January and around 22°C in July. Average daily minimum temperatures are around 18°C in January and 5°C in July. Both seasonal and daily temperature variation tends to be greater in the southern half of the country.

Botswana is characterised by a shortage of surface water resources. In the Kalahari sand areas, run-off is negligible. Groundwater resources vary significantly in quality over much of the country, and are commonly difficult to exploit economically due to the deep sand mantle.

The potential for development of water-intensive land uses (for example, irrigation) is restricted more or less to the vicinity of the Limpopo river and its larger tributaries in the east, and to the vicinity of the Okavango and Chobe/Zambezi systems in the north. Throughout the rest of the country with few exceptions, water resources have potential to provide only drinking water for people and animals, under extensive land-use systems.

Vegetation

Figure 1.A depicts the vegetation of Botswana as derived from Weare and Yalala (1971) with modifications. The whole country is covered with "savanna" of varying density. The southern Kalahari is characterised by wooded shrublands and open woodlands dominated by Acacia erioloba and Acacia luederitzii. The central and northern Kalahari contains a wider range of trees and shrubs and tends to be dominated by broadleaf species such as Lonchocarpus nelsii and Terminalia sericea. The physiognomy here is more variable ranging from open shrubland to woodland. In the southern part of the eastern sector, open woodlands of varied composition occur, with common components being, Combretum apiculatum, Acacia tortilis and Acacia nigrescens. The northern part of the eastern sector is characterised by woodlands or occasionally shrublands dominated by Colophospermum mopane, Acacia nigrescens and Commiphora species. In the north of the country the vegetation is fairly varied. Here, on Kalahari sand, trees and shrubs such as Terminalia sericea, Combretum collinum, Lonchocarpus nelsii and Acacia species are found in shrubland or woodland communities. In slightly better watered areas, woodlands dominated by Baikiaea plurijuga, Pterocarpus angolensis or Burkea africana are found. Where sand is compacted, for example,
Figure 1.A: Vegetation map of Botswana

LEGEND

A NORTHERN WOODLAND
B NORTHERN MOPANE TREE SAVANNA
C EASTERN MOPANE TREE SAVANNA
D EASTERN MIXED TREE SAVANNA
E NORTHERN KALAHARI TREE SAVANNA
F CENTRAL KALAHARI TREE SAVANNA
G SOUTHERN KALAHARI TREE SAVANNA
H SOUTH WESTERN KALAHARI SHRUB SAVANNA
I PAN/PAN GRASSLAND
J DELTA WOODLAND/SWAMP MOSAIC
around pans or on relict alluvial areas or on basalt derived clays, *Colophospermum mopane* is the dominant species. Associated with the Okavango delta and the Chobe system is a complex mosaic of vegetation types, including riparian thicket, floodplain grassland and swamp communities.

*Wildlife*

Since 1986, the Department of Wildlife and National Parks has been conducting an aerial survey programme to determine and monitor larger wildlife populations throughout the country. The aim has been to survey most of the country using a surface area sample of five percent in both the wet and dry seasons each year.

Initial results of the aerial survey programme were presented by FGU-Kronberg (1988b). Detailed results of the rest of the programme are described by Bonifica SpA. (1991) and Gibson (1995). Selected results are summarised in Table 1.1. The total large ungulate population in 1991 was estimated at some 784,800. The totals for all species, except, perhaps elephant, are likely to be underestimates, the degree of underestimation depending on how conspicuous and gregarious the species is (Bonifica SpA., 1991). Some statistically significant trends were detected from survey data during the period by Gibson (1995) from regressions of the natural logarithms of survey estimates. Declines of buffalo, sitatunga and, more recently, lechwe and hippo are a cause for concern while elephant and impala have increased. In all the other species no trends could be proven.

The country can be divided into four broad zones depicting wildlife utilisation potential. These are listed (as wildlife utilisation regions) as follows:

- **A - Kalahari region,**
- **B - Okavango/Chobe region,**
- **C - Makgadikgadi region,** and
- **D - Limpopo region.**

They are depicted in Figure 1.B. The basis for delineation is primarily faunistic but includes other factors differentiating wildlife utilisation practice and potential. Subregions within these
<table>
<thead>
<tr>
<th>Species</th>
<th>1986 - 87*</th>
<th>1989 - 91*</th>
<th>1994*</th>
<th>Trend over period**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buffalo</td>
<td>43,930</td>
<td>41,382</td>
<td>26,893</td>
<td>decline</td>
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<tr>
<td>Duiker</td>
<td>34,415</td>
<td>20,589</td>
<td>33,183</td>
<td>stable</td>
</tr>
<tr>
<td>Eland</td>
<td>17,790</td>
<td>19,724</td>
<td>15,792</td>
<td>stable</td>
</tr>
<tr>
<td>Elephant</td>
<td>50,980</td>
<td>60,902</td>
<td>71,587</td>
<td>increase</td>
</tr>
<tr>
<td>Gemsbok</td>
<td>105,464</td>
<td>91,710</td>
<td>126,514</td>
<td>stable</td>
</tr>
<tr>
<td>Giraffe</td>
<td>8,172</td>
<td>11,706</td>
<td>12,028</td>
<td>stable</td>
</tr>
<tr>
<td>Hartebeest</td>
<td>48,459</td>
<td>36,431</td>
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</tr>
<tr>
<td>Hippo</td>
<td>1,610</td>
<td>2,921</td>
<td>2,859</td>
<td>decline***</td>
</tr>
<tr>
<td>Impala</td>
<td>53,517</td>
<td>60,747</td>
<td>61,509</td>
<td>increase</td>
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<td>Kudu</td>
<td>14,906</td>
<td>20,411</td>
<td>26,080</td>
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<td>Lechwe</td>
<td>28,590</td>
<td>69,785</td>
<td>70,274</td>
<td>decline***</td>
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<tr>
<td>Reedbuck</td>
<td>1,690</td>
<td>2,985</td>
<td>2,166</td>
<td>stable</td>
</tr>
<tr>
<td>Roan</td>
<td>1,110</td>
<td>970</td>
<td>1,357</td>
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</tr>
<tr>
<td>Sable</td>
<td>2,980</td>
<td>3,424</td>
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<tr>
<td>Sitatunga</td>
<td>1,580</td>
<td>1,803</td>
<td>816</td>
<td>decline</td>
</tr>
<tr>
<td>Springbok</td>
<td>110,910</td>
<td>128,468</td>
<td>120,546</td>
<td>stable</td>
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<tr>
<td>Steenbok</td>
<td>18,033</td>
<td>36,296</td>
<td>72,400</td>
<td>stable</td>
</tr>
<tr>
<td>Tsessebe</td>
<td>9,770</td>
<td>10,935</td>
<td>10,015</td>
<td>stable</td>
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<tr>
<td>Warthog</td>
<td>5,795</td>
<td>7,829</td>
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<tr>
<td>Waterbuck</td>
<td>980</td>
<td>342</td>
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<tr>
<td>Wildebeest</td>
<td>34,506</td>
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</tr>
<tr>
<td>Zebra</td>
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<td>47,310</td>
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<td>stable</td>
</tr>
<tr>
<td>Ostrich</td>
<td>56,889</td>
<td>62,359</td>
<td>55,778</td>
<td>stable</td>
</tr>
</tbody>
</table>


** These species trends do not relate to the preceeding figures but, instead, are statistically significant country-wide trends detected (or not) by Gibson (1995) from multiple counts within the period between 1986 and 1995

*** Decline detected between 1990 and 1994 only
Figure 1.B: Map of wildlife utilisation regions in Botswana

LEGEND

A KALAHARI REGION
1 SOUTH
2 NORTH
B OKAVANGO/CHOBÉ REGION
1 WEST
2 EAST
C MAKADIKGADI REGION
1 WEST
2 EAST
D LIMPOPO REGION
1 WEST
2 EAST
have been delineated where minor differences in faunal characteristics or animal abundance affect the economic value of the resource. The regions and subregions can be further divided on the basis of land tenure which has a significant effect on utilisation potential but this can only be done on a more detailed scale. Descriptions of the regions and subregions are presented below.

The Kalahari region is representative of the savanna component of the south-west arid biome of southern Africa. It contains the vegetation types E, F, G and H, described in Figure 1.A. There is no permanent surface water and supplies are derived from artificial boreholes. Wildlife species present are independent of water to varying degrees. They include\(^1\), for example, gemsbok, springbok, hartebeest, wildebeest, steenbok, duiker, ostrich, lion, leopard, brown hyaena, baboon, black-backed jackal, silver fox, bat-eared fox and wild cat. Other characteristic animals include springhare, ground squirrel, yellow mongoose, Burchell's sandgrouse, black korhaan and Orange river francolin. The region can be divided into two subregions on the basis that the north contains giraffe, a species of economic importance for tourism. It also contains vegetation types E and F, in contrast to the south which is dominated by G and H.

The Kalahari wildlife utilisation region contains the Gemsbok National Park on state land, the Central Kalahari and Mabuasehube game reserves on state land, and the Khutse Game Reserve on tribal land. It also contains six gazetted wildlife management areas (WMAs), one proposed wildlife management area, communal grazing land, commercial leasehold ranchland (all on tribal land) and commercial freehold ranchland.

Evidence from aerial wildlife surveys suggests that catastrophic losses have occurred among ungulate populations of this region, most likely as a result of the severe, prolonged drought of the 1980s. This was noted by Gibson (1995) and illustrated by FGU-Kronberg (1988a), where some results from 1978/79 counts (DHV Consulting Engineers, 1980) were compared with those of the Department of Wildlife and National Parks from 1986/87 and 1990/91. These data suggested that populations of the more drought sensitive species, such as wildebeest, may have declined by as much as 80 percent. These data were not analysed for statistical

_____________
\(^1\) Scientific names of wildlife species are provided in Appendix 2.2
significance but the wide differences between the results of counts and their confidence limits, suggest that the declines are real.

The Okavango/Chobe region is the richest in terms of wildlife stocks and wildlife utilisation potential. In fact, it forms part of what is one of the richest wildlife areas in southern Africa. It contains elements from the south-west arid biome, the central African plateau and the east African lowlands. A fairly wide variety of habitats are represented and there are areas which are well supplied with water.

Important wildlife species include elephant, buffalo, impala, lechwe, zebra, wildebeest, tsessebe, gemsbok, ostrich, giraffe, kudu, warthog, sable, sitatunga, hippo, roan, eland, waterbuck, bushbuck (subspecies ornatus), duiker, steenbok, reedbuck, lion, leopard, cheetah, side-striped jackal, black-backed jackal, wild dog and spotted hyaena. Less common but also significant are puku, Sharpe's steenbok, oribi and bushpig. An extremely small, relict, reintroduced population of white rhino and an almost extinct population of black rhino are currently under threat from poaching.

Numerous birds occur, including gamebirds such as ducks, geese, francolin, guineafowl and sandgrouse. The region has been divided into two subregions, one to the south and west of the Okavango delta where the larger game species are few and more or less limited to eland, kudu, gemsbok, duiker, warthog, steenbok and ostrich, and one to the east of the foot-and-mouth-disease fence (the so-called "buffalo fence") which is much richer.

FGU-Kronberg (1988a) presented some data showing seasonal and temporal variations apparent from aerial census data in the Okavango delta, derived from UNDP/FAO (1977) and Department of Wildlife and National Parks surveys. These suggested that the population of elephant had increased between 1977 and 1987, while those of many lesser ungulates may have declined. More recent declines in several species (Table 1.1) may have been due to over-hunting, or in the case of sitatunga, burning of papyrus beds (Gibson, 1995).

The Okavango/Chobe region contains the Chobe National Park on state land, the Moremi Wildlife Reserve on tribal land, five forest reserves on state land, two gazetted wildlife
management areas on tribal land, communal grazing land, commercial leasehold ranchland on
tribal land and small areas of irrigated agricultural land.

The Makgadikgadi region lies around the Boteti river and the Ntwetwe, Sua and Nxai pans. It
is transitional in nature between the two previous regions and has fairly large herds of zebra,
wildebeest and springbok. The full spectrum of wildlife species present in the Kgalagadi
region are found here, with some species from the Okavango/Chobe region such as zebra,
impala, buffalo, roan, and occasionally reedbuck, hippo and elephant.

FGU-Kronberg (1988a) presented some results of Department of Wildlife and National Parks
aerial wildlife surveys, which suggested that there was some dispersal of the more mobile
species from the region during the dry season. In addition, there was evidence that the
numbers of the most abundant species had declined very significantly during the years between
1978/79, when DHV Consulting Engineers (1980) conducted a survey, and 1986/87. The
estimated numbers of number of zebra and wildebeest appeared to have declined by some 65
percent and 75 percent, respectively. Drought-induced mortality was observed and is the
likely cause. The Makgadikgadi region contains the Nxai Pan National Park and
Makgadikgadi National Park both on state land, gazetted wildlife management areas on state
land, communal grazing land and commercial leasehold ranchland.

The Limpopo region is essentially the eastern region and comprises all the land which is not
covered with Kalahari sand. Well defined drainage lines occur, which permit some storage of
seasonal run-off. Groundwater is obtainable with relative ease. The region has a biotic
character typical of the Limpopo basin or eastern lowlands of southern Africa.

The Limpopo region is the most densely settled part of Botswana. Relict game populations
include impala, kudu, steenbok, duiker, ostrich, warthog, bushbuck (subspecies roualeyni) and
leopard. More localised, are populations of elephant, waterbuck, wildebeest, zebra, eland,
klipspringer, tsessebe, Cape and yellow-spotted dassie, reedbuck, mountain reedbuck,
bushpig, lion and cheetah. Giraffe have been locally reintroduced.

The region is occasionally visited by gemsbok and hartebeest from the west and there have
been two, unconfirmed, sight records of nyala in the extreme east. The latter record and
evidence from further east, suggests that nyala may be in the process of spreading into Botswana. This region has been divided into two subregions, the west with limited wildlife stocks and the east which contains species such as elephant, zebra, eland and lion.

FGU-Kronberg (1988a) showed some of the aerial survey results for this subregion, derived from Nchunga (1978) and E. Steyn (pers. comm.). These would suggest that game populations had been fairly stable between 1977 and 1986. The Limpopo wildlife utilisation region is dominated by communal grazing land but also contains limited areas of commercial leasehold ranchland in tribal areas and commercial freehold ranchland. The latter is fairly important from the point of view of wildlife utilisation. It also contains some potential for intensive irrigated fodder or crop production.

The social and economic resources

The social and economic setting within which wildlife utilisation does and will take place is the subject of this section. Descriptions are of necessity brief; for more detail the reader is referred to accounts such as CSO (1985), Anon. (1985), Arntzen and Veenendaal (1986) and Patrick (1992).

The human population

The human population census, conducted in 1981, showed Botswana as having a population of 941,000. It is presently estimated at some 1,348,000. During the period 1964 to 1971, the population had an average annual growth rate of 3.1 percent, between 1971 and 1981 this figure was 4.1 percent and between 1980 and 1987 it was 3.4. Population growth rates have been among the highest in the world, but the rate appears to be slowing. Most of the people are concentrated in the east, particularly the south-east. The overall density is in the region of 1.62 people per square kilometre, low by world standards. About 75 percent of the people reside in the rural areas. There is an urbanisation process occurring, as shown by the fact that the urban percentage grew by 9.4 percent between 1965 and the present.

The female fertility rate was high, particularly during the 1970s and 1980s, but it appears to have started to decline. This is in spite of some substantial national gains in education,
urbanisation and the overall economic status of the people. There is, however, a negative relationship between fertility and both education level and degree of urbanisation (Chernichovsky, 1976; CSO, 1987a). This is in agreement with world-wide findings. Average rural household size is in the region of six. In 1992 the fertility rate in urban areas was 4.1 while that for rural women was 6.1. Lucas (1981) found that the percentage of people with no education at all was highest in the smaller rural villages (about 72 percent of men and between 57 and 60 percent of women) and lowest in the larger villages (about 52 percent of men and between 33 and 36 percent of women). It would appear that children continue to have significant economic utility, especially among rural women.

It is estimated that the national population will have increased to 1.89 million by 2001 and to 2.6 million by 2011 (CSO, 1987b).

*Rural income and consumption*

The rural income distribution survey of 1974/75 (CSO, 1976) provided a wealth of data on the characteristics of rural income at that time. It was found that very little wage labour had been established outside the urban areas and freehold farms. Only about 15 percent of rural wage workers were engaged in agricultural or forestry activities, illustrating the labour-extensive nature of agricultural resource use in Botswana.

The calculated Gini coefficient based on the rural income distribution survey data was 52 percent, indicating a relatively high disparity in income by world standards. The major sources of income for the lower and higher percentiles of income level were found to be somewhat different. Four categories were arbitrarily defined for this purpose.

The lowest income group, consisting of the 0.5 percent to 10 percent percentiles, had income averaging P161 per annum, and was heavily dependent on transfers, employment and gathering of veld foods, wood and grass. Very few of these households owned livestock and they derived almost no income from hunting.

The next highest income group, consisting of the 15 percent to 50 percent percentiles and with income averaging P430 per annum, was heavily dependent on employment, transfers, and
crops and livestock. Gathering still played an important role and hunting accounted for almost no income (0.23 percent).

The third or next highest income group, consisting of the 60 percent to 95 percent percentiles and with income averaging P1,669 per annum, was most heavily dependent on employment, and crops and livestock. Income derived from gathering by this group was moderately low (two percent) and that derived from hunting was low (0.12 percent).

The fourth or highest income group, consisting of the 95 percent to 99.7 percent percentiles derived more than half its income (62 percent) from livestock and a significant amount from trading. This group obtained two percent of its income from hunting and no income from gathering.

The rural income distribution survey covered the whole country, with emphasis placed on the more densely populated parts. A need was recognised for an additional special survey to measure the incomes of remote area dwellers who, because of mobility or being resident in "less dense" areas, were excluded from the main survey. A special survey of this nature was conducted in the area of /Xai/xai in western Ngamiland and was reported on by Wilmsen (1976). It is of special importance to this survey in that remote area dwellers, mostly Basarwa, make up a significant portion of the people in and around wildlife areas. In this study it was found that hunting contributed substantially to the Basarwa economy and that the people had entered the cash economy to a limited extent only. Occasional meagre cash income was used sometimes to buy domestic animals as well as meat from these. Meat obtained from wild animals was almost never sold but was distributed among the immediate group. Gifts were expected in return and were eventually received through the general exchange of goods and services but there was no specification that one thing was rendered in payment for another. Thus, no cash income of any kind was realised from the edible portions of wildlife.

Wilmsen’s survey showed that each person at /Xai/xai received 32.6 kilograms of meat per year. The daily amount per person was at a high of about 225 grams in May and June and reached a low of about 30 grams between November and January. Others, including Murray (1976, 1978) and Lee (1979) have documented the economies of remote area communities.
Lee found in a detailed study of Basarwa in the Dobe, /Xai/xai area of western Ngamiland that, overall, hunting provided 40 percent of energy requirements. Gathered vegetable food resulting from gathering formed the bulk (60 percent) of the food and energy requirements. Throughout the year the proportion of meat in the diet rarely fell below 20 percent and during peak periods, when hunting was good, may have reached 90 percent with per capita consumption of over two kilograms per day.

Gulbrandsen et al. (1986), in reviewing Botswana’s "Remote Area Dweller Development Programme", state that during the seventies people who owned few or no livestock depended on hunting or gathering for 82 percent of their total subsistence in cash or kind. Today, however, the remote area dwellers are up to 90 percent dependent for their subsistence on food relief distributed by the Government. In some of the remote area dweller settlements many people have discontinued pursuing independent economic strategies. It would appear that this is particularly the case in the larger settlements where access to natural foods and particularly wild animals is diminished.

If the information, described above, from the rural income distribution survey of 1974/75 (CSO, 1976), is combined with that concerning remote area dwellers, an apparent pattern emerges regarding the use of wildlife in the economy of the rural populace. On the one hand there are the very poor (remote area dwellers) in the most remote areas who have depended to a significant extent on hunting and gathering but who are becoming increasingly dependent on Government transfers. Among the very poor in larger settlements and villages in less remote areas, hunting is unimportant due to decreased access to wildlife while dependence on transfers and gathering remains important. As income rises, dependence on gathering and transfers decreases and income from employment and agriculture, in particular livestock, increases. Among the most well-off rural people, by far the most important income source is livestock, with trading another, lesser source. It is in this group that hunting again becomes important and this is most likely due to increased access to wildlife as a result of increased means (vehicles, weapons, etc.). The apparent existence of two distinct groups, the remote area dwellers and the rural rich, for whom hunting is important is in agreement with the findings of White (1986a).
There is relatively little information available on the details of rural consumption. The 1974/75 rural income distribution survey (CSO, 1976) focused some attention on the measurement or estimation of savings. From this it was possible to show that the pattern of distribution of consumption among rural households was similar to the pattern of income distribution. It was suggested that, at that time, the 84 percent of all households in Botswana which were rural citizen households, consumed about 60.7 percent of all the goods and services that were supplied in Botswana. The remaining rural non-citizen and urban households accounted for about 29.3 percent of consumption.

More recent studies suggest that the Gini coefficient had not changed in the ten to 15 years since the 1974/75 study. One study by the Bank of Botswana suggested that it could have increased as a result of the effects of drought. There appears to have been a decline in the proportion of low income households gaining access to wildlife.

The economy

Botswana has an open economy and promotes a free enterprise system with minimal government intervention. The economic position has improved considerably since independence. Important factors responsible for this include the discovery and exploitation of large mineral deposits, the maintenance of a stable, democratic political environment and the negotiation of the 1969 Southern African Customs Union (SACU) agreement (Anon., 1985). The gross domestic product (GDP) at current market prices is estimated to have been P760 million in 1981/82. Mining was very important with a value added of P139 million or 18 percent of the GDP. The contribution of mining was only P16 million or nine percent of GDP in 1973/74. The value added by agriculture was P62.4 million or 34 percent of GDP in 1973/74. This had only risen to P76 million or ten percent of GDP by 1981/82. The contribution of wildlife utilisation to the GDP is not recorded as a unit but is spread among sectors. It has been estimated that the contribution of wildlife in formal terms amounted in 1982/83 to some P16 million or 1.7 percent of the GDP at that time. Per capita GDP was P879 in 1981/82.

The growth of GDP was dramatic between 1965 and 1990, averaging 12.9 percent per annum. In 1989/90 it was estimated at P5,850 million at current prices and the per capita GDP was
around P4,500. Growth in formal domestic employment has been around 11.4 percent per annum. The rapid growth in the economy is almost entirely attributable to the mining sector, dominated by diamonds. Growth in manufacturing, construction, transport, general government, social services, banking, insurance and business services has been steady but the value added in agriculture tended to decrease slightly as a result of drought.

The rate of inflation between 1986 and 1990 had an average of 10.85 per annum. The pula is pegged to a pula evaluation basket comprising the SDR and the rand.

Development policy

The basic philosophy behind the Government’s strategy for development is the achievement of Kagisano or social harmony. This is based on four principles, namely: democracy, development, self reliance and unity. These are expressed in the national objectives:

1. Rapid economic growth,
2. Social justice,
3. Economic independence,
4. Sustained development.

Development planning is centralised within the Ministry of Finance and Development Planning, and a system based on five-year national development plans is adhered to. These plans have so far been cautious because of the economy’s constant vulnerability to such factors as drought, animal disease and the fluctuations of international markets. No large new mineral developments are expected in the next five years, and economic growth will depend largely on what happens in terms of expansion, diversification and intensification within the manufacturing, agricultural and commercial sectors. A high priority is put on rural development. The wildlife resource is underdeveloped at present and could thus play a significant role in rural development.

Commercial organisation and credit

The most common business body is the private company as described in the Companies Act of 1959. The law also distinguishes between public and external companies. There is no stock
exchange. Economic activity may also be carried out within sole proprietaries, partnerships, cooperatives, non-profit associations, close companies and building societies.

Credit is available from three commercial banks at commercial rates. The government-owned National Development Bank (NDB) provides development loans for small- to large-scale approved undertakings including livestock and wildlife use. It also disburses grants to such enterprises under the Financial Assistance Policy for Government. The Botswana Development Corporation (BDC) assists development through providing equity in joint ventures. The Botswana Cooperative Bank, a private bank, provides banking facilities for primary cooperatives. The Financial Services Company controlled by the National Development Bank and the Botswana Development Corporation engages in hire purchase finance, industrial leasing and medium term lending and the Botswana Building Society (BBS) provides normal building society finance.

The tax system

Taxation in Botswana is described lucidly in Anon. (1985). Income tax is chargeable on all income accrued, or deemed to be accrued, from sources in, or deemed to be in, Botswana. Except where specific legislation provided for it, there was no capital gains tax at the time of the study.

Company tax, at 40 percent during the study, was low compared with that in neighbouring countries. Income tax rates for individuals operated on a sliding scale ranging from low in the first bracket (five percent for the first P1,000) to relatively high in the upper brackets (60 percent marginal rate for amounts exceeding P63,000). These rates are more or less comparable with rates in neighbouring countries.

Trade relations

Botswana has signed a number of bi- and multilateral trade agreements. The most significant of these is the SACU agreement of 1969 (GITEC GmbH, 1984). The SACU agreement is between Botswana, Lesotho, Swaziland and South Africa. Namibia, for historical reasons is a de facto member. All goods entering the union are subject to a common tariff regime.
Because of the relatively large size and higher degree of industrialisation of South Africa, the sharing arrangement for customs and excise duties is very beneficial to the other smaller members of the union. Goods circulate freely through the common customs area but there is some provision for the imposition of additional duties for limited periods aimed at protecting "infant industries" and also for the control of prohibited or restricted trade.

The Lomé Convention between the European Union (EU) and the Africa, Caribbean, Pacific (ACP) states provides Botswana, as a signatory, with unrestricted and duty-free access to the European Union market for a large number of commodities on a non-reciprocal basis. This incorporates a wide range of wildlife products including game meat, wild animal hides and products processed thereof, and bone or horn carvings. Prior to 1989, it also included ivory.

Botswana joined with the front-line states of southern Africa in 1979 to form the Southern Africa Development Coordination Conference (SADCC) (Anon., 1985). In 1992, the name was changed to the Southern African Development Community (SADC). This has had, as its primary objectives:

- the reduction of economic dependence, particularly on South Africa,
- the forging of links to create a genuine and equitable regional integration,
- the mobilisation of resources to promote national, interstate and regional policies, and
- concerted action to secure international cooperation within the framework of a strategy for economic liberation.

SADC represents an important attempt at regional integration which could hold abundant advantages for Botswana.

*Markets*

The internal market of Botswana, with a population of only one million and a per capita gross domestic product of P950 is small. Several important export markets are apparent. The first is that provided by the European Union under the Lomé Convention. This is very large and contains markets for such wildlife products as tourism (particularly valuable in view of size and current currency exchange rate conditions), venison, luxury hides, skins and crafts and selected live animals. The exploitation of this market particularly as regards consumptive
products is hindered by transport costs. The United States at present offers a market for tourism and some luxury hide, skin and craft products. Here again, transport costs are a hindrance. The South African market is the largest in the immediate region. There is a limited market for up-market tourism, luxury hides, skins and crafts and fairly large markets for biltong and live game. A major obstacle to the development of the South African markets for consumptive products is the existence of disease-based import restrictions in that country. The SADC region, with a population of 50 million, represents a potentially significant market despite the low per capita incomes.

**Land tenure**

Botswana is dominated by tribal land. This covers some 71 percent of the country and is allocated by Tribal Land Boards in terms of the Tribal Land Act of 1968. This act aims at developing the process of land allocation in accordance with the country’s democratic principles, providing a legal framework for land allocation in tribal areas and encouraging land reform (Anon., 1985; Patrick, 1992). The second most important category of land tenure is state land which covers 23 percent of the land surface. Control of leases is held by the Ministry of Local Government and Lands. Freehold land covers six percent of the country, mostly in four blocks, namely: Ghanzi, Molopo, Tuli and North-East District. This is under the full control of private landowners.

**Wildlife utilisation**

In 1986, cabinet approved an important white paper, the Wildlife Conservation Policy (Government of Botswana, 1986). This is essentially a policy promoting the sustainable utilisation of the wildlife resource of Botswana. In short, it has the specific objectives:

- to develop the full potential of the wildlife resource,
- to develop a commercial wildlife industry in order to create economic opportunities, jobs and incomes for the rural population, and to enable more rural dwellers to enter the wage economy, and
- to increase the supply of game meat for commercial or subsistence consumption, and so contribute to the nutritional objectives of the national food strategy.
In 1990 a Tourism Policy (Government of Botswana, 1990) was passed by cabinet. This, due to Botswana’s geographic setting, lays emphasis on the development of high-cost, low-volume eco-tourism at the expense of low-cost, mass tourism. It supports the development of both non-consumptive and consumptive activities, where economically appropriate.

The administration of the wildlife resource is the duty of the Department of Wildlife and National Parks, within the Ministry of Commerce and Industry. This service has generally been unable to effectively meet its many and varied obligations primarily as a result of severe staff and equipment shortages. The total staff complement at the time of the study only amounted to some 340. A consolidated development programme for the overall development of the department was prepared in 1987 (FGU-Kronberg, 1987a). This recommended a doubling of staff, some organisational changes and significant improvements in equipment and infrastructure. It has formed the basis for many of the more recent developments in the department.

Before 1992 the wildlife resource was administered under the Fauna Conservation Act of 1979 and the National Parks Act of 1967. A review of the legislation was begun in 1986 and in 1992 a revised, consolidated act, the Wildlife Conservation Act was passed by parliament.

Wildlife utilisation takes place in the following ways:
- wildlife viewing tourism,
- safari hunting tourism,
- game meat consumption (subsistence),
- commercial wildlife production (harvesting, farming, ranching), and
- trade in, and processing of, wildlife products.

Preliminary estimates, based partly on work by Tlusty (1987), suggest that the after-tax, private sector value added, attributable to wildlife-viewing tourism was, prior to this study, some P11.4 million. This was made up of private hotel and lodge operations around and in the wildlife areas. A very small portion of the value added but a high portion of the tourist numbers are attributable to self-driven campers who utilise government camping facilities at very low rates.
Safari-hunting tourism was, prior to this study, responsible for contributing an estimated P2.1 million in after-tax value added to the gross domestic product. This sector is currently in the hands of two major groups and several much smaller operators. Concessions, mostly situated on tribal land, are large and are delineated on the basis of controlled hunting area (CHA) boundaries.

Game meat consumption resulting from licensed and illegal hunting appears to have declined substantially since 1979 when previous studies took place (Murray, 1978; Government of Botswana, 1986). This is largely the result of very severe drought which drastically reduced game stocks in the Kgalagadi and Makgadikgadi regions of the country. The result has been reduced quotas and reduced hunter success. The fact that many Basarwa, who were previously hunter-gatherers, are currently dependent on food relief is testimony to this. The value of informal subsistence consumption of wildlife prior to this study is estimated to have been some P6 million. This estimate is based on licence issues, hunter success estimates and estimates of illegal hunting.

Commercial production of game and game products includes harvesting, ranching and farming. Prior to this study it included some wildlife capture, some supplementary use of game on private land and some intensive production of wildlife. The wildlife capture involved an enterprise which concentrates on small birds for export to overseas markets. The supplementary use of game on private land consisted of both consumptive and non-consumptive use of free-ranging or stocked game populations on freehold land. The wildlife use was commonly secondary to extensive livestock production. Intensive production involved two crocodile rearing stations which are being developed into farms.

At the time of this study, trade in, and processing of, wildlife products had been established for a relatively long time. It was centred around buying and processing of trophies from licensed hunters and safari hunters. Due to prohibitive export taxes, export of the produce had been largely restricted to so-called luxury items. More recently, much of the raw material for production had been imported. This sector was and is still dominated by several medium-to large-sized operations. A number of attempts have been made over the years to develop small-scale processing and craft production in remote settlements and villages. These have
had limited success. The value of current production in this sector, prior to the study, is not known accurately but has been estimated at some P700,000 (FGU-Kronberg, 1988b).

**A description of land designated for wildlife**

Figure 1.C depicts the areas designated for, or proposed for, wildlife in Botswana (the "wildlife estate"). This amounts to 227,000 square kilometres or 39 percent of country’s land surface. These areas include the national parks, game reserves and areas designated as "wildlife management areas". In addition, the whole country is divided into controlled hunting areas" which are designed to assist the Department of Wildlife and National Parks in its management of the centralised licensed hunting system. These were radically redesigned in 1992 with the aim of promoting more efficient land use. Different hunting quotas are set for each controlled hunting area. The boundaries of the safari hunting and non-consumptive tourism concessions are contiguous with CHA boundaries.

**National parks and game reserves**

The primary protected areas for wildlife are the national parks and game reserves, which occupy some 103,800 square kilometres or 17.8 percent of the country’s land surface. There are four national parks and four game reserves. No consumptive uses are permitted inside national parks, where the fauna and flora are fully protected, and de-proclamation requires presidential decree. Game reserves have less constraints on resource use and can be de-proclaimed more easily.

The **Chobe National Park** is the second largest national park covering 1,110,000 hectares in extent on the Chobe river in the extreme north-east of the country. The main source of permanent water here is the Linyanti/Chobe river system. Away from this river front, in the rest of the park, several boreholes have been developed for water.

The park is dominated by Kalahari sand vegetation types including northern woodland, northern mopane and northern Kalahari tree savanna, as described earlier. There is a limited area of open mopane/**Acacia** savanna in the east on heavy basalt-derived soils, and a patch of
open floodplain grassland with *Acacia tortilis* open woodland on medium-textured soils in the Mababe depression in the south-west.

Game populations in Chobe National Park include all the species listed earlier for the Okavango/Chobe region except sitatunga. Planning of the park (Deloitte & Touche Management Consultants, 1992, 1993) has resulted in the designation of three primary use zones. The first is a high-density tourism area on the Chobe river front which is the only part of the park (and the only part of any park or reserve) that is accessible to non-four-wheel drive vehicles. It is also accessible from Nata and Victoria Falls by tarred road. The second use zone in Chobe National Park is one permitting low-impact tourism around sites on the Linyanti river, the Savuti channel and Nogotsha borehole areas. The third zone is a wilderness one in which no development will occur, and this occupies the remainder.

The *Nxai Pan National Park* is relatively small covering 210,000 hectares in extent, and located around the Nxai Pan complex. There is no natural permanent water and the pan contains open wooded grassland plains and is surrounded by northern Kalahari tree savanna with some northern mopane tree savanna.

The Nxai pan area is interesting from the point of view that it is on the interface between the Kalahari, with species such as springbok and hartebeest, and the northern and eastern regions, with species such as impala and, occasionally, elephant. There are two government campsites with borehole water provided. The park has potential for development of lodges, catering for short-stop tours as part of integrated packages.

The *Makgadikgadi National Park* occupies 390,000 hectares of the grasslands, wooded grasslands and shrublands on the fringes of the Makgadikgadi Pans system. It is contiguous with the Nxai Pan National Park to the north. The western border is made up by the Boteti river which has perennial water.

The Makgadikgadi park, which until recently was a game reserve, is seriously threatened by invasion of communally grazed livestock. Numbers of the dominant game species, zebra and wildebeest, appear to have suffered significant declines during the droughts of the 1980s.
Figure 1.C:  Land designated for wildlife in Botswana
There is potential for lodge or tented camp development, offering short-stop visits as part of larger tourist packages.

The Gemsbok National Park is the largest national park covering 2,480,000 hectares in extent. It occupies the driest part of the country with mean annual rainfall around 250 millimetres. The western boundary (which coincides with the national border) follows the Nossob watercourse. It is adjacent to the South African Kalahari Gemsbok National Park, where some 80 functional boreholes have been developed, many of these along the Nossob river bed.

The Gemsbok National Park has open Acacia erioloba wooded shrubland on Kalahari sand which forms relict dunes in the extreme south-west. Calcrete is exposed around pans and along the river bed. Game populations are typical of the southern Kgalagadi subregion.

There are limited camping facilities in the Gemsbok National Park. There is potential for development of short-stop tourism lodges along the Nossob and, with appropriate water development, utilisation of some pans in the park. However, development would need to be carefully dovetailed with that of the adjoining, South African Kalahari Gemsbok National Park, from which the Nossob river bed is already used for tourism.

The Moremi Game Reserve is representative of the northern Okavango delta and occupies 491,400 hectares. It has northern mopane tree savanna and various riparian, floodplain and permanent swamp habitats. High water occurs in winter as floods, which originate in Angola, arrive. Summer rain and flow channels provide year-round permanent water.

Wildlife in Moremi is diverse. Most species listed for the Okavango/Chobe region are present with the exceptions of eland, puku, oribi, Sharpe's steenbok and black or white rhino.

Planning of the reserve (Kalahari Game Services, 1991) has resulted in the designation of several use zones. There is a high density tourism use zone in the east along the main channels and floodplains. Here, there is lodge and campsite development, with much potential for improved use of capacity. The west, including Chief's island, is designated as a wilderness area with no development.
The Central Kgalagadi Game Reserve is the largest of the conserved areas in Botswana, covering some 5,280,000 hectares in extent. It has no permanent surface water. Several boreholes have been drilled and equipped, some for the benefit of human occupants and some for the benefit of wildlife.

The vegetation of the Central Kgalagadi Game Reserve consists of northern and central Kalahari tree savanna. The drought of the 1980s appears to have resulted in significant tree mortality in some parts, particularly among sensitive species such as *Burkea africana*. Game populations are typical of the northern Kgalagadi subregion. As stated, the more water-dependent species, such as wildebeest, appear to have declined significantly in number during the 1980s.

The central reserve was established in 1961 both to protect wildlife resources and to reserve sufficient land for traditional use by hunter-gatherer communities. The human population of the reserve consists mostly of Basarwa, and numbers an estimated 1,400, of which some 980 are resident in Xade settlement. The reserve has potential for the development of tourism facilities around selected sites offering short visits as part of bigger packages. A preliminary management plan for the area was prepared by KCS (1988).

*Khutse Game Reserve* occupies 250,000 hectares on tribal land on the southern boundary of the Central Kalahari Game Reserve. It protects an example of this natural environment for the benefit of the Kweneng District. There are two functional boreholes, primarily to provide water for wildlife. Vegetation and wildlife communities are similar to those in the Central Reserve. Khutse is fairly accessible to Gaborone and could support a short-stay tented camp development.

*Mabuasehube Game Reserve* is situated on state land adjacent to the Gemsbok National Park. It embraces some 180,000 hectares and contains a number of attractive pans typical of the area. It is traversed by the Hukuntsi-Tsabong track and contains at least three boreholes which are equipped to supply game. The vegetation and wildlife communities are similar to those in the Gemsbok Park. At the time of the study the most common game appeared to be gemsbok; numbers of other species having declined substantially during the preceding dry years.
Wildlife management areas

There are 12 wildlife management areas in the country. Nine of these have been gazetted. The remainder are in various stages of acceptance by the local authorities. For some the chances of gazettement in the face of increasing land pressures and the lack of meaningful development in wildlife utilisation are rapidly diminishing. As there is little published data on these areas the observations made in the course of this study are set out in some detail below. The total land area zoned for wildlife management areas is some 123,190 square kilometres, or 21.2 percent of the country’s land surface.

The Nunga Wildlife Management Area is a small (233,400 hectares) gazetted tract situated on recently tribalised land to the west of the Chobe National Park and south of the Maikaelo Forest Reserve. It consists of medium open shrubland and short wooded shrubland on Kalahari sand, dominated by woody species such as Terminalia sericea, Combretum collinum and Burkea africana. Grasses include Eragrostis lehmanniana and Aristida stipitata. In the eastern part along the Nxai Pan-Pandamatenga track is a series of small pans associated with Colophospermum mopane short shrubland or woodland.

Game animals recorded in the Nunga area during a brief visit, include sable, giraffe, elephant, kudu and steenbok, and signs of lion, buffalo and zebra were recorded. There is one functional borehole to the north east, previously used by a safari company and two other non-functional boreholes. The area experiences significant movement of elephant in and out of its boundaries during the wet season so that fencing the area is not considered technically feasible.

Game densities appear to be low but could be increased during the dry season with adequate provision of water and mineral supplements. The area has potential for safari hunting with limited photographic tourism or small-scale (artisanal) hunting for biltong and trophies. A carefully organised elephant harvesting venture would have potential if elephant breeding herds could be attracted to concentrate in the area during the dry season.

The Masama Wildlife Management Area is a large gazetted area (1,293,800 hectares) of state land situated south of Chobe National Park and to the west of Nxai Pan National Park. This
area is similar to the Nunga Wildlife Management Area in nature, is also part of the Okavango/Chobe region and receives seasonal visits from elephant and buffalo.

The Masama area has a fairly high potential for wildlife utilisation and possibilities are similar to those of the Nunga area. The Kanyu area is a small piece of land situated adjacent to the southern part of Nxai Pan National Park and the Makgadikgadi Game Reserve. It contains short open shrublands, short open wooded shrubland and wide areas of open grassland around pans. The substrate consists of Kalahari sand, commonly with areas of surface calcrite and calcareous sands. Common woody species include *Grewia flava*, *Combretum hereroense*, *Dichrostachys cinerea*, *Terminalia sericea* and *Acacia erioloba*. Common grasses include *Stipagrostis uniplumis*, *Eragrostis lehmanniana* and *Aristida* species. Game observed in the area during this study included zebra, wildebeest, ostrich, duiker, gemsbok, impala, springbok and signs were seen of giraffe. The Kanyu area, given protective management and water/mineral supplements provision, has some potential to be developed for small-scale (artisanal) or medium-scale hunting for biltong and trophies, and lodge development for short-stop game viewing safaris and balloon safaris.

The *Tamafupa Wildlife Management Area* is a large (1,113,800 hectares) proposed wildlife management area on state land in northern Central District. It is situated east of the Masama and south of the Nunga areas. The eastern boundary is formed by the Zimbabwe border and the Hwange National Park. It is similar to the Nunga and Masama wildlife management areas in character and has the same potential.

The *Ngamiland Wildlife Management Area* is a large (2,244,400 hectares) gazetted wildlife management area situated in the north-east of the Ngamiland subdivision of the North West District. It straddles the Okavango Delta, and land between this and the Kwando river, and has the highest potential for wildlife utilisation of all the wildlife management areas. It is fairly well described and is suited to both non-consumptive and safari hunting tourism. There is also potential for some small-scale (artisanal) game cropping for biltong and trophy production. A carefully planned elephant harvesting programme could be developed in the east.
The proposed West Sandveld Wildlife Management Area is fairly small (323,400 hectares), situated on tribal land to the south of lake Xau and bordering on the north east boundary of the Central Kalahari Game Reserve. It contains northern Kalahari tree savanna with some incursions of Colophospermum mopane. In the past it has experienced, very occasional, high concentrations and mortalities of wildebeest coinciding with severe drought. At present, game densities are very low and characteristic of the Kgalagadi as a whole. The wildlife management area is severely threatened by communal livestock grazing interests and contains 14 boreholes initially developed primarily for livestock. In its present condition it has suitability for limited small-scale (artisanal) hunting for biltong and trophies.

The Groote Laagte Wildlife Management Area occupies some 385,300 hectares of tribal land in the northern Ghanzi District and is enclosed by the Ghanzi freehold farm block, the Namibian border and the Kuke veterinary cordon fence. Generally the vegetation is representative of the northern Kalahari savanna. The southern part, south of the relict "Groote Laagte" watercourse, is shrub grassland or dwarf or very short, open shrubland. The dominant grasses are Eragrostis lehmanniana, Schmidia pappophoroides and Stipagrostis uninodis. The common shrubs are Grewia flava and Lonchocarpus nelsii. North of the relict drainage line a dense shrubland dominated by Terminalia sericea, Combretum collinum, Lonchocarpus nelsii and Croton gratusimus occurs. Common grasses here are Eragrostis pallens and Eragrostis lehmanniana. Wildlife present in the area includes ostrich, eland, wildebeest, kudu and springbok. Densities are very low and representative of the Kgalagadi region as a whole. There is a human population of around 300, nearly all Basarwa, settled around the only borehole in the area. The dense shrubland in most of the area and the very low game numbers result in a very low current potential for wildlife use. Small-scale (artisanal) hunting operations for biltong and trophies and limited, selective, use of trophy animals by safari operators are possible.

The designated Okwa Wildlife Management Area is fairly large (1,515,900 hectares), occupying tribal land. It is bounded on the east by the Central Kalahari Game Reserve, on the west by the Lobatse-Ghanzi road and to the north by the Ghanzi farms and the Kuke fence. It contains northern Kalahari tree savannah with some central Kalahari tree savannah in the south. Vegetation is more open than in the Groote Laagte wildlife management area, with wooded, open shrubland in the north, changing to open woodland in the south. Common
woody species are *Terminalia sericea* (north), *Acacia erioloba* (south), *Acacia fleckii*, *Acacia melifera*, *Acacia luederitzii*, *Combretum collinum* and *Lonchocarpus nelsi*. The grass layer is dominated by *Eragrostis lehmanniana* and *Stipagrostis uniplumis*. Pans are fairly common and there are several important relict rivers. Wildlife densities are low. There are a number of Basarwa settlements in the area based on boreholes and where subsistence and health services are provided by the Government. More such settlements are expected and it is considered that the area is suitable only for the development of limited small-scale hunting enterprises with extremely limited use of selected trophy animals by safari operators.

The proposed *West Ghanzi Wildlife Management Area* occupies 886,100 hectares, situated on tribal land in the Ghanzi District to the west of the Lobatse-Ghanzi road and south of the Ncojane farms. The characteristics of the area are similar to those of the Okwa Wildlife Management Area (above). Stocks of game are generally extremely limited, and species are representative of the Kgalagadi region as a whole. The Mathlo-a-Phuduhudu area is the most attractive part for tourism and appears to contain the highest game density. For the foreseeable future, potential for wildlife use is largely restricted to the development of small-scale hunting by residents of the few Basarwa settlements. Very limited safari hunting is possible.

The proposed *Kgalagadi Wildlife Management Area* is large (3,448,100 hectares), occupying all the remoter parts of the Kgalagadi District. It consists totally of tribal land and is currently under threat due to pressure for livestock grazing land. It borders on the Gemsbok National Park and the Mabuasehube Game Reserve. Currently there are no developed water sources. The vegetation is predominantly central Kalahari tree savanna with some southern Kalahari tree savanna in the south. It contains attractive short open woodland to short wooded, short open shrubland or short wooded grassland. The most important tree species are *Acacia erioloba*, *Acacia luederitzii* and *Boscia albitrunca*. *Eragrostis lehmanniana* is the dominant grass with *Stipagrostis uniplumis*, but the composition of associate species tends to change from the dry south-west to the more mesic north-east. Wildlife densities in this wildlife management area appear to be higher than those of Ghanzi District. Animals present include gemsbok, springbok, hartebeest, kudu, ostrich, lion, steenbok, duiker, black-backed jackal and other Kgalagadi region species. The area is suitable for limited tourist lodge development to
make use of the adjacent parks and reserves, limited safari hunting and small-scale hunting enterprises.

The designated Kweneng Wildlife Management Area is relatively small (607,500 hectares), occupying tribal land in the Kweneng District to the west of Khotse Game Reserve. It is bounded on the north by the Central Kalahari Game Reserve. There is no developed water supply in the area. It is essentially transitional between the northern and central Kalahari savanna types and common woody species include Acacia luederitzii, Boscia albitrunca and Lonchocarpus nelsii. Game densities are low and animals present include hartebeest, gemsbok, ostrich, steenbok and most of the other Kgalagadi species. The area is suitable for community small-scale hunting enterprises for biltong and trophies and limited safari hunting and/or tourist camp development.

The designated Ngwaketse Wildlife Management Area is small (267,200 hectares), situated on tribal land in the less settled part of western Ngwaketse (Southern) District. It contains at least one borehole developed for the purpose of livestock watering. The vegetation is characteristic of the central Kalahari tree savanna and the most common woody species include Acacia luederitzii, Boscia albitrunca and Grewia flava. Wildlife densities are very low. The area is suited to community-based small-scale (artisanal) harvesting enterprises.
Chapter 2

Conceptual framework and general methodology

2.1 Motivation for the study

This thesis is about finding out how the set of resources defined as the "wildlife resources of Botswana" can be best allocated to contribute sustainably to the welfare of Botswana society. Economics is about efficiency which in turn means giving people as much welfare or utility as they can be, given the existing resource endowment. Most contemporary definitions of economics are merely extensions of this basic thought. The thesis is an exercise in economic analysis and planning, aimed at achieving an economically efficient allocation of the wildlife resource within a set of public policy constraints.

In its Wildlife Conservation Policy (Government of Botswana, 1986) the Government of Botswana stated that it recognises wildlife as "an important national resource that must be conserved". This consideration has driven wildlife conservation since the 1950s, and led to the allocation of 17.8 percent of the country's land surface to national parks and game reserves, as well as 21.2 percent of the country's land surface to wildlife management areas. The Department of Wildlife and National Parks is entrusted with this conservation task and its objectives are (as described by Ministry of Finance and Development Planning, 1991):

- to play an effective leadership and coordinating role at national level on all matters concerning wildlife and national parks,
- to conserve manage and promote and use productively the national wildlife resources and the country's protected areas, such as national parks, game reserves and sanctuaries, and
to ensure the maintenance of a sustainable ecological balance in national parks, game reserves and other wildlife areas.

In 1987, a development plan for the Department of Wildlife and National Parks was developed (FGU-Kronberg, 1987a). This plan was based on an objective technical analysis of what was the minimum investment required to enable the department to effectively achieve its objectives. The plan involved a significant augmentation of capital and recurrent expenditures, aimed at "securing the wildlife estate for present and future generations, through both protection and the maximising of its economic benefits". Three years later, in the national Tourism Policy (Government of Botswana, 1990), the need for an significantly enhanced investment in the sector was reiterated. The main elements of the 1987 plan were included in the seventh National Development Plan (NDP7) (Ministry of Finance and Development Planning, 1991).

The Wildlife Conservation Policy (Government of Botswana, 1986) lays heavy emphasis on the full development of wildlife utilisation: tourism in national parks and game reserves, and consumptive wildlife uses, including hunting, culling/cropping, live capture, ranching/farming and product processing, in the wildlife management areas. It stresses the importance of land use zoning, both to grant wildlife a position among other resource uses, such as livestock-keeping, mining and crop production, and to allocate land according to its suitability for different wildlife uses. FGU-Kronberg (1988a) provided the first spacial analysis of the physical and technical suitability of various forms of wildlife use in the wildlife estate. This was later refined and amplified into a national, wildlife, zoning plan, for implementation during NDP7 (N.D. Hunter, Director, Department of Wildlife and National Parks, 1992, pers.comm.).

When this study was initiated, before the implementation of NDP7, the questions facing the government of Botswana were:

- Does the wildlife resource have the economic use values it is assumed to have in policy?
- What allocation of land uses within the wildlife estate will maximise the contribution of the wildlife resource to the national income, without jeopardising the maintenance of the resource and the ecological balance?
These two questions are essentially what this thesis sets out to answer, and they beget the hypothesis, already presented in chapter one: "that wildlife in Botswana can contribute positively and sustainably to national income, and that this can happen without loss of biological diversity".

The policy framework for the study was rather rigid. I needed to determine the value of the various wildlife uses which are technically possible within the context of commitments: to maintain or increase wildlife stocks, and to maintain the land zoning framework of the wildlife estate. Then I needed to determine the most appropriate allocation of resources within this zoning framework in the wildlife estate, which allowed me to maximise national income without any loss of the natural resource base. Sustainability was a dominant criterion, and efficiency was a secondary one, and equity was addressed in passing.

2.2 Methods in the context of theory

"Wildlife resources of Botswana" refers to all the resources associated with wildlife land and their physical, social and economic settings, described in chapter 1. The term "welfare" is taken as synonymous with utility or satisfaction, as determined by preferences and rights as perceived by humans. "Intrinsic" value, defined as being value in, and of, itself or the value the resource (say a species) derives from its own existence (Aylward, 1992) is not included, except where it becomes reflected in human preferences.

The contribution in welfare is derived from the supply of marketed and non-marketed goods and services from the natural capital asset, wildlife. A "sustainable" contribution implies no decline in this natural capital base over time. This is the result of the public policy constraints, described in more detail above. The welfare of "Botswana society" means the aggregate of welfare of all the individuals with Botswana nationality.

*Total economic value*

The components of welfare or utility derived from the wildlife resource are assumed to be those of total economic value as described by Pearce and Turner (1990). These include direct use, indirect use, option, bequest and existence values associated with the resources. *Direct
use values are derived from the actual utilisation of the resource (such as through hunting, wildlife viewing, etc.). They involve production and consumption of marketable products, and are generally relatively easily measured from expenditures in money and other physical resources. They contribute tangible value in the form of income, and make up the main component of formal economic growth which in turn is the focus of national development efforts. This thesis is about direct use values in the context of total economic value. Throughout, the word "use" is deployed to refer to "direct use".

Indirect use values are derived from ecological or social function (such as erosion protection, waste assimilation, political stability, etc.). Option values reflect the values perceived in retaining the option to use the resource in the future. Bequest values reflect the value perceived in preserving or retaining the resource for others in the future. Existence values reflect the value perceived in retaining the mere existence of the resource, for example, if a British citizen was prepared to pay to ensure the continued existence of elephant in Africa (even if the elephant are never to be used). Option, bequest and existence values are commonly classed as non-use or preservation values. Indirect use and non-use values present special difficulties of measurement, and no attempt is made to measure them in this thesis. Instead, the approach has been to try to maximise direct use (use) value without loss of indirect and non-use values.

The fundamental measure of economic direct use value used in this study is that of national income, as defined by Gittingser (1982) and Pearce (1986). National income is taken to mean the return in gross value added to factors of production owned by Botswana nationals. Gross value added and net value added (after deduction of capital depreciation) is measured for each wildlife use activity. The annual gross value added for each activity (enterprise) is the gross income (turnover) minus the annual intermediate costs (payments for factors external to the enterprise or belonging to non-nationals). It is made up of the returns to and of capital, and the returns to labour and entrepreneurship, where these factors belong to nationals. Annual net value added is the gross value added minus annual capital asset depreciation (Gittingser, 1982). The measure of national income used is, by itself, a conventional national accounting measure (with shadow pricing, as described below), as opposed to a green national
accounting measure\(^1\), as described by Hamilton (1994). Data are not yet available in Botswana to enable estimation of a green national income. However, by making it a component of total economic value and estimating it within the framework of the stock and land allocation commitments of the Botswana government, I am imparting some "green" characteristics to it.

The economic cost, or the cost to society, of using or producing a resource is taken to be its opportunity cost (the value of its best alternative use). Generally, the "value in use" as defined by Gittinger (1982) is assumed to be opportunity cost. The data source is financial expenditure, but where financial prices are considered to differ significantly from opportunity cost then shadow pricing is applied. The measure of value added and net value added is thus presented as opportunity cost (or economic prices, or shadow prices). It is thus a measure of economic efficiency.

The measure of economic use value is derived from data on expenditure (at financial or market prices) to which standard, national shadow-pricing criteria (discussed below) have been applied. The financial expenditure data is also used to derive a variation of use value, which is the financial return on investment for the wildlife user. This financial measure gives an indication of the private inventive for investment in the activity. The extent to which private returns differ from the economic ones is taken to indicate the influence of policy and/or market imperfections, as described by Jansen et al. (1992).

Cost-benefit analysis

The framework used to measure use value is one of cost-benefit analysis, basically that of Gittinger (1982), but also Pearce (1983) and Pearce and Nash (1981). Preliminary static budget models of wildlife use activities arrive at a measure of annual gross and net value added to the national economy at shadow prices\(^2\) (the economic value), as well as an annual

\(^1\) Green national accounts can be defined as adjusted accounting aggregates which attempt to value depletion/replenishment of natural resources, or environmental deterioration/amelioration. Ideally, all values, embracing use and non-use values, would be taken into account

\(^2\) Because these measures of value added involve shadow pricing, they are measures of economic efficiency, which the conventional measures of value added applied in national accounts are not
financial net income for the investor (the financial value). If these are positive, then they are extended to five- and ten-year net benefit flow models. These arrive at economic net present values and economic internal rates of return at economic prices. The return represents the contribution to net national income as defined above. To measure private incentives, the models also arrive at financial net present value and financial internal rate of return.

The net present value (NPV) measure can be formally described as:

$$NPV = \sum_{t=0}^{t=T} (B_t - C_t) \cdot \frac{1}{(1+r)^t}$$

where \( t \) is the time in years, \( T \) is the life of the project or the period of analysis, \( B \) is the benefits in year \( t \) (where \( t = 1, 2, \ldots, T \)), \( C \) is the costs in year \( t \), and \( r \) is the discount rate. The basic model is applied in both economic and financial analyses.

The formal description of the internal rate of return (IRR) is:

$$IRR = \sum_{t=0}^{t=T} (B_t - C_t) \cdot \frac{1}{(1+r^*)^t} = 0$$

where \( r^* \) is the rate of return at which the condition, \( NPV = 0 \), is met.

Cost-benefit models of wildlife use activities were detailed spreadsheets, subjectively developed to be representative examples of wildlife use activities for relatively homogeneous wildlife utilisation regions. Data for the models were derived between 1988 and 1992 from various sources including (in 1988) 70 financial statements (income statements and balance sheets) accompanying income tax returns from wildlife use enterprises, 27 financial budget projections contained in applications for permits (from prospective wildlife users in the private sector) to the Department of Wildlife and National Parks, and 11 sets of results from enumerated financial questionnaire surveys of specifically targeted wildlife use enterprises.
Wildlife and other use activities modelled, include lodge-based wildlife viewing, safari hunting, community game cropping, game ranching, livestock (beef) ranching, ostrich farming, crocodile farming and ranching, elephant cropping and wildlife product processing. Appendix 2.1 depicts specimen examples of enterprise models; the first for a safari hunting enterprise in the Okavango-Chobe region and the second for an ostrich breeding and rearing enterprise in the Limpopo region.

Rigorous sensitivity analysis was used to determine how robust the models and assumptions were, and the strength of any conclusions that could be drawn from the results. Interest was excluded from all calculations except for that of net cash income. Inflation was excluded from cash flows, which necessitated the use of real discount rates. In the five- and ten-year models all capital expenditures were included and depreciation (or appreciation) was accounted for in the residual value of assets in the final year of analysis. In all the economic models inflows from, and outflows to, non-nationals were treated as benefits and costs, respectively.

*Shadow pricing* was aimed at ensuring that values applied to inputs and outputs reflected their real scarcity in society (the cost to society of their being used or produced in the specific activities). The criteria were based on those in use by the Botswana central planning authorities to appraise applications for the Financial Assistance Policy (FAP) grant system. Ministry of Finance and Development Planning (1986) and Matambo (1988) described the criteria used. Apart from the inclusion of inflows from, and outflows to, non-nationals (treated as benefits and costs) the approach is similar to those described in manuals developed for South Africa (CEAS, 1989) and the World Bank (Gittinger, 1982).

Where there is unemployment and social pressure for higher wages, the market price of labour is generally higher than its scarcity value. A general shadow price for unskilled and semi-skilled labour of 0.5 of the market price was applied in all models to reflect general unemployment. This is the shadow price recommended by the central planning authorities (Ministry of Finance and Development Planning, 1986; Matambo, 1988). In Botswana general unemployment is significant but unlikely to be more than that in South Africa as a whole, and likely to be less than that for neighbouring Namibia. In Namibia in 1994, the shadow price of unskilled labour was coarsely estimated to be some 0.35 of the market price.
It can be reasonably assumed that Botswana and South Africa have a similar shadow price.

The Central Economic Advisory Service in South Africa (CEAS, 1989) made detailed estimates of 1987 shadow wages for unskilled labour in different development regions in that country. These estimates were based on the average income per earner in the region concerned. They were highest in the urbanised Gauteng (PWV) area and in the Western Cape, and lowest in the northern and eastern regions of the country. If one takes the average of the unskilled shadow wages estimated for the South African regions, and inflates it (by 10.85 percent per annum) to 1990 prices, it can then be compared with the financial wage for unskilled labour, determined empirically in Botswana for wildlife use activities in this thesis. The result of this comparison is a factor of 0.46 to be applied to financial unskilled labour wages to arrive at the shadow wage. For this thesis, it thus seems reasonable to adopt the officially accepted factor of 0.5. The market price of skilled labour and management was considered to be equal to the economic price.

Wherever there is excess demand for traded and tradable goods and services, economic analysis should include a premium for foreign exchange. Such excess demand commonly results from exchange control restrictions and the artificial setting of exchange rates. The Botswana pula is pegged to a pula evaluation basket comprising the SDR and the South African rand. The value of the pula closely followed that of the rand during the study. The rand exchange rate is free floating but, during the study, was maintained at some ten percent above a true market value due to foreign exchange restrictions, typified by a dual exchange rate system. Matambo (1988), considered the pula to be overvalued in the short term because the current rapid economic growth due to diamond exports cannot be maintained for long.

During the period of study, all imports to Botswana from outside the Southern African Customs Union (SACU) were subject to customs duties or tariffs, paid into a SACU revenue pool from which revenue payments were made to Botswana. The SACU tariffs had a protection effect which almost certainly influenced prices of all or most Botswana’s imports, including imports of products manufactured within SACU, such as those produced in South Africa. The prices tend to be higher than they would be without the tariffs. This causes excess demand for foreign exchange and therefore it causes the need for a foreign exchange
premium. However, as explained by Low (1996), the SACU revenue sharing arrangement is specifically designed to compensate smaller SACU members, such as Botswana, for the price-raising effects of SACU tariffs. It can be assumed that SACU receipts (economic benefits) approximated the economic costs of the SACU tariff effect. This means that any foreign exchange premium applied in shadow pricing in Botswana must be based on the short-term overvaluation of the exchange rate alone. A foreign exchange premium of ten percent was added to the prices of all tradable items in this study. This conforms with the official rate applied by government at the time of the study, in the appraisal of Financial Assistance Policy (FAP) grant applications.

The effects of domestic taxes and subsidies on market prices were removed where necessary, to get economic prices. During the study, the Botswana economy was relatively free of such transfers, so that only licence and permit fees and some input/market subsidies specific to livestock production were involved. There were no indirect sales taxes or duties. Licence and permit fees included entry fees for protected areas, hunting licences, export duties for wildlife products, land rentals and resource royalties (payable to local communities). Import duties and taxes were negligible for imports from within SACU, which was where nearly all the imports dealt with in the study were from. The only input and market subsidies were those for livestock production. These are described specifically in chapter 7.

In both financial and economic analyses, cost and benefit flows were discounted over time to reflect the time value of money. Constant prices were used in cost and benefit streams (inflation was excluded) so that discount rates had to be in real terms. It has been argued by some that discount rates for economic analysis of environmental projects should be kept low to ensure that inter-generational equity values are accounted for. It is perceived that environmental benefit and cost flows are commonly long term in nature while benefits and cost flows associated with development are short term in nature. High discount rates thus undervalue environmental services.

There is in fact, no unambiguous relationship between environmental degradation and high discount rates (Pearce and Turner, 1990). The latter tend to slow investment reducing the pace of economic development and thus, often, environmental damage. They also discount the long-term costs associated with maintaining environmental benefits and the long-term
development benefits associated with the generation of long-term environmental costs. It is suggested that there is no sound basis for lowering discount rates on environmental grounds, and that inter-generational equity considerations need to be accounted for separately.

The private opportunity cost of capital, provides a realistic discount rate for financial analysis. The opportunity cost of capital can also be used for economic valuation but here the long-term cost of funds to the state is relevant. Generally high discount rates reflect scarcity of capital relative to investment opportunities and favour labour intensity over capital intensity. According to CEAS (1989), the World Bank considers the opportunity cost of capital in developing countries to be commonly between eight and ten percent. The rate recommended by CEAS (1989) for use in South Africa is between eight and ten percent. The appropriate economic rate is considered to be higher than the financial rate.

During the study in Botswana, financial resources were relatively abundant and inflation was relatively low, in comparison with conditions in South Africa. The Ministry of Finance and Development Planning (1986) and Matambo (1988) recommended use of a discount rate of between six and eight percent for relatively risk-free projects. The private discount rate was again considered to be lower than the economic or public sector rate. For this study a discount rate of six percent was applied to both economic and financial economic models. Different rates were also applied in sensitivity analysis and, as described below, a risk premium was included in the financial rate.

The Ministry of Finance and Development Planning (1986) and Matambo (1988) recommended using a premium on the discount rate to reflect risk. Others (Markandya and Pearce, 1991) consider this inappropriate and suggest adjusting for risk in other ways. The US Secretary of the Interior (1988) commissioned a study in which cost-benefit farm-simulation models were used to evaluate effects of federal policy on wetlands in the United States (USA). This analysis was accompanied by coefficients of variation, characterising seasonal variation in farm production, which were measures of farming risk. Such an approach is absent from the models in this study. Instead, in accordance with the official Botswana approach, my financial discount rates incorporate a risk premium of six percent. Thus, for financial analysis the rate used was 12 percent (the six percent premium was added to the discount rate).
In the financial enterprise models, the value of land was reflected as a cost in rentals. In the economic analysis, land rental was treated as a domestic transfer and excluded. My economic measures of enterprise value are thus made before inclusion of land opportunity costs (i.e. the economic cost of land is assumed to be zero for all models). The economic enterprise models also did not include central government expenditures in the wildlife and agricultural sectors, because these expenditures are extremely difficult to allocate correctly, and also because it is conventional to treat the public sector separately in national income accounts.

Cost-benefit models aimed at analysing the value of projects, strategies and policies at regional or sectoral level were constructed using the financial and economic enterprise models as basic building blocks. Here (in cost-benefit models of elephant management, of game protection/off-take strategies, and of the whole wildlife sector), central government expenditures were normally included. The opportunity cost of land was included in the linear programming model of the wildlife sector, described below; although it must be noted that this was incomplete in that one important alternative land use, traditional livestock keeping, was excluded from the model.

The treatment of training costs in cost-benefit models depended on whether they were borne by the investors themselves or others. Training costs incurred by enterprise or project investors were treated as costs in financial analysis. Those incurred by foreign donors were treated as benefits financially and economically. In all other cases they were ignored because it was assumed that during the analytical time horizon, commensurate benefits accrued to the economy as a result of the expenditures. No attempt was made to incorporate demand or supply effects on price in the cost-benefit models. Thus, except where demand is infinitely price elastic, expansion of different wildlife use activities in models was assumed to take place within the growth rate of overall demand for the relevant product(s). The economic cost-benefit models also did not take account of any consequential changes in consumer surplus. This is because in Botswana most (some 70 percent of) output modelled was for export and thus most of any consumer surplus changes did not affect national welfare.
Econometric analysis

Simple ordinary least squares regression was applied to characterise the price - quantity demand function for wildlife viewing tourism. Four functional forms were tested on the data to try and find the best fit. These forms can be described as follows (Gujarati, 1988).

linear model:

\[ Y_i = \beta_1 + \beta_2 X_i + u_i \]

Semi log (log-lin) model:

\[ \ln Y_i = \beta_1 + \beta_2 X_i + u_i \]

Log-linear (log-log or double log or constant elasticity) model:

\[ \ln Y_i = \ln \beta_1 + \beta_2 \ln X_i + u_i \]

Reciprocal model:

\[ Y_i = \beta_1 + \beta_2 \left( \frac{1}{X_i} \right) + u_i \]

Where \( Y_i \) is the dependent variable, \( X_i \) is the explanatory variable, \( \beta_1 \) is the intercept, \( \beta_2 \) is the slope coefficient, \( \ln \) is the natural log, and \( u_i \) is the stochastic error term.

Linear programming

To determine appropriate allocation of resources within the wildlife utilisation sector as a whole, a linear programming model, as described by Jameson et al. (1974), Doll and Orazem (1984) and Dykstra (1984), was developed. The linear programming model maximised net national income returns to land, capital, labour, management and various other physical inputs which could constrain development. The policy framework of analysis, described under 2.1,
above, required that there be no loss of wildlife stocks over time, and that certain land allocation commitments be adhered to.

The mathematical model of linear programming is presented by Dykstra (1984). In the model the problem is to find a set of numbers \( x_1, x_2, \ldots, x_n \) that maximises an objective function:

\[
z = \sum_{j=1}^{N} C_j x_j
\]

within a set of constraints, such that:

\[
\sum_{j=1}^{N} A_{ij} x_j \begin{cases} \leq & B_i \\ \geq & B_i \end{cases} \quad i = 1, 2, \ldots, M
\]

and

\[
x_j \geq 0 \quad j = 1, 2, \ldots, N
\]

where \( N \) is the number of decision variables, \( M \) is the number of constraints, \( x_j \) is the decision variable, \( C_j \) is the objective function coefficient (often called cost coefficient regardless of whether the objective function measures cost) corresponding to variable \( x_j \); \( A_{ij} \) is the technological coefficient corresponding to variable \( x_j \) in constraint \( i \), and \( B_i \) is the right-hand side constant for constraint \( i \).

No attempt was made to incorporate demand functions, supply functions, or risk in the linear programming model, as described by Ortmann (1988). Thus again, except where demand is infinitely price elastic, expansion of different wildlife use activities in the model was assumed to take place within the growth rate of overall demand for the relevant product(s).
Sustainable wildlife utilisation is defined here as that where wildlife populations are stable or increasing (use values are thus stable or increasing). This is prescribed by the policy framework, described in section 2.1 above. It is assumed that this also means no net loss in non-use values. Thus, sustainable wildlife use should mean stable or increasing total economic value for wildlife. Because knowledge about the effects of use on non-use values is weak, the tendency is for assumptions about the sustainability to be subjective. Where an empirical estimate has been made on the current contribution of wildlife to national income (chapter 12), this has only been made once, so that it is not a "green" estimate, as described by Hamilton (1994) and Pearce et al. (1996) where changes in national income are adjusted for changes in the stocks of natural resources.

Sustainable consumptive off-take from wildlife populations is calculated according to the method used by Spinage (FGU-Kronberg, 1987b) which followed the rule that the sustainable off-take rate is 0.4 \( r_m \), where \( r_m \) is the intrinsic rate of increase of the population and a function of body weight of the species concerned. A simple relationship between the intrinsic rate of increase and body weight for animal species was described and determined by Caughley (1983) and Caughley and Krebs (1983) as:

\[
\frac{r_m}{0.36} = 1.5 W - 0.36
\]

Where \( W \) is the mean of the average live body weights of adult males and females.

Craig and Lawson (1990) recommend using a factor of 0.5 rather than 0.4 to get the sustainable off-take from the intrinsic rate of increase of each species. In both cases the factor is applied based on the assumption that the population is at ecological carrying capacity and that, with utilisation, it will stabilise at around 0.5 or 0.4 of that level. Ecological carrying...
capacity is defined as $k$ in the well known logistic model of population growth (Krebs, 1985; Starfield and Bleloch, 1986; Hartwick and Olewiler, 1986; Pearce and Turner, 1990):

$$X_t = \frac{k}{1 + e^{a-r}}$$

where $X$ is population size, $t$ is time, $k$ is the maximal value of $X$, $e$ is the base of natural logarithms, $a$ is the constant of integration defining the position of the curve relative to the origin, and $r$ is $r_m$ or the intrinsic annual rate of increase of population.

The biological maximum sustainable yield, which is $r_m$, is defined as occurring when the derivative of the logistic growth (or rate of growth, or sustainable off-take) function is equal to zero:

$$\frac{dX}{dt} = rX \left(\frac{k-X}{k}\right) = 0$$

The sustainable off-take function multiplied by the price of off-take product results in a sustainable revenue function. The economic carrying capacity in the logistic model is defined as the stock level at which the net economic benefit, or difference between the revenue and costs of off-take, is greatest. In the logistic growth function model this is the point where the slope of the sustainable revenue function equals the slope of the appropriate cost function describing off-take of the species. Open access equilibrium is assumed to result when the system has no restrictions on access (off-take) and unrestricted competition dissipates net economic benefit to an equilibrium point where revenues equal costs. Appropriate common or private property rights are assumed to be necessary to avoid open access problems and allow attainment of economic carrying capacity.

No attempt is made in this thesis to determine the economically optimal stock levels in the dynamic context, for example, with optimal control models. As shown by Pearce and Turner (1990), Clark (1985, 1990), Chapman (1993) and Roughgarden and Smith (1995), inclusion of time lag effects and the discount rate result in higher economically optimal stock levels than are revealed by the static logistic model. Roughgarden and Smith (1995) show how
economically optimal harvesting strategies determined using dynamic models tend to be unstable biologically, and suggest that stock levels below that of maximum sustainable yield should be selected for this reason. Thus the use of 0.4 to calculate sustainable off-take rates, while conservative, can be considered biologically safe. It has generally been adopted for calculation of off-take rates.

Some cost-benefit models in this thesis contain dynamic animal population models. In ranch and farm models, herd/flock projections were developed on spreadsheet, incorporating birth rates, mortality rates, off-takes and purchases, within the constraint of ranch/farm physical carrying capacity. In cost-benefit models to examine the trade-off between protection and/or off-take strategies free ranging game populations are assumed to grow at constant rates of $0.5r_m$. In these models constant or exponential growth according to the model:

$$\frac{dX}{dt} = rX$$

is applied instead of logistic growth. This is partly for simplicity, but also because it is not well established that population growth in large mammals always conforms to a logistic pattern. Some empirical evidence (Craig and Lawson, 1990) suggests that, at least at low levels, wildlife populations may exhibit constant growth.

*Biological carrying capacity* is defined as the area of habitat required to support one large stock biomass unit, while the animal population is such that maximum sustainable yield is possible. This varies spatially with mean annual rainfall, vegetation type, the animal species or community involved, and other factors. It also varies temporally with climatic factors, most importantly rainfall. *Biomass* is used as a measure of wildlife and livestock density and calibrated in *large stock unit equivalents* (LSU). One LSU is the metabolic mass equivalent of a 450 kilogram bovine steer or ox, as determined for various species and intra-specific age groups by Meissner (1982).

Wildlife and plant species nomenclature follows that of Smithers (1971, 1983) for mammals, Maclean (1993) for birds, Patterson (1987) for reptiles, Coates Palgrave (1977) for trees and
shrubs, and Gibbs Russell et al. (1990) for grasses. Common names for animals and scientific names for plants, are used in the text. Appendix 2.2 provides a complete list of common and scientific names used in the text and their corresponding scientific or common ones, respectively.
Chapter 3

Review of wildlife economics in Africa

3.1 Background

In this chapter the development of wildlife economics as a field of study in Africa, is described. Emphasis is placed on southern and eastern Africa, and on work that has influenced this thesis. The treatment is brief because others (Pearce, 1996; Wells, 1996) have already partially reviewed the topic and because much review and evaluation of literature is reserved for specific topics dealt with later in the thesis.

Wildlife economics in Africa remains embryonic. It behoves us first to look further back at its evolution elsewhere in the world. The use value of wildlife to early man was as an object of subsistence hunting. Later this was supplemented by the recreational value of hunting, and in some cases, commercial cropping of game. Even more recently, this century, wildlife has become the object of viewing activities.

Generally, wildlife has been considered a public resource. In instances where it became scarce from overuse, the tendency has been for the state to simply restrict access to it. Wildlife conservation involved policing the use of the resource and eliminating predators. Later, it came to be recognised that active management of wildlife populations could enhance their availability for use and the study of the ecological aspects of wildlife became an important activity.

Leopold (1933) in his book on game management, presented a good account of leading developments in wildlife conservation at that time. He drew attention to recreational values
and the relationships between these, human populations, wildlife management intensity and naturalness. This was an early recognition of values associated with wildlife and the need to incorporate these in wildlife policy. However, very little consideration was given to measuring and comparing the values of wildlife, until well into the 1950’s. These values were generally seen as intangible and external to the realm of economic analysis.

Most early developments in wildlife economics took place in north America and these have tended to fall into two categories. On the one hand the persistent problem of low income in Canada’s commercial marine fisheries was subjected to ground-breaking economic and biological study by Gordon (1954), Schaefer (1957) and others. This early theoretical work on fisheries in the 1950s forms the basis for much current economic theory of consumptive wildlife use. Since then empirical evidence has consistently borne out these early findings. The emphasis was on the biological production function and the effects of common property management systems on consumptive use systems.

On the other hand, the predominantly unpaid for recreational use value of terrestrial wildlife was subjected to economic empirical analysis of a somewhat different type by Clawson (1959), Knetsch (1963), Davis (1964), Robinson (1967) and others. Here the emphasis was on estimating demand functions and measuring the consumer surpluses associated with outdoor recreational pursuits such as hunting and nature tourism. Important field techniques, such as contingent valuation and travel cost analysis, to measure wildlife users’ expenditures and consumer surpluses were developed. The emphasis has been on demand functions with little work being done on the relationships between investment in, and supply of, recreational services.

A vast international literature has developed around these two main fields of endeavour in wildlife economics. Work on fisheries economics has tended to result in sophisticated theoretical modelling as described by Clark (1985, 1990) and Munro and Scott (1985). Similarly, the techniques used to estimate wildlife use amenity values have become very sophisticated (McConnell, 1985). Besides being used to measure use value, the contingent valuation technique has been successfully applied in the measurement of the non-use values of wildlife (Brookshire et al., 1983; Fisher and Krutilla, 1985; Kristroem, 1990; Boman and Bostedt, 1995).
3.2 Wildlife economics in Africa

Early basic work

Much of the following review does not deal with economics as such, but instead work that formed the basis for African wildlife economics, which remains very much in its infancy. The 1960s saw the first serious attempts to develop the potential for production of meat and hides from African wildlife. Dassman and Mossman (1961) described the biological potential for cropping wildlife, most notably impala, on private ranchland in south-west Zimbabwe. They were instrumental in the initiation of several cropping schemes in Zimbabwe during the 1960s. Later evaluation suggested that sustainable off-take rates (and thus financial viability) might have been overestimated (Caughley, 1983). Mossman and Mossman (1976), evaluating these projects found that by the late 1960s safari hunting had largely replaced cropping as the main income-earning activity on game ranches.

Consumptive wildlife use on private land in Zimbabwe expanded, primarily owing to the introduction of relatively profitable safari hunting tourism activities. Johnstone (1975) published a useful, empirical financial budget analysis of the use of private land for safari hunting and venison production, and in Botswana, Manning (1977) published some succinct financial data on wildlife cropping on private land in the Tuli Block of the Limpopo region. Collinson (1979) presented the results of a brief, simple analysis of the financial viability of impala cropping in a cattle and game ranch system in Natal. A few studies were conducted on game bird and waterfowl shooting mostly on private land in southern Africa (Woodall, 1975; Dixon, 1978). These were unusual studies, in that shooters were surveyed to estimate the national financial impacts of these activities. The basis for viable use of wildlife on private land in Africa had been set.

In East Africa attention was drawn to the potential for medium- to large-scale cropping of vast, free ranging wildlife herds on public land for meat. Bindernagel (1968, 1975) examined the physical potential for this in Uganda and Tanzania. Reinwald and Hemingway (1968) published a useful empirical analysis of the financial profitability associated with a zebra cropping scheme in the Rukwa valley in Tanzania. Jahneke (1972), in Uganda, undertook what was possibly the first truly economic study of a whole wildlife sector. As part of this he
determined the financial viability of existing and potential government wildlife cropping schemes. Hampson (1974a, 1974b) did a detailed analysis of the financial viability of wildlife (mostly wildebeest and zebra) cropping in the Kajiado district of Kenya, using data from a United Nations Development Programme/Food and Agriculture Organisation (UNDP/FAO) pilot project. Apoli Mugwanga (1974) examined financial viability of canning meat from this source. Densham and Tomkinson (1979) provided useful empirical financial data from the cropping of impala, nyala and wildebeest in Mkusi Game Reserve, KwaZulu-Natal, South Africa. In all these studies profitability tended to be low. Apart from elephant cropping in southern Africa, no medium- to large-scale cropping initiatives on public land endured into the 1980s. Parker (1984) pointed to disturbance effects and marketing costs as well as generally low profitability, as reasons for their collapse.


Guided safari hunting for tourists on public land was found to be a financially efficient activity, and to have a significant financial impact within economies. Clarke and Mitchell (1968) in Kenya, and Prowse (1974) in Botswana, provided empirical financial data from both tourists and operators to this effect. Jahnke (1972) in Uganda derived useful measures of the economic value of safari hunting by tourists and recreational hunting by residents. The latter was shown to be less important and less economically efficient than the former.

Some early ground-breaking work was done on both the financial and the economic aspects of non-consumptive tourism in East Africa. Mitchell (1968) in Kenya, outlined the economic principles needed for analysing the contribution of wildlife viewing to the national income. This included use of opportunity cost for valuation. Then he undertook one of the first cost-benefit analyses for a protected area in Africa (Mitchell, 1969). This involved a 30-year
projection of returns to government investment in the Amboseli National Park, and showed positive returns.

Jahnke (1972) applied shadow-pricing techniques to determine the social value of national parks and game reserves, in relation to the costs of government investment in them, in Uganda. Protected areas were found to have positive net social value, primarily as a result of wildlife viewing lodge development. At the same time Thresher (1972) developed a hypothetical cost-benefit model for a Tanzanian national park, and went on to develop a detailed, computerised, cost-benefit simulation model of tourism development for Amboseli National Park and the surrounding wet season game dispersal areas, in Kenya (Thresher, 1976). This built on Mitchell’s model and confirmed that positive financial returns were possible from investment in the park. He also used an impact analysis approach to demonstrate the high economic value attributable to a male lion in Amboseli (Thresher, 1977).

Unfortunately, apart from an internal appraisal undertaken in 1977 by the World Bank on an investment in Kenya’s parks (Umetsu, 1993), this useful, early, cost-benefit analysis work in East Africa seems not to have been built on. In Botswana, consultancies were commissioned to plan tourism developments, and some provided useful financial as well as economic data. Huntington-Rockford International (1970) did detailed financial analyses of recommended private sector tourism developments in the north. The Irish Tourist Board (1979) in Botswana, made an estimate of the national income multiplier using a macro-economic model and postulated a multiplier of 1.1 for the tourism sector in the north of Botswana.

It is notable that the approach taken in valuing wildlife use in Africa was somewhat different to those manifested in north America. The general tendency in Africa, was to develop financial budgets for wildlife use activities, usually with the aim of determining profitability. This financial data formed the basis for limited economic analysis, where shadow prices were applied, cost-benefit models were developed and impacts were determined.

Economics of wildlife use on private land

Much of southern Africa and small areas in eastern Africa are covered with private commercial farm land. In areas receiving mean annual rainfall of less than about 750
millimetres, extensive livestock production, based on natural rangeland is the norm. In this setting the use of wildlife has developed as a supplementary activity and, to a lesser extent, as a primary one.

As previously stated, the early work on wildlife ranching in Zimbabwe, showed safari hunting to be an important contributor to viability. Child (1984, 1988) undertook the first serious study of the comparative financial and economic characteristics of wildlife and livestock on private land. This involved the use of empirical financial records from a sample of ranches to estimate financial profitability. Shadow pricing of these made it possible to show that wildlife use on ranches in south-east Zimbabwe was *economically* more viable than livestock production. Cumming (1990a) and Cumming and Bond (1991) laid the ground for further rigorous work along these lines in Zimbabwe. Detailed empirical research, also using a static budget framework, was done and reported on by Jansen *et al.* (1992), Bond (1993) and Kreuter and Workman (1994a, 1994b). A *policy analysis matrix* was used in each of these studies to compare the economic values with financial ones. Findings generally confirmed those of Child but the economic superiority of wildlife ranching was less clear, particularly in higher rainfall zones.

In South Africa, Benson (1988) and Behr and Groenewald (1990a) provided useful physical, social and gross income data on private land wildlife users, from a detailed postal survey with some 1,500 responses. Several other studies, also in South Africa, have involved financial analysis of wildlife ranching activities, to determine profitability. Berry (1986) made a useful comparative study of different wildlife use activities on a large private estate in the northern Cape Province. This empirical work has been continued with results being presented periodically (Berry, 1991; Bigalke *et al.*, 1992). Behr conducted a fairly detailed analysis of wildlife ranching budgets from a sample of 12 ranches (Joubert and Behr, 1986; Behr, 1988; Behr and Groenewald, 1990b). Other relatively brief, financial analyses of wildlife ranching using budgets were made by Loxton Venn and Associates and Rural Development Services (Pty.) Ltd. (1985) in North West Province, Davies and Chadwick (1991) in KwaZulu-Natal and Grobler (1991) in the Eastern Cape.

In Namibia, early financial analysis of different wildlife use activities on arid land, private ranches was done by Brand (1984). Barnes and de Jager (1996) and Swanson *et al.* (1996)
recently applied the same cost-benefit analysis techniques which I use in this thesis to measure financial and economic values for various wildlife and livestock ranching combinations at different scales in Namibia. In Kenya, Thresher (1980), compared the financial viability of producing domesticated oryx and cattle in arid ranchland. Also in Kenya, a study by McDowell et al. (1983) compared the financial viability of wildlife use with livestock production on the Athi-Kapiti plains.

In Botswana, White (1985) developed a financial budget model for a wildlife ranch in the Ghanzi District and Booth (1988) did a simple budget for a Tuli Block ranch. The financial models which form the basis of the work presented in this thesis are those of Barnes (1988), FGU-Kronberg (1988a) and Conybeare and Rozemeijer (1991). A general finding from all of the African studies, above, was that production of wildlife on ranches has low financial profitability owing to its high capital requirements and low product values. Economic viability tends to be higher due to various price distortions. Safari hunting was a small but important contributor to viability throughout.

Very little work on the financial or economic viability of intensive wildlife production systems (for example, crocodile or ostrich production) was done prior to this thesis. Pass (1983) constructed a rather detailed financial cost-benefit model of a crocodile farming venture in the Luangwa valley in Zambia. A brief study by van der Riet (1987) in Zimbabwe showed the importance of scale to the financial profitability in crocodile farming. Both these studies showed intensive crocodile production systems to be relatively profitable compared with extensive game ranching. A recent study on the financial values associated with recreational greywing francolin shooting in the Eastern Cape, South Africa (Crowe et al., 1994), showed this activity to have financial importance to farmers and the economy as well as indirect use value.

Economics of community-based wildlife use

Much of what might be called public land in Africa is under communal tenure. Wildlife on communal land is a public resource. The general failure of early medium- and large-scale wildlife cropping systems on public land, the problems of de facto open access on communal land, and the failure of national governments to protect public wildlife on communal land, all
pointed to the need for community involvement in wildlife conservation and use. Various workers continued to document the scale and importance of small-scale cropping of wildlife for subsistence and commercial purposes. Asibey (1980), Martin (1983) and Juste et al. (1995) have illustrated cases in West African forest habitats, while Tanaka (1980) and White (1986a) did so for Botswana. Sale (1981) reviewed and evaluated this work, documenting resource use volumes and prices, and making recommendations for future research. Recent work in Kenya, Zimbabwe and Namibia has been aimed at developing improved methods for the difficult task of appropriately valuing small-scale natural resource use (Lynam et al., 1994; Emerton, 1996a, 1996b; LaFranchi, 1996).

Technical, but also financial, proposals for wildlife use within communities in Botswana were developed by Economic Consultancies (Pty.) Ltd. (1985), Environmental Services Botswana (1986, 1988), and FGU-Kronberg (1988a). UNDP/FAO (1978, 1980) developed detailed financial plans for the development of wildlife viewing tourism on group ranch (communal) lands in Kajiado District, Kenya, where the rural communities would derive benefits through revenue sharing. The vehicle for income distribution was to have been a central or district wildlife utilisation fund.

The need for appropriate property rights for public land wildlife and resources was highlighted by Brown (1983a) in Botswana and by Pass (1983) in Zambia. Further, the need for common property management institutions for management of communal land wildlife, was pointed out by Martin (1986), Child and Nduku (1986) and Cumming and Bond (1991) in Zimbabwe. Community-based wildlife use projects were subjected to financial analysis by various workers. Pass (1983) in Zambia and Clarke et al. (1986) in Zimbabwe, examined the financial efficiency of the use of wildlife in communal land setting. Murindagomo (1989), Jansen (1989, 1990), Bond (1993, 1994) and Child (1993) in Zimbabwe, Cumming and Taylor (1989) in Botswana, and Barbier (1992), all provided financial data and analyses of proposed and existing community, wildlife use initiatives, where safari hunting was the main form of resource use. Jansen, quoted by Muir et al. (1994), undertook primarily financial cost-benefit analysis of three such projects in Zimbabwe and found positive net present values.
Important and valuable work was that of Ruitenbeek (1989, 1990, 1992, 1994), associated with community use of tropical forest wildlife and other resources in and around the Korup National Park in Cameroon. Here a detailed economic cost-benefit model was developed, including direct and indirect use values as well as social non-use values. More recently, in Namibia the methods which are used in this thesis have been applied to community-based wildlife use plans and initiatives. Barnes (1995a, 1995b), Ashley et al. (1994), Ashley and Garland (1994), Ashley (1995) and Ashley and Barnes (1996) all determined both financial and economic values for community-based natural resource use in communal land. The dominant form of resource use in these examples was non-consumptive tourism.

Generally the development of community-based wildlife use was found to be financially and economically viable. Where problems have arisen they tend to be institutional or structural in nature (Jansen, 1990; Barbier, 1992; Barrett and Arcese, 1995).

Economics of wildlife-based tourism and preservation

Whenever there have been attempts to place value on the formal components of wildlife sectors in Africa, the value of tourism on public lands, particularly non-consumptive tourism in protected areas, shows up as having the highest aggregates. Studies and data presented by Jahnke (1972) in Uganda, International Trade Centre (ITC, 1989) in Tanzania, Muir et al. (1994) and Bond (1996) in Zimbabwe, UNDP/FAO (1980) in Kenya, and FGU-Kronberg (1988b) and Tyler (1996) in Botswana, all highlighted the relative financial or economic importance of consumptive and non-consumptive wildlife-based tourism, compared with other wildlife uses, on public land.

Several studies have used surveys of tourists or operators to simply estimate aggregate expenditures for non-consumptive tourism in wildlife areas. These include the work of Fowkes (1985) and Borge et al. (1990) in Botswana. Others have attempted to assess costs and benefits associated with park development and the use of wildlife through tourism in parks. Here the financial cost-benefit analysis of Settlement Planning Services (Pty.) Ltd. (1991), and the somewhat unorthodox economic analyses of Davies (1993) and Engelbrecht and van der Walt (1993), all in South Africa, are relevant. These studies all concluded that investment in protected areas could be recovered through tourism. Boonzaaier and Brockett
(1987) conducted a financial analysis of costs and benefits for Pilanesberg National Park in North West Province, South Africa, in which the values of wildlife stocks were taken into account.


An interesting approach to valuation of wildlife-based tourism has been applied by Norton-Griffiths (1994) and Norton-Griffiths and Southey (1995) in Tanzania and Kenya. The opportunity costs of land allocated to wildlife conservation were valued and found to outweigh the estimated net benefits of wildlife-based tourism. Norton-Griffiths (1996) has followed this with a more focused cost-benefit analysis of the Mara Reserve in Kenya. The results highlighted the need for international transfers to secure investments in wildlife there. In KwaZulu-Natal, Creemers (1996) and Creemers et al. (1995) have combined an economic impact analysis approach with the concept of opportunity cost to illustrate the value, at local, national and international scale, of wildlife resources for tourism. Vorhies and Vorhies (1993) did an interesting cost-benefit analysis of the proposal to introduce lion to the Pilanesberg National Park in North West Province, South Africa (an economic study although financial prices were used). Skonhoft and Solstad (1996) and Schulz and Skonhoft (1996) have built theoretical models of hypothetical park/park neighbour interactions in east Africa, which tend to confirm the empirical findings, above.

A relatively recent development in wildlife economics in Africa has been the application of contingent valuation, travel cost analysis and associated methods, to value demand for wildlife use, among tourists and others. This is an extension of the tried and tested north American
recreational demand field of work (referred to in the introduction to this chapter). Brown and Henry (1989) conducted a preliminary contingent valuation and travel cost analysis of the value of elephant viewing in Kenya. This was followed by a more detailed study of the consumer surplus associated with wildlife viewing visitors in Kenya, generally (Brown et al., 1994; Moran, 1994). Navrud and Mungatana (1994) conducted a similar study which was focused more specifically on use by foreign and resident tourists of Nakuru National Park, also in Kenya.

In Zimbabwe, Brown et al. (1995) combined a contingent valuation/travel cost study with analysis of expenditures and leakage to determine the economic value of wildlife viewing in Hwange and Mana Pools National Parks. Barnes et al. (1997) in Namibia applied the same contingent valuation technique that is applied in this thesis, to measure expenditures and the willingness-to-pay among tourists for wildlife viewing and wildlife conservation in the country. The results were used to obtain aggregate economic direct use values for wildlife viewing. Also in Namibia, Söderstedt (1995) developed preliminary travel cost models for the use of Etosha National Park and Waterberg Plateau Park. She found demand for park use to be price-elastic but considered that the homogeneity assumption had been violated. Travel cost models have been developed in South Africa by Turpie (1996) for the De Hoop coastal nature reserve in Western Province, and by Geach (1997) for the Addo Elephant National Park in Eastern Province.

A few studies in Kenya, have provided useful information on tourist carrying capacities. Western (1975, 1986) and Henry (1980) studied and reported on these in the Samburu, Shaba, and Mara Game Reserves, and the Amboseli National Park. Tourism use rates in Kenya are high so the data is particularly useful. Child and Heath (1990) pointed out that park pricing structures in Zimbabwe were economically inefficient. Other studies have applied economic data and principles to the analysis of park and wildlife area pricing structures in Tanzania (Clark et al., 1995), Zimbabwe (Jansen, 1993) and Namibia (Barnes et al., 1997; Stoltz, 1996, 1997). In all cases fee increases within a differentiated structure were recommended for economic efficiency.

Non-use values for wildlife have received very little attention so far, but have been the subject of some study in South Africa. Holland (1993) surveyed tourists visiting four parks and
resorts in KwaZulu-Natal to determine their perceived option, bequest and existence values for these sites. Oellerman et al. (1994) used contingent valuation to determine the existence value of a small wetland in Mpumalanga for members of a local conservation society. Turpie (1996) used contingent valuation to value local and regional willingness to pay for the preservation of the De Hoop nature reserve in the Western Cape. All these studies found positive non-use values among predominantly middle class samples.

**Economics of elephant and rhino management**

The exploitation of elephant for ivory for international trade has a very long history, as the work of Thorbahn (1979) shows. Recently, particularly during the 1980s, the relatively high value of products such as ivory and rhino horn, resulted in serious threats to elephant and rhino from poaching. In consequence, some economics research has been focused directly on these species. Milner-Gulland and Mace (1991) presented ivory trade data which suggested that this trade was closely associated with recorded declines in African elephant numbers.


In the latter part of that decade, growing realisation that poaching and the ivory trade was endangering elephant existence, led to some econometric analysis on the determinants of international demand for ivory (Barbier and Burgess, 1989; Barbier et al., 1990; Milner-Gulland, 1993). Demand was generally found to be price inelastic and income elastic in eastern consumer countries. Rhino poaching for horn has long been severely threatening rhino populations in most of Africa, and ’t Sas-Rolffes (1993, 1995) discussed and examined the characteristics of demand in the middle east for rhino horn. ’t Sas-Rolffes et al. (1994) and Milner-Gulland (1993) found rhino horn demand to be price-elastic (but possibly inelastic at
higher prices), and to have unitary income elasticity, respectively. Lack of suitable data was a constraint in both studies.

Other work at the same time centred around the costs of protection for these species. Leader-Williams et al. (1990) in Zambia, and Martin (1990b) in Zimbabwe, provided useful empirical evidence concerning the enforcement costs required to protect elephant and black rhino in parks and on public lands. The need to concentrate limited resources in smaller areas was demonstrated. Milner-Gulland and Leader-Williams (1992) developed an optimal control model of the investment problem faced by rhino and elephant poaching gangs in the Luangwa valley, Zambia. The low opportunity costs generally made poaching financially attractive and elephant poaching can be dependent on more lucrative rhino poaching. Milner-Gulland et al. (1992) developed a sophisticated model of rhino horn harvesting and sale, through dehorning, from wild populations. They determined a strategy for optimum financial, horn harvest profitability.

Several authors have examined the policy issues surrounding the conservation of elephant and rhino in Africa (Barbier et al., 1990; Sugg and Kreuter, 1994; 't Sas-Rolffes, 1995, 1996). Others, such as Swanson (1992, 1994), Fernandez and Swanson (1995) and, again, Barbier et al. (1990) have applied principles of economic theory to the problems of over-exploitation of elephant and rhino. These developments are essentially extensions to the North American theoretical work on fishery exploitation (referred to in the introduction to this chapter) and they provide theoretical underpinning for this thesis.

Economics of marketing wildlife products

Wildlife economics in Africa stems largely from the desire of non-economists to justify the existence of wildlife in the face of population and development pressure. The tendency was for technical experts to develop "production" systems based primarily on conservation needs, and then to ask how use values could be gained from them. The tendency has been to try and develop markets for existing products rather than to tailor products to markets. Market research has thus been limited, as pointed out by Muir-Leresche (1987) and Barnes (1989c).
Several authors have examined the markets for game meat from private land including Westcott (1984) and Steenkamp (1982) in South Africa, FGU Consulting + Engineering (1991) in Botswana, and Drew and Schwarting (1994) in Namibia. GITEC GmbH. (1984) in Botswana, examined the feasibility of processing and marketing game meat through biltong manufacture and canning. Kaye (1982) and White (1986b) did surveys of the markets available to Botswana producers of hides, skins and crafts. von der Goltz et al. (1986) studied markets for the whole wildlife sector in Zimbabwe. Infield (1986a, 1986b), in a useful and detailed study, examined the financial viability, for local communities, of processing and marketing game products from the Natal Parks Board estate in South Africa. All these studies found markets constrained to varying degrees by low profitability and, in places, veterinary barriers. The need for active market development was clear. Cumming (1990b) examined the policy implications of wildlife product marketing in Zimbabwe and its effect on conservation.

Wildlife in natural resource accounts

Most of the work in wildlife economics in Africa has been at the micro-economic level. A recent development, at least in southern Africa has been initiatives to develop natural resource accounts, commonly as "satellites" to support the national accounts. Although none of these are yet firmly institutionalised, Perrings et al. (1989) and Gilbert (1990) in Botswana, Crowards (1994) in Zimbabwe, and Lange and Barnes (1996) in Namibia, have all been involved in developing preliminary sets of accounts. So far, only those for Botswana and Namibia embrace the wildlife sector, and data constraints make the wildlife accounts incomplete. However, as more fundamental work on the physical stocks and the economics of wildlife is undertaken, these constraints should disappear.

3.3 Chapter conclusion

This chapter is an attempt to describe how the embryonic field of wildlife economics is emerging in Africa, and diversifying into several different directions of speciality. Sale (1981) in his review of the importance and values of wild plants and animals in Africa, recommended economic studies. However, he was of the opinion that just one economist, employed as a consultant on a series of studies, would be sufficient. A general lack of understanding, among conservation decision-makers and others, of what economics is about, and how it can assist
wildlife conservation, along with a shortage of skills, have restrained wildlife economic research in Africa. South Africa, considering its needs, has particularly suffered from this but there are signs of an emerging awareness and understanding, among biologists, of the vital role economic research must play in conservation (Turpie and Siegfried, 1996).

As stated, there are interesting differences in the way wildlife economics is developing in Africa, compared with the way it has in north America. Wildlife sectors in Africa are threatened because they do not adequately address the development needs of Africa’s people. Recent and belated attempts to address this have resulted in emphasis being put on direct use values rather than public goods. In addition, the need for wildlife to compete for land with agricultural pursuits, has tended to result in an agricultural economic or business economic approach to analysis. As Matulich and Adams (1987) pointed out, wildlife economics in north America has suffered because so much emphasis has been put on measuring benefits and studying demand. Research on the economics of supply of wildlife amenities and values has received much less attention. A result has been that investment in wildlife continues to suffer relative to that in other land uses.

The approach emerging in Africa, where new studies are measuring the value of investment in wildlife, appears more sound. There is, however, a vast backlog of research to be done on both the supply and demand side. Use values, particularly direct ones, can contribute tangibly to development and must take priority, but there is a great need for work to ensure that non-use values of wildlife are reflected in decision-making. Because of the vast backlog, a number of workers aim to apply policy analysis tools directly to wildlife and environmental matters without undertaking research. This is particularly the case in South Africa (Miltz and Pearce, 1995; ’t Sas-Rolfes, 1996) and is sound, given current resource constraints. However, policy analysis will ultimately fail if not backed by significant, ongoing inputs into empirical research in wildlife economics. It is hoped that this thesis will contribute something toward meeting this requirement.
Part II

Specific wildlife uses
Chapter 4

Wildlife-viewing tourism

4.1 Introduction

In this chapter some of the factors which affect the attainment of an economically efficient level of tourism within the wildlife sector of Botswana are discussed. The focus is specifically on the use of protected areas, such as National Parks and Game Reserves. Experience from Botswana and elsewhere is described and recommendations made on this basis. Some of the results in the chapter have been reported elsewhere Barnes (1990b, 1991a, 1992a), Barnes and Hartley (1991), Barnes et al. (1992) and Barnes (1996a).

4.2 The objective of protected area development

The primary motive for the proclamation and development of national parks and game reserves has traditionally been the preservation of wild species and communities. This has generally been considered to be more of an ethical question than an economic one. More recently, resource economists have begun to measure the economic value of wildlife conservation (Krutilla, 1967; Krutilla and Fisher, 1975; Thresher, 1976; Brookshire et al., 1983; Peterson and Randall, 1984; Fisher and Krutilla, 1985; Decker and Goff, 1987; Ruitenbeek, 1989; Brown and Henry, 1989; Barbier et al., 1991; Dixon and Sherman, 1991, among many others).

As discussed in chapter 2, it is recognised in resource economics that the total economic value of a natural resource is made up of both "utilisation" values and "preservation" values. Pearce and Turner (1990) and Fisher and Krutilla (1985) refer to these concepts. There is
increasing demand for the management and development of protected areas to be orientated towards maximising realisable utilisation values. Non-consumptive, wildlife-based (game-viewing) tourism is the primary way in which utilisation can be achieved in protected areas.

4.3 The role of wildlife-based tourism in protected areas

The question may be asked as to what the most economically suitable strategies for the development of wildlife-based tourism in protected areas are. It is assumed here that the objective should be to maximise net total economic value on a sustainable basis. African wildlife populations and areas appear to have high preservation values, primarily because of their dramatic diversity of large mammals. The pursuit of utilisation values alone, commonly tends to reduce preservation values because human activity causes degradation and reduces the pristine character of the resource. Optimal preservation means no use. Maximisation of net total economic value clearly requires a balance between the conflicting effects of preservation and utilisation. Utilisation options which minimise detriment to the natural environment while resulting in high returns, are preferred.

The strategy of development in wildlife-based tourism in Kenya has attracted large numbers of tourists who are efficiently processed in packages with a high turnover. This high volume tourism appears to be linked with coastal tourism development where tourist numbers are even greater (Anon., 1978; Chebures, 1991). The contribution of tourism in Kenya to the economy is extremely high but it can be argued that it takes place with a significant cost in preservation values.

In parts of southern Africa, including Zimbabwe, Namibia, South Africa, and to some extent, Botswana, there has been a tendency to promote the use of protected areas by self-driven tourists from domestic and regional markets. Low-priced park visits have been possible for large numbers of tourists as a result of subsidisation by governments. The Kruger National Park in South Africa is a good example (Knobel, 1971; Fourie, 1984; de Graaff, 1987). In Zimbabwe, Heath (1991) pointed out that the subsidised pricing policy tends to undermine private sector wildlife-based tourism development. Lindberg (1991) and Lindberg and Huber (1993) discussed in detail policies for reducing subsidies to, and maximising economic benefits
from parks. They pointed out that multi-tiered differential pricing can go a long way to satisfying both economic efficiency and equity needs.

Recently, the policy in southern African wildlife-based tourism development has moved towards the tapping of growing demand in the high-priced tourism market. This aims at providing high quality game-viewing experiences and involves lower numbers of tourists. Policy in Botswana and, to a lesser extent Zimbabwe, is now aimed at increasing this type of development (Government of Botswana, 1990; Matenge, 1991; von der Goltz et al., 1986; Heath, 1991).

The wildlife resource can only absorb game-viewing activities up to a certain level before the quality of the product is threatened and the carrying capacity for tourism is exceeded. Lindsay (1986) defines the tourism carrying capacity as the physical, biological, social and psychological capacity for the park environment to support tourist activity without diminishing environmental quality or visitor satisfaction. This is a function of the quantity of the park’s resources, the tolerance of the resource in use, the number of visitors, the type of use, the design and management of visitor facilities, and the attitude and behaviour of its visitors and managers. A better description of the physical tourism carrying capacity is that it simply relates to the ability to absorb demand. The economic tourism carrying capacity is that which provides the highest sustainable net economic value. This need not coincide with the physical carrying capacity.

Tourism carrying capacities have been studied in detail in Kenya by Henry (1980), Western (1975, 1986). Their work indicated that, in 1986, tourist carrying capacities in that country’s parks were between three and five times the current usage levels. The latter were, even then, much higher than those in Botswana. Botswana received 45,000 and 64,000 visitors to all its parks and reserves in 1988 and 1989 respectively (FGU-Kronberg, 1988b; Borge et al., 1990). In Kenya the Amboseli National Park, alone, had 120,000 visitors in 1984. The Kruger National Park in South Africa accepted 445,600 visitors in the 1982/83 season (Fourie, 1984).

In the present study, empirical information has been used to provide an indication of the likely tourism carrying capacity for high-priced tourism in southern Africa’s better quality protected
areas. The information was gathered from nine successful, commercial game-viewing tourism operations, aimed at up-market clients from overseas and situated on private land in comparable conditions within southern Africa. The size of the property involved was divided by the number of tourist beds on hand to get an estimate of carrying capacity. Carrying capacities of between 510 and 980 hectares of viewing area per lodge bed were calculated for the sample; the average being 700 hectares per bed. These carrying capacities are relatively low, compared with an estimate for the Kruger National Park in South Africa (144 hectares per bed) where tourism is lower priced.

The up-market, low-density tourism described above, is generally associated with less environmental damage than cheap-priced, high-density tourism. The fact that, of the two, up-market, low-density tourism is chosen by private landholders (for example, Varty, 1982) suggests that its financial return on investment is higher. This type of tourism is to be encouraged in Botswana, wherever possible, according to policy. Fowkes (1991) has, however, pointed out the dangers of excluding other segments of the market.

High-density tourism has the advantage that the wider population is afforded access to the wildlife resources. Popular sentiments for wildlife preservation and conservation, basic to preservation values, can thus be promoted. Reservation of protected areas for more exclusive, high-priced tourism can tend to alienate this support. However, high financial returns derived through high-priced tourism can be distributed as income among households and communities and this may be a more powerful tool for conservation, particularly where people are poor.

Development of wildlife-based tourism in Botswana needs to be carefully planned to strike a balance between the conflicting factors outlined above. Option and existence values in protected areas must be preserved while high utilisation values are realised for the promotion of conservation. An important consideration is that development in wildlife-based tourism should be closely guided by market demand. Muir-Leresche (1987), discussing marketing of wildlife products in sub-Saharan Africa, stressed the need for more investment in research and promotion on the demand side of the equation in wildlife utilisation. A general shift towards market orientated planning in wildlife utilisation is necessary.
There has been a lack of adequate information about the characteristics of markets for wildlife-based tourism in Botswana on which to base market orientated development. Similarly, there is very little information on the characteristics and extent of the preservation (option and existence) values associated with wildlife in Botswana. This points to the need for an ongoing market research programme which will address these two problems. The following section describes the results of an initial market study for Botswana.

4.4 Analysis of demand for wildlife-viewing tourism

Demand for wildlife-viewing visits

In 1992 a questionnaire survey of tourists in and around the northern national parks and game reserves was conducted in an attempt to determine the characteristics of demand for wildlife-viewing tourism. In particular, this survey was aimed at getting an idea of the proportion of tourist expenditures consisting of the consumer surplus, the willingness of tourists to contribute to a conservation fund in Botswana and the willingness of tourists to pay the park entry fees which had been increased in 1989. A contingent valuation approach was used here. A secondary objective was to research tourist preferences, a subject that has been studied in detail in other surveys (Fowkes, 1985; Roberts et al., 1985; Hill, 1988; Borge et al., 1990; Kalahari Game Services, 1991). The approach used to determine willingness to pay for wildlife-viewing visits involved soliciting a direct measure of each individual respondent's actual expenditure, through an open-ended question, and then soliciting their willingness to pay in excess of this, using a payment card. The methodological approach is discussed in more detail below.

A pilot survey involving 12 draft questionnaires during late 1991, led to the development of a final version. During 1992, the final questionnaire was distributed to tourists by both park personnel based at the gates of Moremi Game Reserve and Chobe National Park, and by enumerators in the economics section of the Department of Wildlife and National Parks who visited lodges and campsites. Most tourists were simply asked to fill in the questionnaire and hand it back, but some responses were obtained by direct interview. Sampling was not systematic or random but was simply aimed at getting as many responses as possible from both lodge and campsite users, and during both the wet and dry seasons. The total number of
responses obtained was 212, of which 48 percent were from lodge or fixed facility users and 52 percent were from campsite users. The method of sampling thus allows only relative comparison between these two specific market categories or segments. Only two percent of respondents were citizens of Botswana, eight percent were non-citizen residents of Botswana, and 90 percent were non-residents (of which 69 percent were from overseas and 31 percent were from the southern African region). The sampled ratio of overseas to southern African non-resident visitors was similar to that in tourism statistics, indicating a low sample bias.

A copy of the questionnaire is presented in Appendix 4.1. Respondents were asked, using open-ended questions, what their annual income was (question 1.13), what their total holiday had cost (question 2.1), and how much of this they had personally spent within Botswana (question 2.2). They were also asked whether they would be willing to donate money to a fund aimed at conserving wildlife in Botswana (question 2.7) and, if so, how much (question 2.8). To try and identify any consumer surplus being experienced by tourists (i.e. the most they would have been willing to pay for the experience they were having), a payment card was used to ask respondents about their willingness to pay for a similar return trip. They were first asked whether they would be willing to return on a similar trip (question 2.4). If they said "yes", they were asked to name the cost level (in relation to their present cost) which would prevent them from returning (question 2.6). If they said "no" they were asked to name the cost level (also in relation to their present cost) that would induce them to return (question 2.5). Answers to these two questions were taken as their willingness to pay for a return trip and were used to derive two things: the consumer surplus enjoyed by each tourist, and a price - quantity demand function for the tourist population. Consumer surplus was determined as follows. For each respondent, the difference between the maximum willingness to pay for a return trip (question 2.6) and the actual cost of the whole trip, where positive, was taken to be her/his consumer surplus. The consumer surpluses for all respondents in the whole sample were then aggregated and the mean determined.

Getting respondents to focus on the cost of their whole trip was considered important as this seemed to be the only measure of trip cost that all respondents had in common. Moran (1994), in Kenya, also found it necessary to focus respondents' attention on the cost of their whole trip. Getting respondents to focus on return trips in their consideration of willingness to pay was thought to reduce confusion between actual and maximum estimates, which might
arise if they were to focus on the actual trip. In as much as desire for return trips is likely to be less than that for first time trips, the estimates of actual demand and consumer surplus are likely to be conservative. The way the question was worded (using the words "prevent" and "induce") was thought to minimise the possibility of strategic bias (as described by Mitchell and Carson, 1989). Generally, question design was aimed at minimising this and other possible sources of bias as defined by Mitchell and Carson, such as compliance bias, starting point bias, range bias, relational bias and positional bias.

It was considered useful to compare results between market segments, so that lodge users were compared with campsite users, and non-resident visitors from overseas (overseas visitors) were compared with non-resident visitors from the southern African region (regional visitors). Table 4.1 shows the mean annual incomes, trip expenditures, estimated consumer surpluses, and willingness to donate to a Botswana wildlife conservation fund, for these user categories. The results show that annual income levels for overseas visitors were significantly higher (twice as high) than those of regional visitors. Expenditures on the whole trip were significantly greater for lodge users (some twice as great) than they were for campsite users, and were also significantly greater for overseas visitors (nearly four times greater) than they were for regional visitors. Similarly, expenditures on the Botswana component of the trip were significantly higher for lodge users and overseas visitors (twice as high) than they were for campsite users and regional visitors.

With regard to the estimated consumer surpluses experienced by visitors for both their whole trip and the Botswana component, there was no significant difference between the different market segments. However, the mean "whole trip" consumer surplus estimated for overseas visitors was significantly higher (at the 10 percent level) than that of regional visitors. There was no statistically significant difference found between the amount that visitors in various market segments were willing to pay to a Botswana wildlife conservation fund. Generally, visitors sampled spent some 27 percent of their total trip cost within Botswana. They experienced estimated consumer surpluses amounting between 17 and 20 percent of their trip costs, and were willing to donate to a Botswana wildlife conservation fund one percent of their whole trip cost (equivalent to four percent of the cost of the Botswana component of their trip).
Table 4.1: Means for annual incomes, trip expenditures, estimated consumer surpluses and willingness to donate to Botswana conservation for various market segments (1992 northern parks tourist survey, Botswana; pula and %)

<table>
<thead>
<tr>
<th></th>
<th>Lodge users</th>
<th>Campsite users</th>
<th>Overseas visitors</th>
<th>Regional visitors</th>
<th>All visitors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual income</td>
<td>149,328</td>
<td>107,074</td>
<td>165,856</td>
<td>77,852**</td>
<td>125,678</td>
</tr>
<tr>
<td>sample no.</td>
<td>(59)</td>
<td>(75)</td>
<td>(79)</td>
<td>(43)</td>
<td>(134)</td>
</tr>
<tr>
<td>W. to donate*</td>
<td>133</td>
<td>119</td>
<td>143</td>
<td>94</td>
<td>125</td>
</tr>
<tr>
<td>sample no.</td>
<td>(76)</td>
<td>(87)</td>
<td>(101)</td>
<td>(44)</td>
<td>(163)</td>
</tr>
<tr>
<td>Whole trip**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trip expenditure</td>
<td>16,082</td>
<td>6,956++</td>
<td>16,221</td>
<td>4,111++</td>
<td>11,367</td>
</tr>
<tr>
<td>sample no.</td>
<td>(87)</td>
<td>(93)</td>
<td>(111)</td>
<td>(53)</td>
<td>(180)</td>
</tr>
<tr>
<td>Consumer surplus</td>
<td>2,697</td>
<td>1,161</td>
<td>7,263</td>
<td>714+</td>
<td>1934</td>
</tr>
<tr>
<td>sample no.</td>
<td>(70)</td>
<td>(69)</td>
<td>(84)</td>
<td>(40)</td>
<td>(139)</td>
</tr>
<tr>
<td>Consumer surplus as</td>
<td>16.8%</td>
<td>16.7%</td>
<td>17.4%</td>
<td>17.4%</td>
<td>17.0%</td>
</tr>
<tr>
<td>% of trip exp.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>W. to donate* as</td>
<td>0.8%</td>
<td>1.7%</td>
<td>0.8%</td>
<td>2.3%</td>
<td>1.1%</td>
</tr>
<tr>
<td>% of trip expend.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Botswana trip***</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trip expenditure</td>
<td>4,370</td>
<td>1,937++</td>
<td>3,828</td>
<td>2,053++</td>
<td>3,114</td>
</tr>
<tr>
<td>sample no.</td>
<td>(89)</td>
<td>(95)</td>
<td>(114)</td>
<td>(54)</td>
<td>(184)</td>
</tr>
<tr>
<td>Botswana trip exp.</td>
<td>27.2%</td>
<td>27.9%</td>
<td>23.6%</td>
<td>49.9%</td>
<td>27.4%</td>
</tr>
<tr>
<td>as % of whole exp.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consumer surplus</td>
<td>941</td>
<td>333</td>
<td>911</td>
<td>221</td>
<td>639</td>
</tr>
<tr>
<td>sample no.</td>
<td>(72)</td>
<td>(71)</td>
<td>(87)</td>
<td>(41)</td>
<td>(143)</td>
</tr>
<tr>
<td>Consumer surplus as</td>
<td>21.5%</td>
<td>17.2%</td>
<td>23.8%</td>
<td>10.8%</td>
<td>20.5%</td>
</tr>
<tr>
<td>% of trip exp.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>W. to donate* as</td>
<td>3.0%</td>
<td>6.1%</td>
<td>3.8%</td>
<td>4.6%</td>
<td>4.0%</td>
</tr>
<tr>
<td>% of trip expend.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Mean amount respondents are willing to donate to a Botswana conservation fund
** Whole trip, including travel, Botswana portion and visits to other countries
*** Relates to trip expenditures made directly during Botswana portion of trip
+ Difference (with preceding mean) significant at the 10% level ("t-test")
++ Difference (with preceding mean) significant at the 5% level ("t-test")
As described above, the responses to the questionnaire which indicated willingness to pay for a return trip, like that being experienced by the respondent, were used to determine two things. These were the consumer surplus for each tourist and demand functions for wildlife viewing trips for the tourist population. *Demand functions*, reflecting the simple relationship between price and quantity, were determined as follows. All the respondents' willingness to pay bids for a return trip (derived from questions 2.5 and 2.6 in the questionnaire) were divided into 26 price categories, resulting in a frequency distribution, as shown by the example in Figure 4.A. Much effort was spent, using simple regression, finding functions which fit the distribution of points in the frequency diagrams as closely as possible. Linear, reciprocal, exponential (semi-log) and multiplicative (log-log or log-linear) models were tested in an attempt to find the best-fitting functions.

Demand functions were first derived for *return whole trips*, and then, by adjustment, for return Botswana trips (applying the willingness to pay proportions to expenditures for Botswana only). Demand functions for *actual trips* (whole trips and the Botswana component of whole trips) were derived similarly, but by assuming that a respondent's willingness to pay for actual trips was represented, either by bids from question 2.6, or actual expenditures, whichever was highest. Thus, demand functions were obtained for actual whole trips, return whole trips, actual Botswana trips (Botswana section only) and return Botswana trips (Botswana section only). These were, in turn, derived for the total sample, for the lodge-user market segment and for the campsite-user market segment. Exponential (semi-log) models consistently gave the best fit but only when price was estimated as a function of quantity (this may seem absurd but the underlying theory of causality is irrelevant to determining the relationship between two variables). In some cases reciprocal models resulted in good fit - again, when price was estimated as a function of quantity. Linear models consistently resulted in moderate fit but multiplicative (log-log or log-linear) models always resulted in very poor fit and were rejected. The theoretical equations used are presented in chapter 2, under "econometric analysis".

Price elasticity coefficients were determined by calculating the point elasticity of demand at the mean price (trip cost) for selected curves (in most functions derived, the reciprocal of price flexibility was used to get price elasticity). Table 4.2 shows the elasticities calculated in three ways. First, those calculated from semi-log curves (most of which had good fit), then those
Figure 4.A: An example of a frequency diagram, used to derive the demand function, through simple regression
calculated by selecting curves with good fit (mostly semi-log but some reciprocal) and, lastly, those averaging the calculation of all curves with moderate to good fit (semi-log, reciprocal and linear). The results are fairly consistent indicating that general demand for wildlife viewing trips involving Botswana, is very close to having unitary price elasticity (with the coefficient being some -0.93). There is a difference between the results for trips involving use of campsites (where demand is inelastic with the coefficient being some -0.68) and those for trips involving use of lodges (where demand is elastic with the coefficient being some -1.35). It is noteworthy that using the median, rather than the mean, for determining point elasticities (although this was not done) would have resulted in coefficients with lower elasticity. Table 4.3 shows three representative semi-log demand functions for actual visits within Botswana (Botswana portion of trip only). Figure 4.B shows plots of the functions for the campsite- and lodge-use segments.

A section on tourist preferences in the questionnaire survey involved asking respondents to rate wildlife species and attributes according to their relative contribution to the tourist’s enjoyment and satisfaction. Examination of the results suggests that the technique used introduces a significant starting point bias (as described by Mitchell and Carson, 1989). From a preliminary survey of tourists in Kenya, Brown and Henry (1989) calculated a preference value for elephant of 22 percent after giving respondents a list of five wildlife group options, one of which was elephant. In the present survey, a preference value for elephant of 5.4 percent was calculated, after respondents were given 30 wildlife options, one of which was elephant (question 3.2, Appendix 4.1). The discrepancy between the two estimates could well be due to a starting point bias. The results of this part of the survey have therefore been rejected.

The contingent valuation study has indicated that wildlife-viewing tourists in Botswana have moderate consumer surpluses, most of which is not contributing to domestic or national income (since most tourists are non-residents or non-citizens). There does, however, seem to be some potential for Botswana to capture some of this consumer surplus via donations to a Botswana wildlife conservation fund. Borge et al. (1990) provided an estimation of the number of tourists visiting northern Botswana in 1989, as 64,000. Since in Table 4.1 the mean consumer surplus per visitor attributable to the Botswana section of the trip is P639, the aggregate consumer surplus could then have been some P40.9 million.
Table 4.2: Estimates of price elasticities of demand* for wildlife-viewing trips to northern Botswana in 1992, determined though contingent valuation

<table>
<thead>
<tr>
<th></th>
<th>Use of campsites</th>
<th>Use of lodges</th>
<th>Use of all facilities</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Elasticities for semi-log demand functions</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Return visits (whole trip)</td>
<td>-0.68</td>
<td>-1.46</td>
<td>-0.90</td>
</tr>
<tr>
<td>Return visits (Botswana section)</td>
<td>-0.66</td>
<td>-1.43</td>
<td>-0.98</td>
</tr>
<tr>
<td>Actual visits (whole trip)</td>
<td>-0.69</td>
<td>-2.03</td>
<td>-0.95</td>
</tr>
<tr>
<td>Actual visits (Botswana section)</td>
<td>-0.69</td>
<td>-1.39</td>
<td>-0.97</td>
</tr>
<tr>
<td><strong>Means of elasticities for demand functions with good fit</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Return visits (whole trip)</td>
<td>-0.65</td>
<td>-1.40</td>
<td>-0.90</td>
</tr>
<tr>
<td>Return visits (Botswana section)</td>
<td>-0.66</td>
<td>-1.31</td>
<td>-1.11</td>
</tr>
<tr>
<td>Actual visits (whole trip)</td>
<td>-0.69</td>
<td>-</td>
<td>-0.95</td>
</tr>
<tr>
<td>Actual visits (Botswana section)</td>
<td>-0.69</td>
<td>-1.24</td>
<td>-0.97</td>
</tr>
<tr>
<td><strong>Means of elasticities for all demand functions</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Return visits (whole trip)</td>
<td>-0.68</td>
<td>-1.09</td>
<td>-0.83</td>
</tr>
<tr>
<td>Return visits (Botswana section)</td>
<td>-0.69</td>
<td>-1.08</td>
<td>-0.87</td>
</tr>
<tr>
<td>Actual visits (whole trip)</td>
<td>-0.70</td>
<td>-1.39</td>
<td>-0.83</td>
</tr>
<tr>
<td>Actual visits (Botswana section)</td>
<td>-0.70</td>
<td>-1.05</td>
<td>-0.85</td>
</tr>
<tr>
<td><strong>Means of all estimates</strong></td>
<td>-0.68</td>
<td>-1.35</td>
<td>-0.93</td>
</tr>
</tbody>
</table>

* Point elasticity coefficients, measured at mean price of trip
** Most demand functions with good fit ($r^2$ between 56.10% and 89.65%) except for actual whole trip visits to lodges ($r^2 = 36.05$%). All models and parameters are significant (ANOVA and "t-test")
*** Semi-log and reciprocal demand functions all with good fit ($r^2$ between 74.60% and 96.00%). All models and slope parameters significant (ANOVA and "t-test")
**** Linear, semi-log and reciprocal demand functions, most with good fit ($r^2$ between 36.05% and 96.00%). All models and slope parameters significant (ANOVA and "t-test")

The finding that consumer surplus amounted to some 20.5 percent of trip expenditure is in striking agreement with findings from elsewhere in southern Africa. Using an almost identical technique with much larger samples in Namibia, Barnes et al. (1997) found this proportion to
Table 4.3  Estimated semi-log (or exponential) demand functions* for wildlife-viewing trips to northern Botswana in 1992, determined though contingent valuation and simple regression

Wildlife trips using all facilities

\[ P = \exp (9.22252 - 0.0705919 Q) \]

\[ r^2 = 84.34\%, \quad F\text{-Ratio} = 123.9114 \quad (P = 0.00000) \]

SE: \(0.0813012\) \(6.3416E-3\)
t-value: \(113.436\) \(-11.1315\)
PL: \(0.00000\) \(0.00000\)

Wildlife trips making use of campsites

\[ P = \exp (9.14485 - 0.112559 Q) \]

\[ r^2 = 82.82\%, \quad F\text{-Ratio} = 110.8630 \quad (P = 0.00000) \]

SE: \(0.0814987\) \(0.0106903\)
t-value: \(112.209\) \(-10.5291\)
PL: \(0.00000\) \(0.00000\)

Wildlife trips making use of lodges

\[ P = \exp (9.26324 - 0.162538 Q) \]

\[ r^2 = 74.60\%, \quad F\text{-Ratio} = 67.56837 \quad (P = 0.00000) \]

SE: \(0.108592\) \(0.0197735\)
t-value: \(85.3031\) \(-8.22\)
PL: \(0.00000\) \(0.00000\)

* With quantity expressed as function of price to improve accuracy of regression

be 26 percent. Perhaps more significantly for convergent validation, Brown et al. (1995), using completely different methods (including a dichotomous choice approach) in Zimbabwe, found the consumer surplus among tourists to be 23 percent of expenditures. The mean amount the average tourist was willing to pay to a conservation fund was P125, and thus the potential for donations could amount to some P8 million. This as a proportion of total trip expenditures is in agreement with the findings of Barnes et al. (1997) in Namibia.
Figure 4.B: Estimated semi-log (or exponential) demand functions for wildlife-viewing trips to northern Botswana in 1992 determined though contingent valuation and simple regression (two market segments)
When respondents express a willingness to pay for the fund, the amount they give may be part of their consumer surplus or not. In other words, they may be considering it as a part of their overall trip cost, or as a separate, additional cost. From this study it is not possible to determine by how much the willingness to pay for a fund overlaps (if at all) with the consumer surplus. Our assumption should be conservative, i.e., that any donations to a conservation fund would reduce the consumer surplus. The consumer surplus reflects willingness to pay for use of the resource and so this surplus (and any fund donations coming out of it) represents direct use value and not non-use value. We cannot safely assume that any of the willingness to pay for conservation, measured in this chapter, represents pure non-use values.

The results of the analysis of price elasticity suggest that increases or decreases in the general costs of wildlife-viewing visits to Botswana will tend to be compensated for by decreases or increases in the numbers of tourists so that little change in turnover or gross output will result. The results also suggest that, overall, the gross output is being maximised. However, there would seem to be potential for improvement within specific segments of the market. In the segment using campsites an increase in general prices would result in an increase in gross output despite a drop in tourist numbers. There appears to be potential for extracting additional expenditures from this segment. From the campsite-user demand model it can be calculated that the gross output would be maximised if trip costs were some 50 percent higher (at unitary elasticity). On the other hand, within the lodge-user segment it appears that an increase in both tourist numbers and gross output would occur if there was a drop in prices. There appear to be potential advantages in reducing prices within this segment.

From the lodge-user demand model it can be calculated that gross output would be maximised if trip costs were some 25 percent lower (at unitary elasticity). It must be noted (see below) that the confidence limits associated with the results preclude the use of these calculations other than as indicators. Generally, the findings on price elasticity are consistent with those from studies in east Africa (Navrud and Mungatana, 1994; Brown et al., 1994).

It is worth considering the reliability of the willingness to pay analysis in this chapter. Mitchell and Carson (1989) provide a means of determining the reliability of samples for contingent valuation. Using the coefficient of variation and the sample size for a set of data,
it is possible to determine the degree of possible deviation of the estimated mean from the "true" mean. In this study, the possible deviation varies from 15 to 25 percent in the case of trip expenditure estimates, from 25 to 50 percent in the case of estimates of tourist willingness to donate and tourist annual income, and from 40 to 50 percent in the case of consumer surplus estimates. This means that some of the willingness to pay estimates in this study could differ from the real values by up to 50 percent, due to small samples, the variability of the data, and, possibly, the failure to deal with outliers. However, similarities described above between my estimates and those of other similar studies, using different methods and larger samples, tend to provide some convergent validation.

It is also worth discussing the limitations of the particular elicitation approaches used here for the willingness to pay analysis, compared with other possible methods. In this study the willingness to pay for wildlife viewing trips was elicited using a payment card system, while estimates of personal income, trip expenditures and willingness to donate were obtained through open-ended questions. Payment card techniques tend to be prone to strategic bias, starting point bias, and in particular range bias (where starting point relates to suggested benchmarks and where range relates to the specified range offered). In this study the range offered was anchored to a benchmark well known to the respondents (their own actual trip cost), and the range offered was intuitively realistic, given respondents incomes and their options for expenditure. This particular payment card involved intervals of at least 25 percent, so that, for example, if a respondent was willing to pay between 1.26 and 1.49 times his/her actual trip cost, then 1.25 was recorded as his/her bid. Estimates, thus, will have tended to be underestimated. If there was any strategic bias with this payment card, it is likely to have involved low bidding to minimise potential price increases for return trips. Thus, it is likely that willingness to pay in this study has been underestimated rather than overestimated. Navrud and Mungatana (1994) used a payment card in a study of willingness to pay among tourists for flamingo conservation in Kenya. Results were compared with, and found much lower than, those for a corresponding willingness to accept question.

Open-ended questions do not suffer from starting point and range biases, but can be prone to strategic bias problems. Kriström (1990) compared results from open-ended and dichotomous choice approaches, and found that open ended questions tend to provide a lower bound willingness to pay. The obvious alternative approach to determining the consumer surplus
would have been use of the dichotomous choice approach. This approach has gained favour through being able to more exactly simulate a real market decision for the respondent, and in virtually eliminating the problem of strategic bias. It has been used in Africa by Brown et al. (1995), Moran (1994), and Brown et al. (1995). Dichotomous choice, however, generates only discrete indicators of willingness to pay, and thus requires a larger sample size than approaches which generate actual willingness to pay. It also necessitates involved statistical procedures to derive useful statistics, and can invoke technical difficulties in the correct specification of valuation functions.

Another method that could have been used to get at the consumer surplus is the travel-cost method. This is preferred by some, because it relies on revealed preferences rather than perceived ones. Navrud and Mungatana (1994), Turpie (1996), and Geach (1997) have used this approach to value specific wildlife parks in Africa. However, in the context of this broader study, the lack of cultural homogeneity within the tourist population, and the multi-destination characteristics of most wildlife viewing trips, make the travel-cost method technically unsuitable.

The use, in this study, of simple regression to derive a price - quantity demand function may have some implications for the price elasticity estimates. In other studies, for example, Stoltz (1996, 1997), demand functions are derived using multiple regression and thus measure the specific direct contribution of each of several explanatory variables to change in the dependent variable. With simple regression we are measuring the total change in quantity, i.e., both the direct change due to price and any possible indirect change due to other variables not included in the model. To this extent the model is mis-specified, and the price elasticity estimates, in Table 4.2, might thus be higher than they would be if estimated using multiple regression. From all the above considerations, it is clear that caution needs to be applied in formulating policy recommendations resulting from this study.

**Demand for entry and use of parks**

On July 1, 1989, the Government of Botswana, in particular, the Department of Wildlife and National Parks, introduced a new set of fees for entry and camping in national parks and game reserves (parks) in the country. One objective of this was to reduce the numbers of "self-
drive”, non-citizen tourists, and encourage the latter to make use of fixed lodges/camps and mobile tour operators. Another objective was to reduce the central government subsidy to the national parks division in the Department.

The new fee structures were developed partly on the basis of recommendations of the Hotel and Trade Association of Botswana (HATAB) and partly on the basis of decisions made within the Department of Wildlife and National Parks. In the context of the southern African region, the fee change raised fees substantially above those of parks in surrounding countries. Some controversy accompanied the fee changes, which were considered by some to be too high. No data were available on the elasticities of demand among the various categories of tourist, so that the likely economic effects of the new fees were not known. With the collection of some park entry data, from both before and after the change, the opportunity for analysis of these effects has arisen.

Table 4.4 shows a selected sample of the fees in question before and after the change with the respective percentage increases. There is general differentiation between those for citizens of Botswana (citizens), non-citizens resident in Botswana (residents) and non-residents. The complete range of fee changes is complex, partly due to the fact that the structure of fees has changed. Weekly and annual permits are no longer issued, neither are there any firearm and guide fees, and there is no longer a differential between drivers and passengers. Privately organised tours are now differentiated from those organised through operators registered, based and licensed in Botswana, or through established lodges and hotels. There is now an annual vehicle entrance fee for operators based within parks. There is also a new excess vehicle weight fee.

Generally the fee increases shown in Table 4.4 are dramatic. The daily entrance fee paid by a non-resident has risen by between 500 and 900 percent (from P5 to P30 or P50), depending on whether that person is travelling in a licensed tour or not. The rise in entrance fee for residents has been similar, but that for citizens has been much more moderate. Since non-residents have consistently made up some 70 percent of park visitors (Hill, 1988; Borge et al., 1990), the changes might have been expected to have a significant impact on tourist numbers entering the parks.
Table 4.4: Examples of national park and game reserve entry fees in Botswana showing the difference before and after the change in July, 1989 (pula and %)

<table>
<thead>
<tr>
<th>Category</th>
<th>Citizen</th>
<th>Resident</th>
<th>Non-resident</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Daily entry fees (per person, per day)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Private tours</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adult fee</td>
<td>before</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td></td>
<td>after</td>
<td>2.00</td>
<td>10.00</td>
</tr>
<tr>
<td></td>
<td>% change</td>
<td>100%</td>
<td>900%</td>
</tr>
<tr>
<td>Licensed tours*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adult fee</td>
<td>before</td>
<td>1.50</td>
<td>1.50</td>
</tr>
<tr>
<td></td>
<td>after</td>
<td>2.00</td>
<td>10.00</td>
</tr>
<tr>
<td></td>
<td>% change</td>
<td>33%</td>
<td>567%</td>
</tr>
<tr>
<td><strong>Camping fees (per person, per night)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Private tours</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adult fee</td>
<td>before</td>
<td>0.80</td>
<td>0.80</td>
</tr>
<tr>
<td></td>
<td>after</td>
<td>5.00</td>
<td>10.00</td>
</tr>
<tr>
<td></td>
<td>% change</td>
<td>525%</td>
<td>1150%</td>
</tr>
<tr>
<td>Licensed tours*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adult fee</td>
<td>before</td>
<td>0.80</td>
<td>0.80</td>
</tr>
<tr>
<td></td>
<td>after</td>
<td>1.00</td>
<td>5.00</td>
</tr>
<tr>
<td></td>
<td>% change</td>
<td>25%</td>
<td>525%</td>
</tr>
<tr>
<td><strong>Vehicle entrance fee (per vehicle, per day)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Botswana**</td>
<td>before</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td></td>
<td>after</td>
<td>2.00</td>
<td>2.00</td>
</tr>
<tr>
<td></td>
<td>% change</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>Foreign**</td>
<td>before</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td></td>
<td>after</td>
<td>10.00</td>
<td>10.00</td>
</tr>
<tr>
<td></td>
<td>% change</td>
<td>900%</td>
<td>900%</td>
</tr>
</tbody>
</table>

* Tours through Botswana registered, based and licensed operators and established lodges and hotels

** Botswana registered and foreign registered vehicles
Data are limited on the numbers of tourist entries and the fees collected at park gates immediately before and after the fees were changed. Such data were, however, collected for Moremi Game Reserve by C.S. Hamilton, between 1989 and 1991 (C.S. Hamilton, 1991, in litt.). These post-fee-change data can be compared directly with pre-fee-change data recorded by Fowkes (1985), Ingram et al. (1985), Hill (1988), and partly presented by FGU-Kronberg (1988b), for the same park during the period between 1984 and 1988. Since payment of weekly and annual fees is no longer possible, and in as much as tourists in the past may have bought weekly and annual fees but stayed for shorter periods, the visitor numbers from before the 1989 fee change may be slightly exaggerated.

Table 4.5 shows visitor numbers and fees recorded before and after the change. While visitor numbers for 1989 do appear to be lower than those of the previous years (this was also observed by Borge et al., 1990), those thereafter appear to be somewhat higher. There is, in fact, an increase of 49% between the mean monthly tourist numbers before and after the change. Measured similarly, a dramatic increase in the total fees received is evident. Both increases were found to be significant statistically ("t-test" P < 0.05). The figures for visitor numbers for the period 1984 to 1991 were subjected to trend analysis where it was attempted to fit linear, exponential, logistic and quadratic functions to the data. The results of this are summarised in Table 4.5. The best fit was found with linear and quadratic curves. The linear trend function and the tourist numbers data are also depicted in Figure 4.C. This model indicates that there has been positive growth in tourist numbers over the eight-year period. The quadratic trend function suggested overall positive growth in tourist numbers after 1987.

To see whether the length of stay in parks by tourists was affected by fee changes, C.J. Hamilton (1991, in litt.) computed the mean number of nights spent in Moremi by tourists for each month between January and November 1989 (i.e. for six months before and five months after the change in fees). The mean number of nights spent per tourist for the six-month-"before" period is 2.16, and that for the five-month-"after" period is 1.85. The difference is not statistically significant.

Table 4.6 shows some of the data available on the origins of visitors to northern Botswana and the parks there, between 1984 and 1992. Because of differences in methods they can only provide a qualitative indication of possible changes in proportion. The records based on
Table 4.5: Visitor numbers and fees taken at entrance gates in Moremi Game Reserve before and after the fee increase of 1 July, 1989

<table>
<thead>
<tr>
<th>Month</th>
<th>Visitor numbers recorded by month for each year**</th>
<th>Mean for Month</th>
<th>Before*</th>
<th>After*</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>-</td>
<td>134</td>
<td>284</td>
<td>288</td>
</tr>
<tr>
<td>February</td>
<td>-</td>
<td>73</td>
<td>177</td>
<td>299</td>
</tr>
<tr>
<td>March</td>
<td>-</td>
<td>314</td>
<td>732</td>
<td>539</td>
</tr>
<tr>
<td>April</td>
<td>-</td>
<td>982</td>
<td>1084</td>
<td>770</td>
</tr>
<tr>
<td>May</td>
<td>-</td>
<td>144</td>
<td>910</td>
<td>381</td>
</tr>
<tr>
<td>June</td>
<td>-</td>
<td>524</td>
<td>1043</td>
<td>1006</td>
</tr>
<tr>
<td>July</td>
<td>2497</td>
<td>1924</td>
<td>2791</td>
<td>3124</td>
</tr>
<tr>
<td>August</td>
<td>1621</td>
<td>1384</td>
<td>2158</td>
<td>1150</td>
</tr>
<tr>
<td>September</td>
<td>648</td>
<td>859</td>
<td>1332</td>
<td>920</td>
</tr>
<tr>
<td>October</td>
<td>717</td>
<td>559</td>
<td>1121</td>
<td>515</td>
</tr>
<tr>
<td>November</td>
<td>2</td>
<td>363</td>
<td>284</td>
<td>166</td>
</tr>
<tr>
<td>December</td>
<td>536</td>
<td>439</td>
<td>687</td>
<td>415</td>
</tr>
</tbody>
</table>

Mean of monthly means for visitor numbers for January to November:

868 | 1024

Apparent increase in numbers (between the means):

49.23%

**t-test** significance = significant

(P < 0.025)

Trend analysis on visitor numbers, 1984-1991

<table>
<thead>
<tr>
<th>Mean error of residuals</th>
<th>Mean SE of residuals</th>
<th>Mean abs. error of residuals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linear model</td>
<td>N = 647.774 + 5.36379(T)</td>
<td>0.00000</td>
</tr>
<tr>
<td>Quadratic model</td>
<td>N = 1149.01 - 21.6941(T) + 0.267705(T^2)</td>
<td>0.00000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Month</th>
<th>Total fees received by month for each year (Pula '000)**</th>
<th>Mean for Month</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>-</td>
<td>1.3</td>
</tr>
<tr>
<td>February</td>
<td>-</td>
<td>0.7</td>
</tr>
<tr>
<td>March</td>
<td>-</td>
<td>2.8</td>
</tr>
<tr>
<td>April</td>
<td>-</td>
<td>9.7</td>
</tr>
<tr>
<td>May</td>
<td>-</td>
<td>1.4</td>
</tr>
<tr>
<td>June</td>
<td>-</td>
<td>2.8</td>
</tr>
<tr>
<td>July</td>
<td>27.1</td>
<td>19.4</td>
</tr>
<tr>
<td>August</td>
<td>16.8</td>
<td>12.2</td>
</tr>
<tr>
<td>September</td>
<td>7.2</td>
<td>10.1</td>
</tr>
<tr>
<td>October</td>
<td>7.5</td>
<td>5.4</td>
</tr>
<tr>
<td>November</td>
<td>0.01</td>
<td>3.9</td>
</tr>
<tr>
<td>December</td>
<td>5.9</td>
<td>4.7</td>
</tr>
</tbody>
</table>

Mean of monthly means for fees for January to November:

7.4 | 73.2

Apparent increase in fees (between the means):

888.91%

**t-test** significance = highly significant

(P < 0.005)

* Refers to changes in national park and game reserve entry fees made on 1 July, 1989

** Dashes indicate data not available
Figure 4.C: Numbers of visitors recorded entering Moremi Game Reserve between 1984 and 1991, before and after the fee increase of 1 July 1989, showing the linear trend in these numbers
Table 4.6: Relative proportions by place of origin recorded in various samples of tourists visiting northern Botswana between 1984 and 1992

<table>
<thead>
<tr>
<th>Place of origin</th>
<th>Year of sample</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Samples based on gate entry permits</strong></td>
<td></td>
</tr>
<tr>
<td>Reference*</td>
<td>(1)</td>
</tr>
<tr>
<td>Southern Africa</td>
<td>58</td>
</tr>
<tr>
<td>Europe</td>
<td>1</td>
</tr>
<tr>
<td>North America</td>
<td>0</td>
</tr>
<tr>
<td>Botswana</td>
<td>38</td>
</tr>
<tr>
<td>Other</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>100</td>
</tr>
<tr>
<td><strong>Samples based on questionnaire or interview surveys</strong></td>
<td></td>
</tr>
<tr>
<td>Reference*</td>
<td>(3)</td>
</tr>
<tr>
<td>Southern Africa</td>
<td>53</td>
</tr>
<tr>
<td>Europe</td>
<td>20</td>
</tr>
<tr>
<td>North America</td>
<td>18</td>
</tr>
<tr>
<td>Botswana</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>9</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>100</td>
</tr>
</tbody>
</table>

* References: (1) Ingram et al. (1985), (2) FGU-Kronberg (1988b), (3) Fowkes (1985), (4) Borge et al. (1990), (5) Kalahari Game Services (1991), (6) This study

examination of gate entry permits tend to emphasise the origins of drivers or tour companies rather than of tourists, because drivers fill in the permit forms. The records from questionnaire and interview surveys give a better idea of tourist origins. All data for 1990 refer to Moremi Game Reserve only. The data recorded under reference 3 (Fowkes, 1985)
refer to estimates made by fixed and mobile tour operators of their own clients. Generally, the data in Table 4.6 suggest that there has been an increase in the proportion of Botswana-registered tour operators at the expense of the proportion registered elsewhere in southern Africa. The data also suggest that there has been a reduction in the proportion of non-resident visitors from southern Africa (most from South Africa) and an increase in the proportion of non-resident visitors from Europe and North America. If this is true it could be due to both political influences, such as the high degree of tension between South Africa and Botswana during the late 1980s, and the change in fees.

Respondents to the 1992 questionnaire survey described above were presented with the (post-fee-change) non-resident, private tour park entry fee (P50 per day) as an example and asked to comment on whether they considered it satisfactory or not (question 2.10, in Appendix 4.1). If they did not, they were asked to suggest an alternative (question 2.11). Table 4.7 shows the pattern of responses to this question among various user categories or market segments. Among all visitors sampled a significant majority were satisfied with the fee. Highly significant majorities among lodge users and tourists from overseas were also satisfied with it. There was a strong tendency for regional visitors to be dissatisfied with the fee and, when these were lumped with Botswana residents, a statistically significant majority were not satisfied. Respondents who were dissatisfied suggested alternatives with mean of P25.

Lodge users tend to be from overseas (74 percent of lodge users sampled were from overseas, while only 39 percent of regional tourists sampled used lodges). Campsite users sampled were more evenly spread between overseas and regional tourists (54 percent of campsite users sampled were from overseas). As shown in Table 4.1, for various reasons, including currency exchange rate differences, lodge visitors have higher trip expenditures than campsite users, and tourists from overseas have both higher incomes and tourist expenditures than tourists from the region. Entry fees must thus make up a larger portion of campsite users’ and regional visitors’ trip expenditures than they do of lodge users’ and overseas visitors’ expenditures. While demand for wildlife-viewing trips appears to be more price elastic among lodge users than that among campsite users, it is quite possible that the opposite is the case with demand for park entry.
### Table 4.7: Proportions of wildlife-viewing tourists in various market segments finding the non-resident park entry fee* satisfactory or not (northern parks tourist survey, Botswana, 1992)

<table>
<thead>
<tr>
<th>User category</th>
<th>Sample number</th>
<th>Fee satisfactory:</th>
<th>Mean Alternative**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lodge users</td>
<td>(98)</td>
<td>72% 28%**</td>
<td>P29</td>
</tr>
<tr>
<td>Campsite users</td>
<td>(102)</td>
<td>48% 52%</td>
<td>P23</td>
</tr>
<tr>
<td>Overseas visitors</td>
<td>(127)</td>
<td>71% 29%+++</td>
<td>P29</td>
</tr>
<tr>
<td>Regional visitors***</td>
<td>(56)</td>
<td>37% 63%+</td>
<td>P20</td>
</tr>
<tr>
<td>Regional visitors and Botswana residents****</td>
<td>(72)</td>
<td>37% 63%++</td>
<td>P20</td>
</tr>
<tr>
<td>All visitors</td>
<td>(200)</td>
<td>60% 40%+++</td>
<td>P25</td>
</tr>
</tbody>
</table>

* Non resident, private tour, park entry fee (P50 per day)
** Mean of alternatives suggested by respondents finding fee not satisfactory
*** Residents of southern Africa excluding Botswana
**** Residents of southern Africa including non-citizen Botswana residents
+ Difference with preceding percentage significant at the 10% level (Chi² test)
++ Difference with preceding percentage significant at the 5% level (Chi² test)
+++ Difference with preceding percentage significant at the 1% level (Chi² test)

The evidence presented above suggests that, contrary to expectations, the introduction of a major increase in park fees had no effect on the general growth pattern in visitor numbers to Moremi. At the same time, fees collected increased dramatically. This indicates that the demand for entrance to, and use of, Moremi Game Reserve by tourists was highly price-inelastic through the range of the fee change. In addition, there is no apparent reason to think that the Moremi visitor patterns have been different from those of the other northern parks in Botswana. Moremi receives some 38 percent of the northern parks visitors, and the northern parks receive some 91 percent of all wildlife-viewing tourists in Botswana (FGU-Kronberg, 1988b).
The fee change of 1989 could well have met its original objective in diverting "self-drive" regional tourists and encouraging the use of Botswana licensed facilities. Comparison of government revenue and recurrent budget data in 1990, shows that it also effectively eliminated the financial subsidy being provided by central government to the game reserves and national parks (another objective). It appears that visitor numbers have not decreased as a result of the new fees and that a majority of 1992 visitors generally found them satisfactory. The market segment encompassing residents of the southern African region, however, finds the present pricing policy unsatisfactory.

It can be recommended that the fee structure for parks be further refined to introduce differentiation between overseas and regional, non-resident tourists. A simple way to do this would be to charge the same fees to regional tourists as are already being charged to residents (non-citizen residents of Botswana). This change would make it possible to recapture a market segment which may have been alienated by the fee change, which has some growth potential, and which can make better use of certain product niches than the overseas segment. It would improve regional cooperation in tourism, regional goodwill and stability in Botswana's tourism industry.

4.5 Supply characteristics of wildlife-based tourism

Enterprise development

Estimates of the contribution of wildlife-based tourism to the macro-economy in Botswana are discussed in detail in chapter 12, and will not be dealt with here. The sub-sector involves use of fixed accommodation (lodges) and use of campsites by mobile guided and self-driven tours. Tlusty (1987) and Africa Asien Bureau (1987) were of the opinion that the economic contribution per tourist among fixed-facility users is much higher than that for campsite users, in particular the self-driven ones. The results given above lend support to this. As described above, policy now places priority on the development of up-market facilities. An important component of this is the development of lodges with capacities of between 12 and 50 beds. In the high quality wildlife areas of the Okavango/Chobe region, fixed units of this type, which can maximise both luxury and personal services, within carrying capacities of around 700
hectares per bed, are seen as being able to maximise eco-tourism use values. Below, the micro-economic characteristics of lodge development are examined.

A financial/economic model of a typical medium- to large-scale wildlife-based tourism enterprise has been developed. The basic model is for a game lodge on the edge of a park within the physical and economic environment in northern Botswana. Unit capacity is 30 beds, an average figure. The land requirement, based on the estimated tourist carrying capacity for the high quality northern areas of 700 hectares per bed, is 21,000 hectares. A wildlife population containing a spectrum of high-value species at a density of 32 hectares per large stock unit equivalent (LSU) is assumed. This conforms with recent aerial survey results for the Okavango Delta.

The game lodge enterprise caters for significant, unsatisfied and expanding demand for quality game lodge experiences notably in the European, USA and, increasingly, "Pacific Rim" markets. In line with empirical evidence (Domestic Technology International, 1991), a ratio of 75 percent long-haul tourists to 25 percent regional tourists is assumed for the clientele.

Based on evidence of Tlusty (1987) and Fowkes (1985) an average occupancy rate of 33 percent is assumed as being easily attainable. It is assumed that the typical operation is 25 percent loan financed. The model includes amortisation of this at 10 percent interest over asset life. It also includes provision for capital replacement (depreciation) with regard to equity financed assets. Working capital requirements are assumed to be 30 percent of operating expenditures. Interest on this is calculated at 15 percent. The model is for one lodge, but it is assumed that administrative costs are shared between three such units.

For the financial analysis a land rental of three pula per hectare is assumed. This would be extracted by the district land board and would be refunded to the district council. The profit before tax, a net cash income, amounting to P14.70 per hectare, is assumed to be shared between the landholders (the community with responsibility for the area) and the commercial operators (the company which would operate the business). It is assumed that for this enterprise, employment for 39 would be created. A financial rate of return and a financial net present value at a 12 percent discount rate were calculated over ten years.
The tourist lodge enterprise model has also been analysed in terms of economic values. To achieve this, the assumptions on shadow pricing, described in chapter 2, have been used. In conformity with these, foreign inflows and outflows have been treated as benefits and costs and foreign financing is assumed to amount to 50 percent of long-term requirements. Repatriation of interest and loans is thus assumed to amount to 50 percent. Outflow of profits is assumed to amount to 50 percent, implying both leakage and repatriation. This is in accordance with empirical evidence to hand. An economic rate of return and an economic net present value at a six percent discount rate have been calculated over ten years. It should be noted that the economic valuation does not, at this stage, include the economic opportunity cost of land or the relevant economic costs of government expenditure in the wildlife sector.

The enterprise, at full production, provides ownership with an annual net cash income of P315,200. The financial rate of return is 18 percent after ten years. With the assumed 12 percent cut-off rate, investment in tourist lodge enterprises is financially attractive over this period. A financial rate of return over the cut-off rate is only attained after six years, however.

In economic terms the domestic resource cost ratio (the ratio of domestic currency required to earn a unit of foreign exchange) is 0.30. This is favourable, reflecting a comparative advantage for the enterprise. The economic rate of return is 28 percent after ten years. Given an assumed six percent economic cut-off rate, this type of development appears to be very attractive economically.

Sensitivity analysis of the model using various changed assumptions was carried out and the results are depicted in Table 4.8. The results in the table indicate that the viability of the enterprise is sensitive to changes in occupancy rates. Financial profitability is more highly sensitive to this factor than economic viability. At occupancies below 28 percent the enterprise is financially unattractive after ten years.

The distortion of financial values from economic ones, at lower occupancy rates, is almost certainly due to the inflexible tax system whereby government revenues are derived from fixed licence and entrance fees. It suggests that more government support could be justifiably
Table 4.8: Results of sensitivity analyses on model of wildlife-viewing lodge (internal rates of return and net present values over ten years, financial/economic model, northern Botswana, 1990)

<table>
<thead>
<tr>
<th>Variation in occupancy rate</th>
<th>Internal rate of return (%)</th>
<th>Net present value (pula '000)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Financial (10 yrs)</td>
<td>Economic (10 yrs)</td>
</tr>
<tr>
<td>23% occupancy</td>
<td>0.2%</td>
<td>17.1%</td>
</tr>
<tr>
<td>33% (normal)</td>
<td>17.5%</td>
<td>27.5%</td>
</tr>
<tr>
<td>43% occupancy</td>
<td>31.0%</td>
<td>36.1%</td>
</tr>
<tr>
<td>Variation in product prices</td>
<td></td>
<td></td>
</tr>
<tr>
<td>+10%</td>
<td>24.5%</td>
<td>31.3%</td>
</tr>
<tr>
<td>Normal</td>
<td>17.5%</td>
<td>27.5%</td>
</tr>
<tr>
<td>-10%</td>
<td>10.0%</td>
<td>23.6%</td>
</tr>
<tr>
<td>Variation in capital cost</td>
<td></td>
<td></td>
</tr>
<tr>
<td>+10%</td>
<td>15.5%</td>
<td>25.4%</td>
</tr>
<tr>
<td>Normal</td>
<td>17.5%</td>
<td>27.5%</td>
</tr>
<tr>
<td>-10%</td>
<td>19.8%</td>
<td>29.9%</td>
</tr>
</tbody>
</table>

Changes in the price of the tourism product also affect the viability of the enterprise but not to the same extent as occupancy rates. This is evident in Table 4.8. The financial sensitivity to product price change is greater than the economic sensitivity. The results of the demand analysis above, where demand was found to be price elastic, suggest that an actual drop in prices for lodge accommodation would tend to be compensated for by an increase in tourist numbers (or occupancy) and turnover. The enterprise viability is less affected by changes in the costs of capital items (or the level of expenditure on capital items). In this case, which is
depicted in Table 4.8, there is also a difference between the effect on economic returns and that on financial returns.

Protected area development

In this section, attention is paid to the degree to which the net economic benefits of game-viewing tourism enterprises can justify government expenditure on protected area development. Cost-benefit analyses of national park or game reserve development have not been commonly performed in Africa, mainly because most benefits have been perceived to be external and difficult to quantify. Mitchell (1969) and Thresher (1976), working on Amboseli National Park in Kenya, and Settlement Planning Services (1991) working on the proposed Madikwe Game Reserve in North West Province, South Africa, undertook financial cost-benefit analyses of government investment in park development, with benefits measured in terms of financial use values. In all cases, positive financial rates of return to expenditures in park development were measured.

Boonzaaier and Brockett (1987) undertook a preliminary financial evaluation of the Pilanesberg National Park and found a positive financial return on park investment costs, in terms of stock "on the hoof". Davies (1993) followed this with an attempt to weigh up the costs and benefits associated with Pilanesberg. This analysis was based on financial prices but included some economic elements such as consumer surplus and non-use values. Engelbrecht and van der Walt (1993) similarly, attempted to compare the value of the Kruger National Park in South Africa with that for the same site under agriculture. This was in financial terms but with qualitative consideration of some economic values. The last three analyses made use of unconventional methods and can provide only an indication of positive financial values for the parks involved.

The Management Plan for Moremi Game Reserve, in the Okavango Delta in Ngamiland District, makes provision for infrastructural and manpower development within an ecological zoning framework (Kalahari Game Services, 1991). The plan was appraised by myself with R. Hartley in 1991. While it is likely that the value of Moremi Game Reserve is dominated by non-use values (see chapter 2), it does contain some measurable use values in the form of wildlife viewing tourism. Therefore, while the primary return on investment in plan
implementation will be in non-use values, it was deemed worthwhile to see to what extent plan implementation would be compensated for in terms of utilisation benefits.

An economic cost-benefit model was constructed for the management plan in which expenditures were those of plan implementation and benefits were measured in the form of incremental net economic benefit resulting from implementation. In the model, anticipated economic benefits include increased net income to game lodges, mobile safaris and campsite use. These are, primarily, the result of expected increases in occupancies in lodges and of expected increases in both capacities and occupancies of campsites. Data presented by Fowkes (1985) suggests that existing facilities have an average occupancy rate of 21 percent. It is assumed that plan implementation will make it possible for the occupancy rate to be increased to 50 percent after eight years. A 50 percent rate is considered easily obtainable by Gibson (1990) and, given expected rapid growth in tourism demand in the region, this seems a reasonable assumption.

The economic benefits also include a very limited effect of increased game stocks and game dispersal on economic benefits to be derived from safari hunting and community wildlife use on neighbouring land. Benefit of backward linkages in the form of provision of fuel-wood and production of crafts from surrounding areas is also included.

Economic enterprise models for wildlife-viewing lodge development, safari hunting and community-based wildlife use, described above and in chapters 5 and 6, were used to estimate the incremental net benefits. The net benefit per tourist night for mobile safaris and camping is assumed to be 33 percent and 20 percent, respectively, of that for game lodges.

Constant 1991 economic values (with shadow pricing based on assumptions described in chapter 2) are used. In the calculation of costs, maintenance is calculated at five percent of initial cost per annum for buildings and infrastructure and six percent of initial cost per annum for vehicles and equipment. Operating costs consist of manpower salaries, wages and allowances. A discount rate of eight percent is used to reflect the opportunity cost of public sector capital. The net present value at eight percent and the economic internal rate of return for the programme have been calculated over 20 years.
The results of the economic cost-benefit analysis are shown in Table 4.9. After 20 years the economic rate of return is 26 percent and the economic net present value (at eight percent) is P26 million. This represents a highly favourable return. The anticipated flow of economic benefits is highly dependent on the assumption that increased occupancy rates will result from plan implementation. The effects on the model of varying this assumption are shown in Table 4.9. It is shown that even if the occupancy rate only rises to 37%, the net present value remains positive.

Table 4.9: Results of sensitivity analysis on the cost-benefit model for Moremi Game Reserve management plan (Botswana, 1991)

<table>
<thead>
<tr>
<th>Attained occupancy rate*</th>
<th>Economic rate of return (20 years)</th>
<th>Economic net present value (20 yrs, @ 8%, P'000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>37%</td>
<td>11.0%</td>
<td>3,436.3</td>
</tr>
<tr>
<td>51% (expected)</td>
<td>23.5%</td>
<td>25,263.0</td>
</tr>
<tr>
<td>65%</td>
<td>37.2%</td>
<td>44,356.0</td>
</tr>
</tbody>
</table>

* Initial occupancy rate assumed = 21%

4.6 Chapter conclusion

Wildlife-viewing tourism is the primary way in which utilisation values can be realised in protected areas. Policy in Botswana gives emphasis to low-density, high-priced tourism. Evidence indicates that this can produce high financial and economic returns with minimal environmental damage and loss of non-use (preservation) values. It needs, however, to be accompanied by mechanisms to distribute resulting economic benefits to households in and around wildlife areas. To a lesser extent policy which makes provision for cheap and easy access for citizens to engage in wildlife-based tourism activities is also supported. Along with maximising total economic value, a central objective should be to generate public support for conservation. In line with the principles described by Lindberg (1991), judicious use of fee
differentials and land zoning can be used to help maximise the combination of use and non-use values.

The market environments for wildlife-based tourism have been poorly known and a general shift in emphasis towards market orientated development is needed. In addition, there is very little information on the nature and extent of preservation values associated with the wildlife resources. Research is required on these subjects. The results from this specific contingent valuation study of the market for wildlife-viewing tourism in northern Botswana show that annual income levels for overseas visitors were significantly higher (twice as high) than those of regional visitors. Expenditures on the whole trip were significantly greater for lodge users (some twice as great) than they were for campsite users and were also significantly greater for overseas visitors (nearly four times greater) than they were for regional visitors. Similarly, expenditures on the Botswana component of the trip were significantly higher for lodge users and overseas visitors (in both cases twice as high) than they were for campsite users and regional visitors, respectively.

Estimates of consumer surplus experienced by visitors were not found to be significantly different between market segments. Similarly, there was no statistically significant difference found between the amount that visitors in various market segments were willing to pay to a Botswana wildlife conservation fund. Generally, sampled visitors spent some 27 percent of their total trip cost within Botswana. They experienced estimated consumer surpluses amounting between 17 and 20 percent of their trip costs and were willing to donate one percent of their whole trip cost, or four percent of the cost of the Botswana component of their trip, into a Botswana wildlife conservation fund.

The contingent valuation study has shown that wildlife-viewing tourists in Botswana have moderate consumer surpluses most of which are not contributing to domestic or national income (since most tourists are non-residents or non-citizens). There does, however, seem to be some potential for Botswana to capture some of this via donations to a Botswana wildlife conservation fund. The national, annual, aggregate consumer surplus for wildlife viewing within Botswana in 1989 is estimated at some P40.9 million. Tourists appear willing to contribute some P8 million out of this towards a conservation fund.
Analysis of demand for wildlife-viewing trips involving Botswana, indicates price elasticity is very close to unity, with the coefficient being some -0.93. For trips involving use of campsites demand is inelastic, with the coefficient being some -0.68, and for trips involving use of lodges demand is elastic, with the coefficient being some -1.35. These results suggest that increases or decreases in the general costs of wildlife-viewing visits to Botswana will tend to be compensated for by decreases or increases in the numbers of tourists so that little change in turnover or gross output will result. Within the segment of the market using campsites, an increase in general prices would result in an increase in gross output despite a drop in tourist numbers. There appears to be potential for extracting additional expenditures, of up to 50 percent of present costs, from this segment (although, as discussed below, this should not be via park entry fees). On the other hand, within the lodge-user segment it appears that an increase in both tourist numbers and gross output would apparently occur if there was a drop in the general prices. There would appear to be potential advantages in reducing prices, by up to 25 percent, within this segment (to some three-quarters of their present levels).

It is clear that caution needs to be applied in formulating policy recommendations resulting from the willingness to pay analysis. It is possible, considering the sample sizes and data variability that expenditure and willingness to pay estimates could differ between 15 and 50 percent from real values, depending on the particular estimate. Although design was aimed at reducing the effects of biases, the elicitation methods used could have resulted in underestimates of real willingness to pay. The statistical methodology used could have resulted in price elasticity estimates higher than the real ones. Nevertheless the approach can be considered suitable, and sufficiently rigorous to assist with the policy questions in hand.

Analysis of the effects of a substantial rise in park entry fees on the demand for park entry and use in Botswana indicates that tourist numbers continued to grow, and fees collected rose dramatically after the change. This suggests that demand for park entry is highly price inelastic through the range of the price change. Questionnaire survey results indicate differences in attitude to the fee change between market segments. Overseas visitors are satisfied with the fee structure, while regional visitors are not. It is recommended that the fee structure be further refined to introduce differentiation between overseas and regional non-resident tourists. A simple way to do this would be to charge the same fees to regional non-residents as are already being charged to residents.
A financial and economic budget model developed for a game-viewing lodge enterprise shows this to be reasonably attractive to the private investor and very desirable economically. Financial profitability is more highly sensitive than economic viability to changes in occupancy rates, product prices and capital costs. When conditions of low profitability occur (such as when occupancies are below 28 percent), the financial enterprise value is distorted below the (real) economic one. This suggests that some government support could be directed towards private investors in this sub-sector, perhaps directly aimed at increasing occupancy rates. Wildlife viewing as a rule has high compatibility with conservation of wildlife, habitats and biological diversity. This is primarily because the very product of wildlife viewing involves appreciation of natural systems. A further reason is that wildlife viewing is non-consumptive.

Cost-benefit analysis shows planned implementation of a management plan for the Moremi Game Reserve will result in a favourable return in terms of economic use values and, by implication, a positive contribution to economic growth, employment creation and economic diversification. Since the primary planning objective was to maintain the reserve's pristine wilderness quality, the plan implementation will most probably also yield significant non-use values.
Chapter 5

Safari-hunting tourism

5.1 Introduction

In this chapter, the one form of tourism which makes consumptive use of wildlife - safari hunting - is investigated. Safari hunting involves providing an outfitting and guiding service to clients offering the tourist a hunting experience. All non-residents hunting in Botswana must do so under the guidance of a licensed professional hunter, and within a specific non-resident hunting quota. The hunting licence fees payable for non-resident hunting are significantly higher than those of citizens and residents. Some safari hunting is done on private land but most is done within concessions on communal or state land. Most non-resident hunters are from overseas and seeking animals of trophy quality. Below, the financial and economic viability of safari hunting as a financial and economic activity is explored. Results have, in part, also been documented by Barnes (1988, 1991a), FGU-Kronberg (1988a) and Barnes and Pearce (1991).

5.2 Technical and market considerations

In 1987 it was decided to review safari hunting in Botswana. Initial recommendations resulting from inter-departmental discussion called for "the derivation of a formula, based on supply, demand, international market prices, etc., that will assist the review of safari hunting lease rentals which are currently too low".

Safari hunting is a significant earner of income and foreign exchange. Flusty (1987) argued that in 1984, 15 percent of non-business tourist expenditures were derived from safari hunters.
who occupied only one percent of the bed-nights. Earlier, Prowse (1974) found that during 1966, hunters contributed 75 percent of total non-business tourist expenditures and made up only two percent of their numbers. At this time safari hunting clients, while constituting 20 percent of hunting licence purchasers, accounted for 76 percent of total licence revenues. Fleming (1976) stated that in 1974, fees paid by safari hunting companies and their clients accounted for over three-quarters of the total revenue collected by the Department of Wildlife, National Parks and Tourism.

Safari hunting is generally considered one of the more profitable wildlife-use enterprises. The financial viability of game ranching in southern Africa is commonly reliant on this form of resource use (see chapter 7; Luxmoore, 1985; Child, 1984, 1988; Joubert and Behr, 1986; Behr, 1988; Behr and Groenewald, 1990b). Similarly, the financial viability of community-based natural resource management projects in southern Africa has been very dependent on the inclusion of safari hunting, particularly that of elephant (see chapter 6; Jansen, 1990; Barbier, 1992; Bond, 1994).

Safari South (Pty.) Ltd. et al. (1982), stated that between 1975 and 1981, the capital investments of the four main companies in Botswana rose from P0.52 million to P1.27 million. Gross income or sales revenue for these four rose from P1.3 million to P2.83 million over the same period. The total number of employees of the four companies based on peak season requirements, was reported to have fluctuated between 250 and 300, and an estimate of game meat supplied to labour and local residents in 1981 amounted to 72.2 tonnes.

Ferrario (1985) quoted an analysis of the safari-hunting market by the Worldwide Outfitters Guide (Safari Club International), which stated that the total African market was split as follows.

- 42 percent South Africa,
- 25 percent Zimbabwe,
- 12 percent Namibia,
- eight percent Sudan,
- seven percent Botswana,
- two percent Tanzania,
- two percent Zambia,
- one percent Cameroon,
- one percent Central African Republic.

Botswana has a resource which compares very favourably with those of South Africa, Zimbabwe and Namibia and it should, therefore, be able to increase its market share. A market survey carried out by Prowse (1974) among delegates to the Second International Big Game Hunter’s and Fisherman’s Conference held in 1969 in Texas, USA, provided some interesting information on hunter preferences. It showed that American safari-hunting clients were more interested in collecting one or a few selected trophies and not large numbers. A stable political climate and a feeling of being welcome were rated highly in determining the clients’ choice of country for a big game hunt. Clients’ choice of outfitter tended to be determined by reliability, honesty and fair play. The choice of professional hunter tended to be dictated by the skill and knowledge of the hunter, and not by factors such as race or popularity. The most highly rated sources of information used as a basis for choosing a hunt are other hunters with previous experience in the area(s) concerned, and professional hunters known to the client. Media advertisements and travel agents were not rated highly for this.

Traditionally, in Botswana, safari hunting has been extensive in nature. Concessions have been very large (up to two million hectares in size) and superimposed on other forms of land use including various forms of licensed citizen hunting as well as, in places, livestock production. Concession rentals have been low (as low as P0.04 per hectare over some 13 million hectares). In neighbouring countries, safari hunting, particularly that on private land, has been much more intensive. In 1987 safari hunting involved a total quota of some 4,600 animals of which about 1,900 were taken. Some 66 percent of these were taken in the Okavango/Chobe region and the balance came from the Makgadikgadi and Kgalagadi regions (FGU-Kronberg, 1988a).

5.3 Financial and economic viability

In 1987, using data from Johnstone (1975), Pass (1983) and Berry (1986) and adapting it to physical conditions in Botswana, Barnes (1988) and FGU-Kronberg (1988a) developed concept financial models for two safari-hunting enterprises representative of the Okavango/Chobe and Kgalagadi regions. The biologically sustainable off-take formula for trophy quality animals of
each species, as calculated by Spinage (FGU-Kronberg, 1987b), were applied to the aerial census data to determine the potential trophy quota for these areas. Based on these quota, balanced hunts were formulated according to the method of Booth (1984). The off-take percentages range from 2.5 percent for springbok to 0.3 percent for elephant. Elephant were included in the model for the Okavango/Chobe region.

With the Ngamiland financial concept model, some 80,000 hectares of prime wildlife land was found to be required to generate P31,000 in hunting licence fees, P36,000 in land rental and P34,000 in before-tax profits for the operator. With the Kgalagadi financial concept model, some 330,000 hectares were found to be required to generate P18,000 in licence fees, P7,000 in rental and P28,000 in before-tax profits for the operator. Through manipulation of fees and rental, the proportions between these different components could be altered. It is clear that the profitability of the Kgalagadi operation is relatively poor and it is likely to be significantly more risky.

These concept models were used as a base to recommend that safari-hunting operations in Ngamiland be intensified from four into 16 concessions of between 80,000 and 100,000 hectares each. They were also used to recommend dividing the two Kgalagadi concessions into five, ranging in size from 330,000 to 350,000 hectares (FGU-Kronberg, 1988a). This would mean that some 1.2 to 1.6 million hectares in the Okavango/Chobe region and some 1.6 to 1.7 million hectares in the Kgalagadi region would be required for safari-hunting concessions.

In 1990, the financial concept model for safari hunting in Ngamiland was upgraded into a financial and economic model using empirical data collected from existing safari-hunting operations (Barnes, 1991a). This model is thus, similarly, of a medium-scale enterprise, set in a high-value wildlife area. The specialised, safari enterprise involves the provision of small, fixed, tented camps to very high paying clients in search of a high quality hunting experience. The unit is an eight-bed camp with capacity for two hunters and some observers. The model represents one hunting camp but this is assumed to be part of a five-camp undertaking and administration costs are shared appropriately. A wildlife population containing a spectrum of high-value species at a density of 32 hectares per large stock unit equivalent (LSU) is assumed. This conforms with aerial survey results from that time for the Okavango Delta.
A concession area of 180,000 hectares was assumed from which a sustainable quota for trophy quality non-resident hunting species are available. Elephant were not included on the quota. The hunting season extends over six months. The average annual occupancy rate assumed (in terms of hunters only) was 27%. This is equivalent to 54% of the seasonal capacity of 365 hunter-days.

It is assumed that the typical operation is 25 percent loan financed. The model includes amortisation of this at ten percent interest over asset life. It also includes provision for capital replacement (depreciation) with regard to equity financed assets. Working capital requirements are assumed to be 30 percent of operating expenditures. Interest on this is calculated at 15 percent. For the financial analysis a concession rental of P0.60 per hectare was assumed. This would be extracted by the District Land Board and part of it would be refunded to the District Council. It is assumed that employment for 14 would be created.

The profit before tax, a net cash income, depicting annual net financial return after deduction of variable, overhead costs, at full production, was derived from the static component of the model. A dynamic financial model, from start-up over five and ten years was also developed, from which a financial rate of return and a financial net present value at a 12 percent discount rate were calculated.

The model was analysed in terms of economic values, and to achieve this, the assumptions on shadow pricing, described in chapter 1, were applied. In conformity with these, foreign inflows and outflows have been treated as benefits and costs, and foreign financing is assumed to amount to 50 percent of long-term requirements. Repatriation of interest and loans is thus assumed to amount to 50 percent. Outflow of profits is assumed to amount to 50 percent, implying both repatriation of profit share by foreigners and also some leakage. This is in accordance with empirical evidence to hand. The static component of the economic model resulted in a annual economic benefit, equivalent to a measure of the gross contribution of the enterprise toward National Income. An economic rate of return and an economic net present value at a six percent discount rate, were calculated over ten years. It should be noted that the economic valuation does not, at this stage, incorporate the economic opportunity cost of land, or the relevant economic costs of government expenditure in the wildlife sector.
Table 5.1 shows the results for the base case model. The enterprise provides ownership with a net cash income of some P129,000 which represents an annual return of 25.6 percent on the initial capital investment of P534,000. The financial rate of return over ten years is 15.6 percent, which given the 12 percent cut-off rate, indicates a reasonably good investment. It takes seven years, however before the financial rate of return begins to exceed the cut-off rate. The economic results for the enterprise are generally very favourable. The annual economic benefit is P288,000. The ten-year economic rate of return is 37.6 percent which is extremely attractive economically, given the six percent cut-off rate. The domestic resource cost ratio is 0.34, indicating comparative advantage, and the enterprise generates an economic net present value of P1.3 million over ten years. This type of development appears to be extremely attractive economically in both the short- and long-term.

Table 5.2 shows the results of sensitivity analyses on the safari-hunting financial and economic model. The general conclusion is that financial viability can be severely threatened (or significantly enhanced) by changes in occupancy rates, moderately affected by changes in the product price and only slightly affected by changes in the costs of capital items. If the occupancy rate falls from 27 percent to below 25 percent the financial rate of return becomes unattractive. Economic viability is robust and is retained even in the face of a severe drop in occupancy rates.

It is interesting to compare the results obtained here, for investment in a safari-hunting camp, with those from the previous chapter where investment in a wildlife-viewing facility is examined. The two enterprise models are set on land of similar high quality. The most notable disparity involves production per unit area. The annual economic benefit per hectare (of land used) is P31.00 for the tourist-lodge enterprise and less than P1.60 for the safari-hunting enterprise. The economic net present value over ten years is P104.00 for wildlife viewing and only P7.00 for safari hunting. By another comparative measure, the number of employment opportunities created per thousand hectares of land used is 1.86 for the tourist-lodge enterprise and only 0.08 for the safari-hunting enterprise.

The original financial concept safari hunting model described by FGU-Kronberg (1988a) included elephant as part of the trophy quota. The land requirement here was 80,000 hectares. The upgraded financial and economic safari-hunting model based on empirical data
Table 5.1: Illustrative financial and economic characteristics for a safari hunting enterprise on public land in the Okavango/Chobe region, Botswana (pula ’000, 1990)

<table>
<thead>
<tr>
<th>Item</th>
<th>Characteristic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land extent (’000 hectares)</td>
<td>181</td>
</tr>
<tr>
<td>Stock on land (large stock unit equivalents ’000)</td>
<td>5.7</td>
</tr>
<tr>
<td>Financial analysis</td>
<td></td>
</tr>
<tr>
<td>Initial capital investment</td>
<td>534</td>
</tr>
<tr>
<td>At stability (full production)</td>
<td></td>
</tr>
<tr>
<td>Annual gross income (sales)</td>
<td>714</td>
</tr>
<tr>
<td>less Variable costs</td>
<td>203</td>
</tr>
<tr>
<td>Gross margin</td>
<td>511</td>
</tr>
<tr>
<td>less Fixed costs</td>
<td>374</td>
</tr>
<tr>
<td>Annual net cash income</td>
<td>137</td>
</tr>
<tr>
<td>Financial worth over ten years</td>
<td></td>
</tr>
<tr>
<td>Financial rate of return</td>
<td>15.6%</td>
</tr>
<tr>
<td>Financial net present value (@ 12%)</td>
<td>129</td>
</tr>
<tr>
<td>Economic analysis</td>
<td></td>
</tr>
<tr>
<td>Capital outlays</td>
<td>563</td>
</tr>
<tr>
<td>At stability</td>
<td></td>
</tr>
<tr>
<td>Annual revenues</td>
<td>785</td>
</tr>
<tr>
<td>less Operating costs</td>
<td>497</td>
</tr>
<tr>
<td>Annual gross value added</td>
<td>288</td>
</tr>
<tr>
<td>Economic worth over ten years</td>
<td></td>
</tr>
<tr>
<td>Economic rate of return (%)</td>
<td>37.6%</td>
</tr>
<tr>
<td>Economic net present value (@ 6%)</td>
<td>1,256</td>
</tr>
</tbody>
</table>

excluded elephant from the quota and had a land requirement of 180,000 hectares. Making allowances for changes in the basic assumptions when the model was upgraded and inflated, it is roughly estimated that inclusion of elephant in the safari-hunting quota would, double the economic contribution of this enterprise per unit area (to some P14.00 annual economic
Table 5.2: Results of sensitivity analyses on safari-hunting enterprise model (internal rates of return and net present values over ten years, financial/economic model, Okavango/Chobe region, northern Botswana, 1990)

<table>
<thead>
<tr>
<th>Item</th>
<th>Internal Rate of Return</th>
<th></th>
<th>Net Present Value</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Financial (%)</td>
<td>Economic (%)</td>
<td>Financial (@ 12%)</td>
<td>Economic (@ 6%)</td>
</tr>
<tr>
<td>Variation in occupancy rate</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17% Occupancy</td>
<td>-1.2%</td>
<td>28.8%</td>
<td>-401.6</td>
<td>812.0</td>
</tr>
<tr>
<td>27% (Normal)</td>
<td>15.6%</td>
<td>37.6%</td>
<td>129.3</td>
<td>1,256.2</td>
</tr>
<tr>
<td>37% Occupancy</td>
<td>26.8%</td>
<td>44.2%</td>
<td>611.6</td>
<td>1,656.4</td>
</tr>
<tr>
<td>Variation in product prices</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>+10%</td>
<td>21.8%</td>
<td>41.9%</td>
<td>369.2</td>
<td>1,443.9</td>
</tr>
<tr>
<td>Normal</td>
<td>15.6%</td>
<td>37.6%</td>
<td>129.3</td>
<td>1,256.2</td>
</tr>
<tr>
<td>-10%</td>
<td>8.8%</td>
<td>33.3%</td>
<td>-110.5</td>
<td>1,068.4</td>
</tr>
<tr>
<td>Variation in capital cost</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>+10%</td>
<td>14.1%</td>
<td>35.2%</td>
<td>80.2</td>
<td>1,220.8</td>
</tr>
<tr>
<td>Normal</td>
<td>15.6%</td>
<td>37.6%</td>
<td>129.3</td>
<td>1,256.2</td>
</tr>
<tr>
<td>-10%</td>
<td>17.1%</td>
<td>40.3%</td>
<td>178.5</td>
<td>1,291.5</td>
</tr>
</tbody>
</table>

benefit per hectare) or double the number of jobs created per thousand hectares (to some 0.16).

When the annual economic benefit per unit of game biomass on the land is considered, the tourism-lodge enterprise again appears to be the most efficient. The annual economic benefit per LSU of game on the land is P910 for this and only P51 for the safari-hunting enterprise. However, with safari hunting, the annual economic benefit per LSU of game actually hunted is estimated at some P7,200.

In terms of efficiency of use of capital resources the safari-hunting enterprise (with an annual economic benefit 51 percent of economic capital outlay) is marginally more favourable than
the wildlife-viewing enterprise (with an annual economic benefit 46 percent of economic capital outlay). When the annual economic benefit produced per tourist day is considered, then safari hunting is again more efficient. The safari hunting enterprise produces an annual economic benefit of P790 per tourist-day. This rises to P1,460 when only hunter days are taken into account, and observers are excluded. For the tourist-lodge enterprise this figure is only P180.

5.4 Chapter conclusion

The recommendation for greater intensification of wildlife use through safari hunting, based on the development of concept financial models, is borne out by the results of financial and economic analysis using empirical data. Investment in safari-hunting enterprises through concessions leased from communal landholders or district land boards provides a reasonably good financial incentive and is very profitable economically. As a form of consumptive wildlife use, safari hunting results in very high economic returns per unit of wildlife consumed, and as a form of tourism it results in very high economic return per tourist-day. It has relatively high compatibility with the preservation of wildlife, natural habitats and biological diversity. This is because the value of the tourism product involved is dependent on maintenance of untrammelled wildlife land, and also because safari hunting involves minimal extraction of resources.

Inclusion of elephant in the trophy quota allocated to safari hunting in the northern Okavango/Chobe region, would double these values generally and, in marginal concessions, would mean the difference between investment or not. Bond (1994) clearly illustrates the critical importance of elephant in much safari hunting in Zimbabwe. In Botswana, land-use planning for reallocation of concessions would best not assume the inclusion of elephant in quotas. If and when inclusion becomes possible, this will simply enhance the viability (and the rents which can be captured) and will reduce the risks inherent in production from a mobile resource.

The mobility of game in Botswana suggests that intensification of safari hunting should be accompanied by more exclusivity of land use, and flexibility in balancing hunts between different areas and concession holders. Smaller concessions, while offering the safari hunting
operators more rights of exclusion should also permit flexibility in terms of the way resources are used.

Intensification of safari hunting is constrained by the biological carrying capacity for wildlife populations, and the limitations inherent in sustainable off-take of trophy-quality quota from these. Although the enterprise makes efficient use of resources, it cannot result in high economic values per unit area. Wildlife-viewing tourism, where financially and economically profitable, can result in much higher economic returns per unit area. The two different wildlife uses must, to a large extent, be spatially mutually exclusive (at least at the scale of a concession). As a general rule, wildlife viewing should be given priority. Apart from intensification resulting from inclusion of elephant in the safari-hunting quotas, the potential for large increases in the economic value added resulting from safari hunting, appears limited.
Chapter 6

Traditional and commercial wildlife cropping

6.1 Introduction

Background

Large tracts of land in Botswana are under public tenure, either as state or communal land. Most land designated for wildlife falls within these tenure types. Resource use in these areas must take place within open-access or medium- to short-term concession systems. For ecological reasons wildlife in these areas is maintained as a free ranging resource. Wildlife users may not fence off game populations, and management of wildlife by users must fit within overall management plans for the greater area. Consumptive wildlife uses in these areas are limited to safari hunting tourism, subsistence hunting and various forms of wildlife cropping. Cropping is defined here as the sustained off-take of wildlife from free-ranging populations for subsistence or commercial purposes.

This chapter is a description of the economic characteristics and potential for medium- or small-scale cropping systems of wildlife in communal areas and in particular in Wildlife Management Areas. Product processing, which can result from these activities, is dealt with in chapter 11. Part of this chapter has also been reported elsewhere (Barnes, 1991c)

6.2 Technical and social considerations

With the exception of elephant, it is considered that there is no potential for large-scale wildlife cropping schemes which are sustainable in Botswana (FGU-Kronberg, 1988a). This is
due to the, generally, low densities of game animals, the difficult transport conditions and the
gregarious nature of the more valuable and otherwise suitable species (for example, zebra).
As Parker (1984) has pointed out very few large- or medium-scale wildlife cropping schemes
have been a success in Africa. Some of the primary reasons for this can be summarised as
follows:

- Animals are adaptable to regular, routine harvesting disturbance and become more and
  more difficult to harvest,
- Wildlife resources are commonly most abundant in inaccessible areas from where their
  harvest and recovery is costly.

Parker (1984) and Woodford (1986) consider that very often the most efficient way to harvest
game for meat and hides is to let rural residents take it for themselves. In chapter 1 of this
thesis and in a paper by White (1986a), evidence is given to show that among the rural
population of Botswana, consumptive wildlife use has been practised mainly by individuals
within two different social groups. These are the very poor of the remotest settlements (using
game for subsistence), and the most wealthy, consisting of livestock owners and traders (using
game for both recreation and subsistence). There is good reason to consider that any strategy
for promoting wildlife use through cropping should be based on the already tried and tested
small-scale hunting systems, practised by these groups.

An important issue in any strategy for wildlife cropping is whether subsistence or commercial
systems should be promoted. Subsistence production can play an important role in poor, rural
peoples’ food security. Commercial production results in surplus creation and capital
formation which contributes to national development objectives and insulates users against
destitution. As a general rule in this thesis, commercial wildlife use is given preference over
subsistence use.

Another important issue relating to strategy for wildlife cropping is that of property rights.
Open access in the use of public lands tends to be inefficient, resulting in dissipation of
surpluses and low production. Making control over access possible, allows production and
surpluses from wildlife use to be maximised and this, in turn, provides incentive for
maintaining control over access. As a general rule, wherever possible, wildlife users should
be enabled to restrict access to their use areas and to maximise their returns from use. In this
thesis some user control over access to wildlife is considered essential. On communal lands, common property wildlife management by community-based institutions at local scale is considered most appropriate.

Wildlife product screening described in FGU-Kronberg (1988a) identified both market and production potential for biltong and selected trophies, mainly skins. This was confirmed in two consultancies undertaken by White (1985 and 1986b).

6.3 Financial analysis of wildlife cropping

Economic Consultancies (1985), in a thorough analysis of the potential for small-scale enterprise development in Botswana, identified opportunities for both medium-scale mobile game cropping units and smaller-scale village hunting units, both producing dried meat and dry, salted skins. They developed simple project profiles or budgets for these and found them both to be financially attractive for medium- and small-scale investors.

I followed up the findings above, with the development of more detailed concept financial models for both small- and medium-scale wildlife cropping enterprises. They are based mainly on the profiles of Economic Consultancies but also on the synthesis of data from others, including Swank et al. (1974), Pass (1983) and Berry (1986). The results are presented in more detail in reports by DWNP (1987), Barnes (1988) and FGU-Kronberg (1988a).

The small-scale (or artisanal) model was for a family-sized, mobile game cropping enterprise set in the Kgalagadi Region. It would employ appropriate technologies based on improvements to existing subsistence hunting methods. Each enterprise would make use of some 60,000 hectares of land, would earn gross income of some P18,000 and would be socially suitable for promotion among remote area dwelling communities. The medium-scale model was also for a mobile game cropping enterprise set in the Kgalagadi Region, but this would require land amounting to some 350,000 hectares, would generate gross income of some P142,000 and would be suitable for rural residents of the upper income group.
The results confirmed the conclusion of Economic Consultancies (1985), that both small and medium-scale game cropping enterprises could be financially attractive for investment. However, a significant finding was that the small-scale (artisanal) game cropping system made much more efficient use of capital than the medium-scale system. For every 100 in capital invested, small-scale cropping resulted in an annual financial return of 106 in profits, wages, rentals and taxes. The equivalent figure for a medium-scale enterprise was 34. These findings are in line with those of Weber and Fontana (1984), working with marine fisheries in Senegal. They found that traditional, small-scale fishing systems have a net product per unit of capital invested of some 50 to 70 percent, while with large-scale industrial fishing systems this is only three to seven percent.

In addition to being more capital efficient, small-scale game cropping could result in five times more employment opportunities per unit area than the medium-scale system. It entailed less risk and would give more direct control to poorer families. However, as Meynell (1986) pointed out in relation to fisheries, while hunting operations may be best undertaken by individual small operators, certain other functions, such as product processing or marketing may be more amenable to group formation.

The financial analyses indicated that wildlife resources allocated for cropping on public, especially communal, lands would best be used by small-scale, family-sized operations. These could then be arranged in loose, community-based groups, which could perhaps better perform the functions of sharing out off-take quota and marketing or processing.

6.4 Economic analysis of community-based wildlife use

Community involvement in wildlife cropping

Policy strongly supports the development of district and local community institutions which can take control of wildlife management in communal public lands and derive optimal benefits from the resource. This is in line with the findings and considerations above. The centrally managed, licensed hunting system through which most wildlife off-take on public land took place in the past, is being gradually replaced. The intention is that controlled hunting area quota be allocated to the communities resident within those areas. This has already happened
in several areas and a specific aid-funded programme (the Botswana Natural Resources Management Project) is aimed at supporting it.

In 1989 the Kedia Game harvesting project was initiated within a remote area community in the north-east of the Kalahari region. Here small-scale subsistence hunters were provided with some rifles, a donor-funded vehicle, a field manager and a hunting quota. They were formed into a group and also assisted with some appropriate meat hide and trophy processing equipment. This project was evaluated after three years of operation by Cumming and Taylor (1989) who found that it was not financially viable. The main reasons for this appeared to be low densities of game and poor management.

The Ngwaketse Community Game Harvesting Project was initiated in the south eastern Kalahari region, after being identified and appraised by I. Kgari (1988, pers. comm.), Environmental Services, Botswana (1988) and Cumming and Taylor (1989). Another initiative, the Mathlo-a-Phuduhudu Community Game Harvesting project, was identified and planned for the western Kalahari by M. Kalikawe and J. Loermans (1988, pers. comm.) and Cumming and Taylor (1989). These were both subjected to financial and economic appraisal with results being presented in detail by Barnes (1989a, 1989b), and in part below. A similar appraisal was undertaken for the Chobe Enclave Community Wildlife Utilisation Project, situated in the Okavango/Chobe region (Barnes, 1991b).

All three of these projects are somewhat unusual within the southern African region in that they incorporate significant small-scale game cropping by community participants. Other community wildlife projects in the region have tended to be dominated by the sale of use rights to private sector safari hunting operations (Jansen, 1990; Barbier, 1992).

**Financial and economic viability**

Table 6.1 shows summarised data from the financial and economic models for the three community projects. These provide a useful comparison between results from areas with both low and medium game densities within the Kalahari environment and from a relatively rich, high-potential game area in the north of the country. The more important base case
assumptions associated with these analyses are presented below, where they supplement the methodology of chapter 1.

The production system in all cases involves lease at token land rentals by resident communities of wildlife-use rights on local land (some 690,000 hectares at Ngwaketse, 360,000 hectares in Mathlo-a-Phuduhudu and 300,000 hectares at Chobe). In all cases the project is allocated the non-resident (trophy) and citizen hunting quota by the Department of Wildlife and National Parks for use as it sees fit. Elephant were excluded from quota. The off-take quota were calculated using the rates proposed by FGU-Kronberg (1987b). Kalahari projects were exempt from paying, but the Chobe project was required to pay a citizen licence fee for quotas received. All communities were to crop their citizen quotas through small-scale hunting operations, producing medium quality biltong for sale in the district, and dry, salted skins and trophy items for sale to small-scale tanneries and trophy dealers. In all cases the trophy quotas were sold to a safari-hunting company. In the case of Chobe, the quota was sufficient to allow the sublease of a safari-hunting concession (with land rentals), within the community project area. Also in the case of Chobe, three wildlife-viewing tourism lodge sites were subleased to private companies using the national park.

In all areas game species composition and abundance were assumed to be the same as those recorded in recent aerial censuses. The assumed overall game density for Ngwaketse was 504 hectares per large stock unit equivalent (LSU); that for Mathlo-a-Phuduhudu was 85 hectares per LSU and that for Chobe was 13 hectares per LSU. In Ngwaketse and Mathlo-a-Phuduhudu the game was on an unfenced area without access to permanent water points, but in Chobe there was access to some permanent surface water, and game was fenced from small areas of crops.

Each project was managed by a single qualified manager or facilitator whose role was planning, coordinating and supervising implementation, and assisting with record-keeping, transport and marketing. In Chobe the facilitator had a local counterpart. The standard of management was assumed to be good. Labour was provided in all areas by community participants. In both the Ngwaketse and Mathlo-a-Phuduhudu areas, full- or part-time community participants received the equivalent of 20 full-time minimum wages. In the Chobe area, community participants received the equivalent of 130 full-time minimum wages.
Each project was assumed to be 25 percent loan financed, with the remainder of the capital requirement initially provided by grants from a donor. Static financial model includes interest and amortisation payments for this at ten percent interest. It also includes provision for capital replacement (depreciation) with regard to the rest of the (equity financed) assets. Loans were amortised over not more than 20 years or, if over less time, over the life of the asset. Assets were depreciated by the straight-line method over life. Working capital was calculated as 30 percent of operating expenditures. Interest on working capital was calculated at 15 percent.

Land rental charged for Ngwaketse project was P0.004 per hectare, and that for both Mathloa-Phuduhudu and Chobe was P0.04 per hectare. Housing for the manager was supplied in all projects and, in addition, housing for 12 participants was supplied in Chobe. A storeroom was provided, water supply was assumed to exist in the village; a water pump, reservoir and some piping were provided. In Ngwaketse one vehicle was provided and elsewhere two vehicles were provided.

In all projects, biltong prices were based on a 1983 market analysis of R. White (1990, pers. comm.) with prices inflated to the 1991 level at a rate of 10.85 percent. In all areas trophy fees for non-resident quotas, charged to safari-hunting firms, were based on market rates. In the Chobe project tourism income was made up of fees for the trophy-hunting quota, a hunting royalty amounting to ten percent of safari-hunting operation turnover, and a wildlife-viewing royalty amounting to four percent of wildlife-viewing operation turnover. In all projects half of the total project vehicle mileage was assumed to be spent on product distribution and marketing. The assumed ammunition use success rate was 1.6 rounds per animal shot. The manager’s salary varied with the profitability of the project involved. Repairs and maintenance were charged at one percent of the value of fixed assets, and six percent of the value of movable assets. Insurance was charged at five percent of the value of movable assets.

For the static financial model, a net cash income was arrived at, after deduction of variable costs, operating overhead costs, rentals, amortisation and depreciation. For the dynamic financial cost-benefit model, interest was excluded and asset depreciation was accounted for by the inclusion of a residual value for assets in the final year of analysis. A financial rate of
Table 6.1: Illustrative financial and economic characteristics for three community-based wildlife cropping/other-use projects, showing the effects of varying site quality, Botswana (pula ’000, 1991****)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Project and quality of site</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A* - Poor</td>
</tr>
<tr>
<td>Land extent ('000 hectares)</td>
<td>692</td>
</tr>
<tr>
<td>Game density (hectares per large stock unit)</td>
<td>503</td>
</tr>
<tr>
<td><strong>Financial analysis</strong></td>
<td></td>
</tr>
<tr>
<td>Initial capital investment</td>
<td>195</td>
</tr>
<tr>
<td><strong>At stability (full production)</strong></td>
<td></td>
</tr>
<tr>
<td>Annual gross income (sales)</td>
<td>125</td>
</tr>
<tr>
<td>less Variable costs</td>
<td>22</td>
</tr>
<tr>
<td>Gross margin</td>
<td>103</td>
</tr>
<tr>
<td>less Fixed costs</td>
<td>57</td>
</tr>
<tr>
<td>Annual net cash income</td>
<td>46</td>
</tr>
<tr>
<td><strong>Financial worth over ten years</strong></td>
<td></td>
</tr>
<tr>
<td>Financial rate of return</td>
<td>15.4%</td>
</tr>
<tr>
<td>Financial net present value (@ 12%)</td>
<td>42</td>
</tr>
<tr>
<td><strong>Economic analysis</strong></td>
<td></td>
</tr>
<tr>
<td>Capital outlay</td>
<td>205</td>
</tr>
<tr>
<td><strong>At stability</strong></td>
<td></td>
</tr>
<tr>
<td>Annual revenues</td>
<td>138</td>
</tr>
<tr>
<td>less Operating costs</td>
<td>52</td>
</tr>
<tr>
<td>Annual gross value added</td>
<td>85</td>
</tr>
<tr>
<td><strong>Economic worth over ten years</strong></td>
<td></td>
</tr>
<tr>
<td>Economic rate of return</td>
<td>16.6%</td>
</tr>
<tr>
<td>Economic net present value (@ 6%)</td>
<td>191</td>
</tr>
<tr>
<td>Economic net present value per hectare (pula)</td>
<td>0.22</td>
</tr>
</tbody>
</table>

* Ngwaketse Project, Kalahari region
** Mathlo-a-Phuduhudu Project, Kalahari region
*** Chobe Enclave Project, Okavango/Chobe region
**** Ngwaketse and Mathlo-a-Phuduhudu appraisals were done in 1989; their values are inflated to 1991 for comparison
return and a financial net present value at a 12 percent discount rate were calculated over five,
seven and ten years.

The value of the projects in economic terms, i.e., their value to society in Botswana, was
determined by converting the financial values in the models to economic ones through shadow
pricing. Here, transfers were ignored, interest was excluded, cross-border flows were taken
into account, and values for tradable items and labour were adjusted to reflect the opportunity
cost. The social discount rate was assumed to be six percent. Both the economic opportunity
cost of land and the economic costs of attributable central government expenditures are
assumed to be zero in the model.

The results in Table 6.1 show attractive to very attractive rates of return which indicate that
community-based wildlife use projects, as planned in Botswana, can have inherent viability
both financially (from the point of view of the community) and economically (from the
national perspective). In particular, there is significant economic value to be derived from
such investments in high value wildlife areas, such as Chobe, where communities can extract
benefits from tourism. Furthermore, in the Chobe area elephant make up a high proportion of
the biomass but are presently excluded from hunting quotas. Inclusion of elephant in the
trophy hunting quota would almost certainly enhance the already high economic rate of return
(67 percent) even further.

The results in Table 6.1 also show the effect of site quality on likely financial success and
economic contribution of projects. The expected economic net present value per hectare
varies from P0.22 at Ngwaketse to P6.33 at Chobe. Sensitivity analysis of these models has
revealed how robust they are in the face of changes in their various assumptions.

The results of these sensitivity analyses suggest that the projects, being generally relatively
efficient in their use of capital, could withstand a significant increase in the price of capital
requirements. It follows that the projects could withstand being financed to a high degree by
loan. The viability of all the projects is moderately sensitive to changes in the prices of
products being produced. This illustrates the value of market development and product
promotion. Similarly, changes in the off-take rates permissible for the various species in the
game populations have a moderate effect on the returns to capital investment. This suggests that investment in stock husbandry and herd structure manipulation, to achieve higher maximum sustainable yields, could enhance project viability.

On the other hand, sensitivity analysis showed that in all projects financial and economic success was highly sensitive to changes in the densities of game populations in the project areas. Table 6.2 and Figure 6.A show the results of sensitivity analysis on the Mathlo-a-Phuduhudu project model, depicting the relationship between game densities (game scarcity) and the financial and economic profit (net cash income and net economic benefit) per LSU of game biomass. The relationship between game densities and the annual return on capital investment per LSU shows a similar pattern but is not linear.

Table 6.2: Mathlo-a-Phuduhudu community wildlife project appraisal, Botswana: effect of game scarcity in project area on the annual financial and economic profitability per unit of game (pula, 1989)

<table>
<thead>
<tr>
<th>Game scarcity</th>
<th>Annual profitability (pula/LSU)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Financial*</td>
</tr>
<tr>
<td>25 hectares per large stock unit</td>
<td>57.06</td>
</tr>
<tr>
<td>85 hectares per large stock unit</td>
<td>29.91</td>
</tr>
<tr>
<td>145 hectares per large stock unit</td>
<td>2.77</td>
</tr>
<tr>
<td>205 hectares per large stock unit</td>
<td>-24.37</td>
</tr>
<tr>
<td>265 hectares per large stock unit</td>
<td>-51.51</td>
</tr>
<tr>
<td>325 hectares per large stock unit</td>
<td>-78.66</td>
</tr>
</tbody>
</table>

* Net cash income per LSU of game biomass
** Gross value added per LSU of game biomass

From the results, it appears that annual financial losses are likely with community wildlife use in the Kalahari environment when game scarcity exceeds 150 hectares per LSU of game. Annual economic viability, however, is only likely to be lost where game scarcity exceeds
Figure 6.A: Mathlo-a-Phuduhudu community wildlife project appraisal, Botswana: effect of game scarcity in project area on the annual financial and economic profitability per unit of game (pula/LSU, 1989)
some 300 hectares per LSU. The difference is considered to be primarily due to the economic value of this type of enterprise in employment creation, since the taxes involved are low. In the case of the Chobe enclave project model a small drop in game densities is matched by a significant drop in profitability and return on investment. Here, given present relative abundance patterns for game species, and with the assumption that elephant are not being used consumptively, game scarcity should not exceed some 15 hectares or more per LSU.

Evaluation of the Kedia project (referred to briefly above) and the Ngwaketse project after several years of operation, suggests that anticipated performance targets have not been met. In the case of Ngwaketse, the Botswana Natural Resources Management Project (BNRMP, 1991a) found the causal factors to be severe management problems, a decline in resource availability, and a tendency for benefits to be concentrated among influential community members. The assumption in the appraisals above that management would be of good standard appears to have not been valid in practice. This consideration led to an additional sensitivity analysis being conducted on the Chobe enclave project model, to determine the effect of delayed attainment of full income on the viability of the project. Table 6.3 shows the results of this.

<table>
<thead>
<tr>
<th>Income growth pattern</th>
<th>Financial rate of return</th>
<th>Economic rate of return</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5 yrs</td>
<td>10 yrs</td>
</tr>
<tr>
<td>Full production attained in year 2 (fast growth)</td>
<td>17.8%</td>
<td>26.4%</td>
</tr>
<tr>
<td>Full production attained in year 3 (mod. growth)</td>
<td>10.8%</td>
<td>21.8%</td>
</tr>
<tr>
<td>Full production attained in year 4 (slow growth)</td>
<td>-0.3%</td>
<td>13.8%</td>
</tr>
<tr>
<td>Full production attained in year 5 (slow growth)</td>
<td>-9.3%</td>
<td>8.6%</td>
</tr>
</tbody>
</table>

The results in Table 6.3 suggest that if the project does not reach full income earning capacity before the fourth year of operation, the number of participants will have to be reduced to
avoid financial failure. This illustrates the importance of good management to ensure timely implementation within community wildlife use projects.

6.5. Bio-economic analysis of game protection and cropping strategies in the Kalahari

Background

In Botswana, in late 1990 and early 1991, the District Councils of Ghanzi and Kgalagadi proposed bans on hunting in their districts (which occupy the western part of the Kalahari region). This was to allow numbers of game animals, primarily in the Wildlife Management Areas (WMAs), to increase from their perceived very low levels. Significantly, rather than being imposed by the central government, these proposals were the result of grass-roots initiatives and consultation at district level. The communities at this level had perceived a need to take control of the wildlife resource for their own benefit. In effect, they were willing to forsake immediate off-take benefits in favour of future better ones.

Aerial surveys of game numbers had been conducted in these districts in the 1978/79 season by DHV Consulting Engineers (1980) and between 1987 and 1991 by the Department of Wildlife and National Parks as part of a country-wide wildlife aerial monitoring programme. Sampling intensities had been low (mostly less than five percent) giving rise to wide confidence limits and making it difficult to determine densities and trends with certainty. However, comparison of results obtained in 1978/79 and 1987 strongly suggested that there had been dramatic declines in the overall numbers of wildebeest and hartebeest (FGU-Kronberg, 1988a).

These two species which had made up the bulk of animal biomass, along with eland, appeared to have lost some 80 to 90 percent of their numbers. Other species also appeared to have declined to varying degrees, the least affected being gemsbok and, to a lesser extent, springbok. Overall game biomass appeared to have declined by about 60 percent. The perceived decline was attributed to the extremely severe drought experienced during the period between surveys.
Since 1987 there has been no drought, but the results of aerial surveys conducted since then suggest that there has not yet been any marked recovery in general wildlife numbers. Table 6.4 depicts apparently steadily increasing game scarcity (decreasing density) in Ghanzi District and possible stabilisation of numbers in Kgalagadi District. The results for Ghanzi District suggest an alarming situation. The reasons for the apparent, continuing decline are not clear but could include uncontrolled off-take.

Table 6.4: Apparent decline in game densities between 1979 and 1991 in wildlife management areas in Kgalagadi and Ghanzi Districts, Botswana (not statistically tested, and excluding one wildlife management area in Ghanzi (G.H.1))

<table>
<thead>
<tr>
<th>District surveyed</th>
<th>Game density from aerial survey</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1979</td>
</tr>
<tr>
<td>Ghanzi wildlife management areas</td>
<td>60</td>
</tr>
<tr>
<td>Kgalagadi wildlife management areas</td>
<td>66</td>
</tr>
</tbody>
</table>

* Measured in terms of area per unit of game biomass

This analysis is an attempt to examine the trade-off between cropping and protection by determining the economic value of different game protection and off-take strategies in Kgalagadi and Ghanzi Districts. The relative merits of different cropping and protection strategies in these areas are assessed in terms of their potential value to the economy. Anticipated costs in management and protection of the resource are weighed against the net benefits which could be obtained from consumptive use of the resource over 20 years in each case. The object is to identify policy options which will yield high economic return.

Biological effects of protection and cropping strategies

It is not clear at what rates wildlife populations in the Kalahari are likely to increase (if at all) when there is no off-take. Craig and Lawson (1990) present an exhaustive analysis of quota-
setting methods for wildlife species in Botswana. They point out that there is little evidence to show that large mammal populations increase according to the theoretical logistic model.

In Craig and Lawson's experience, observable rates of increase are below any theoretical instantaneous rate of increase, $r_m$ (which is described in chapter 2) but may be sustained for many years before any feedback mechanism effects a reduction in rate. In their experience empirical rates of increase found in some ungulates are close to the theoretically calculated rate of $r_m/2$ (i.e., half of $r_m$) for those species. They recommend the use of $r_m/2$ for calculating maximum sustainable off-take quota.

Empirical evidence, from the same habitat zone in neighbouring South Africa, suggests that carefully managed livestock populations (karakul sheep with some cattle) can be kept at densities of 17 to 25 hectares per large stock unit while producing profitably and without damage to rangeland (Fourie et al., 1987). These levels are likely to coincide with maximum sustainable off-take levels, and could represent economically optimal carrying capacities for these species.

Present Kalahari game populations are dominated by selective feeders and do not contain large proportions of bulk grazers or gregarious selective grazers. It is not clear what densities the present populations could attain with protection. Apparent game densities of around 60 to 80 hectares per large stock unit were recorded in 1978/79 but, at that time, much higher proportions of the gregarious grazers, wildebeest and hartebeest, were present.

For the purpose of this analysis the simple assumption was made that populations could increase at a constant rate derived from $r_m/2$ for up to 20 years. It was also assumed that an annual off-take of $r_m/2$ would eliminate growth and an off-take of half of $r_m/2$ would halve growth, and so forth. This is obviously unlikely to correctly simulate real conditions, where growth rate may vary somewhat with density, but is considered adequate for the comparative analysis in hand.

The game population density of 277 hectares per large stock unit (fairly typical for the Kalahari area) was used as a base to see what would happen, over 20 years, under different protection and off-take strategies. The options involved no off-take, maximum sustainable off-
take, half maximum sustainable off-take and three-quarters maximum sustainable off-take in combinations: with no protection, initial three-year protection, initial six-year protection and initial nine-year protection, also in combinations. In addition, the effect of selective protection, as recommended by J. Matlhare (1992, pers. comm.) was briefly investigated. In only one of the cases (the unlikely scenario of a complete hunting ban for 20 years) did the game densities rise to less than 40 hectares per large stock unit.

Costs of game protection

Analysis of strategy options must include the investments by central government on management and protection of the resource. In all the options investigated, it is assumed that the apparent decline in game densities can be halted with protection. It is likely that over-exploitation has been a factor and much improved control of game use is necessary.

The proposed expansion of the Department of Wildlife and National Parks, during the seventh National Development Plan (NDP 7) planning period, includes significant growth in capital and recurrent expenditure. It is estimated that for the wildlife management area in Kgalagadi District expenditure on promotion of wildlife utilisation, wildlife law enforcement, conservation education and wildlife research will rise by some 14.7 percent per annum over six years.

At the time of the study, the estimated departmental expenditure in Kgalagadi wildlife management area amounted to some P2.00 per square kilometre. This was set to rise to some P7.00 per square kilometre by 1996/97. It is estimated that growth thereafter will take place at some six percent per annum. This will mean that after 20 years, the expenditure will amount to some P10.00 per square kilometre. These costs are assumed to apply to all the options investigated in this analysis.

Effect of game densities on the viability of game cropping

The Mathlo-a-Phuduhudu community-based game utilisation project, described in detail above, is situated within Ghanzi District. Game densities in the Mathlo-a-Phuduhudu project area have generally been higher than in other parts of Ghanzi District but, even so, a more recent
review of the project (BNRMP, 1991b) found that they had dropped too low for project viability.

Table 6.2 and Figure 6.A discussed in detail above, can be used to illustrate the relationship, between annual profitability of community wildlife cropping and game densities in the western Kalahari. Generally, as stated, annual financial losses are likely to be incurred by users if game scarcity is greater than some 150 hectares per large stock unit of game. At scarcity exceeding about 300 hectares per large stock unit, economic viability is not possible.

At any one time, depending on the scarcity (density) of game in an area, use of all, or any proportion of, the maximum possible game off-take quota will return a particular profit or loss. The conditions pertaining in each year of each of the protection/off-take scenarios in this analysis, were applied to the Mathlo-a-Phuduhudu financial/economic model to determine attainable annual financial and economic net benefit/costs for wildlife cropping. The assumption is made that management levels would be high and that full production would be attainable soon after initiation of cropping activities.

The net benefit/costs determined are those that would result if all of the wildlife quota is allocated for commercial use by the resident communities. This is considered acceptable as it is in line with policy. Pure subsistence hunting or recreational licensed hunting by citizens would possibly have a slightly different profitability/game scarcity relationship to that in Figure 6.A. It is expected that the curves for these activities would be slightly flatter although they would slope in the same direction.

Financial and economic value of protection and cropping strategies

Twelve different game population growth scenarios were combined with their attainable net benefits/costs for game use, and the projected government costs for game protection. This, discounted at six percent, resulted in a 20 year cost-benefit model to arrive at economic and financial net present values for each option.

Table 6.5 shows the results of this analysis. Several points become clear from these. Net present values are higher with longer off-take moratoria. This suggests that strategy aimed at
Table 6.5: Net present values of different protection/off-take strategies for wildlife
(Kgalagadi District, Botswana, 1991)

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Game density achieved in 20 years** (ha/LSU)</th>
<th>Financial net present value 20 yrs @6% (P'000)</th>
<th>Economic net present value 20 yrs @ 6% (P'000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. No off-take</td>
<td>21</td>
<td>-7,904</td>
<td>-7,657</td>
</tr>
<tr>
<td>2. Maximum off-take</td>
<td>277</td>
<td>-31,792</td>
<td>-4,347</td>
</tr>
<tr>
<td>3. Half maximum off-take</td>
<td>77</td>
<td>-34,972</td>
<td>-7,907</td>
</tr>
<tr>
<td>4. No off-take first three years; thereafter maximum off-take</td>
<td>190</td>
<td>-15,400</td>
<td>4,809</td>
</tr>
<tr>
<td>5. No off-take first three years; thereafter half maximum off-take</td>
<td>63</td>
<td>-19,503</td>
<td>263</td>
</tr>
<tr>
<td>6. No off-take first six years; thereafter maximum off-take</td>
<td>129</td>
<td>-2,579</td>
<td>15,065</td>
</tr>
<tr>
<td>7. No off-take first six years; thereafter half maximum off-take</td>
<td>52</td>
<td>-10,979</td>
<td>5,944</td>
</tr>
<tr>
<td>8. No off-take first nine years; thereafter maximum off-take</td>
<td>87</td>
<td>7,933</td>
<td>22,103</td>
</tr>
<tr>
<td>9. No off-take first nine years; thereafter half maximum off-take</td>
<td>42</td>
<td>-3,004</td>
<td>9,303</td>
</tr>
<tr>
<td>10. No off-take first three years; thereafter 0.75 maximum off-take</td>
<td>110</td>
<td>-16,243</td>
<td>3,889</td>
</tr>
<tr>
<td>11. No off-take first three years; 0.75 maximum off-take for next six years; thereafter maximum off-take</td>
<td>155</td>
<td>-13,682</td>
<td>6,715</td>
</tr>
<tr>
<td>12. No off-take first three years; selective off-take*** for next six years; thereafter maximum off-take</td>
<td>130</td>
<td>-12,726</td>
<td>7,780</td>
</tr>
</tbody>
</table>

* Starting game population density is 277 ha/LSU
** Higher densities (say < 80 ha/LSU) may not be possible with present species composition
*** No off-take for eland, hartebeest and wildebeest and 0.75 maximum off-take for other spp.

getting game population densities up as high as possible, as quickly as possible, will pay off. Figure 6.8 shows the trend for economic value. From Table 6.5 it can be seen that financial
values are consistently lower than economic ones. This can be interpreted as justification for more government support aimed at increasing game densities.

Table 6.5 also shows that, after protection, maximum annual off-take, i.e., taking the maximum sustainable yield, results in higher returns than taking only half of the maximum annual off-take. The latter results in higher game densities but also in lower net present values over the 20 years as a result of less profitable cropping. This suggests that once game densities are up to levels where they can be profitably harvested then, harvesting as much of the permissible, sustainable quota as possible will pay off. This trend is shown in Figure 6.C.

In Table 6.5, options 11 and 12 show that with protection for three years, combinations of three-quarters and full off-take can provide a higher return than three-quarters or full off-take alone. Similarly, introduction of selective protection of eland, hartebeest and wildebeest increases the economic and financial return.

The analysis was extended to four specific controlled hunting areas (CHAs) in Kgalagadi District, where apparent, current game scarcities range from 103 to 209 hectares per LSU. An option with maximum off-take from the beginning but with nine-year protection of eland, hartebeest and wildebeest is compared with an option of three-year total protection, six years of protection for eland, hartebeest and wildebeest only, with three-quarters off-take for the others, and thereafter full off-take. Table 6.6 shows the results.

Generally, the results in Table 6.6 suggest that economic and financial returns are enhanced with complete (total) three-year protection (a hunting ban). However, in the controlled hunting areas with relatively high current game densities, the advantage of three-year protection is much less, particularly in economic terms. The results of these more specific cases tend to confirm the findings for the whole district, presented in Table 6.5.

The findings generally suggest that getting to a point of full production as soon as possible is economically optimal. This resembles the "most rapid approach path" referred to by Clark (1990) and Wilen (1985), who modelled resource use using optimal control theory. Wilen (1985) showed that the most rapid approach path is appropriate with utilisation of "r-selected"
Figure 6.B: Economic net present values of different protection/off-take strategies for wildlife showing the effect of increasing periods of protection (cropping moratoria) prior to the start of maximum sustainable off-take (Kgalagadi District, Botswana, 1991)
Figure 6.C: Economic net present values of different protection/off-take strategies for wildlife showing the effect of increasing off-take intensity (percent of maximum sustainable quota) after three years of protection (cropping moratorium) (Kgalagadi District, Botswana, 1991)
<table>
<thead>
<tr>
<th>Table 6.6: Values for different protection/cropping strategies for game populations in four Kgalagadi District controlled hunting areas (Botswana, 1991)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type of cropping moratorium introduced</strong></td>
</tr>
<tr>
<td><strong>Controlled hunting area no. K.D.1</strong></td>
</tr>
<tr>
<td>Extent ('000 hectares)</td>
</tr>
<tr>
<td>Current game density (ha/LSU)</td>
</tr>
<tr>
<td>Game density after 20 years (ha/LSU)</td>
</tr>
<tr>
<td>Financial net present value (P'000)***</td>
</tr>
<tr>
<td>Economic net present value (P’000)***</td>
</tr>
<tr>
<td><strong>Controlled hunting area no. K.D.2</strong></td>
</tr>
<tr>
<td>Extent ('000 hectares)</td>
</tr>
<tr>
<td>Current game density (ha/LSU)</td>
</tr>
<tr>
<td>Game density after 20 years (ha/LSU)</td>
</tr>
<tr>
<td>Financial net present value (P’000)***</td>
</tr>
<tr>
<td>Economic net present value (P’000)***</td>
</tr>
<tr>
<td><strong>Controlled hunting area no. K.D.12</strong></td>
</tr>
<tr>
<td>Extent ('000 hectares)</td>
</tr>
<tr>
<td>Current game density (ha/LSU)</td>
</tr>
<tr>
<td>Game density after 20 years (ha/LSU)</td>
</tr>
<tr>
<td>Financial net present value (P’000)***</td>
</tr>
<tr>
<td>Economic net present value (P’000)***</td>
</tr>
<tr>
<td><strong>Controlled hunting area no. K.D.15</strong></td>
</tr>
<tr>
<td>Extent ('000 hectares)</td>
</tr>
<tr>
<td>Current game density (ha/LSU)</td>
</tr>
<tr>
<td>Game density after 20 years (ha/LSU)</td>
</tr>
<tr>
<td>Financial net present value (P’000)***</td>
</tr>
<tr>
<td>Economic net present value (P’000)***</td>
</tr>
</tbody>
</table>

* No off-take for eland, hartebeest and wildebeest, and maximum off-take for the other species
** No off-take for eland, hartebeest and wildebeest, and 0.75 maximum off-take for the others
*** Measured over 20 years using a six percent discount rate
species, where population growth tends to result quickly from protection, and use adjustment costs are low. It is not typical with utilisation of "K-selected" species, where the costs of investment and disinvestment are high. If the Kalahari wildlife model had more of these last characteristics, the finding of high-value for total protection and maximum off-take might be diluted to some extent. There is another consideration which, if included, could reduce the strength of the finding. This relates to the possible social costs within communities associated with full protection (and no cropping incomes), which were not included in the bio-economic model.

6.6 Chapter conclusion

Financial analysis has indicated that wildlife cropping at a small-scale is more capital efficient, creates more jobs and is more socially acceptable than medium- or larger-scale cropping. Wildlife resources allocated for cropping on public, especially communal lands would best be used by small-scale, family-sized operations. These could then be arranged in loose, community-based groups, which could perhaps better perform the functions of sharing out off-take quota, and marketing or processing.

Community-based wildlife use projects planned to this end are inherently financially and economically viable. As such they are potentially attractive for rural residents and are generally worth promoting and supporting from the government's point of view. However, analysis shows that the success of these projects is very dependent on the existence of wildlife densities which are high enough, and on the application of good management skills. Government support measures for community-based wildlife projects should be concentrated on these two factors. Community-based wildlife-use projects are moderately compatible with the preservation of wildlife, habitats and biological diversity. This is because they depend for success on the maintenance of high wildlife densities in a natural setting, which permits profitable, sustainable off-take and tourism. Manipulation of wildlife populations and habitat is minimal. In contrast, traditional livestock-keeping on communal land tends to have low compatibility with conservation since it involves intensive use of habitat to the exclusion of wildlife.
Results of the analysis of the relative merits of different game cropping and protection strategies, within community-based wildlife management areas in the Kalahari region, suggest that where game scarcity exceeds about 100 hectares per LSU, policy should be aimed primarily at increasing the game densities as fast as possible. Where game scarcity is lower than about 100 and higher than about 25 hectares per LSU, increasing game densities still yields economic returns, but policy should also be aimed at maximising permissible off-take. An appropriate balance between these two conflicting aims needs to be determined depending partly on other factors.

In the Kalahari region game densities prevailing at the time of the analysis were too low for financially viable community-based wildlife use. This, at least in part, explains the failure to date in this region. Generally, the hunting bans imposed by the district authorities are entirely appropriate. However, there appear to be localised exceptions where judicious off-take combined with tourism initiatives and selective protection could be economically desirable. In all Kalahari areas where off-takes can be permitted it is economically sound that drought-sensitive, gregarious, mixed feeders and grazers, including eland, wildebeest and hartebeest, should be given selective protection for periods of more than six years. This would help restore their proportions and allow higher overall game densities.

Generally, enhancement of community-based cropping incomes is possible through the inclusion of elephant on safari hunting quotas, where this species exists, and through the development of non-consumptive wildlife uses, such as wildlife-viewing tourism, where the potential exists.
Chapter 7

Game and livestock ranching

7.1 Introduction

Background

Botswana's Wildlife Conservation Policy includes the production of wildlife under semi-controlled and controlled conditions (wildlife ranching and farming). In this thesis, wildlife ranching and farming are defined as the keeping and management of wildlife species in controlled or semi-controlled conditions for consumptive and non-consumptive production. The distinction between the two (wildlife ranching and farming) is not a clear one. Definitions in the literature are inconsistent, depending on the species involved. Here, the distinction is made on the basis that farming involves controlled breeding (propagation) while ranching involves leaving breeding to take place more or less naturally.

The rationale for the promotion of wildlife ranching and farming is, basically, the perception that wildlife will only survive where wildlife values exceed the opportunity costs of letting it survive. Only the values that can be captured by Botswana are relevant to the policy-maker and, currently, these are mainly values of utilisation. Another reason for the promotion of wildlife ranching, is the perception that commercial production feeds demand for wildlife products, and can displace other undesirable (illegal or open access) production systems.

Wildlife ranching and farming are basically peripheral to the other forms of wildlife-based land use in Botswana. The other forms involve utilisation of free-ranging wildlife populations on medium- to short-term concessions on public land. Here, the undisturbed nature of wildlife
has value. Surrounding the protected public lands, are settled and more disturbed areas where land is in high demand for livestock keeping. It is here that wildlife ranching and farming offer ways to increase wildlife values in relation to alternative land uses.

The ongoing initiatives in wildlife ranching and farming include mixed species ranching, ostrich farming, and crocodile farming and ranching. This chapter deals with mixed species ranching. Ostrich and crocodile production are treated in chapters 8 and 9.

The objective of this chapter is to describe the economic characteristics of, and potential for, wildlife ranching in Botswana. It embraces partially controlled mixed species (mainly antelopes and equines) production on rangelands for recreational use, meat/skin production and live sales. This can be practised exclusively, or as a supplementary enterprise alongside livestock. Results are incorporated from a specific survey on the progress of wildlife ranching in Central District by Kalikawe (1991), and technical and economic research into wildlife ranching (Conybeare and Rozemeijer, 1991; Barnes, 1988; Barnes and Kalikawe, 1994). Results from a comparative analysis which estimates the economic value of livestock production is also included. This has also been reported on by Barnes (1994a).

7.2 Technical and market considerations

Wildlife ranching, since it involves investment in, and varying degrees of, control and manipulation of the resource for commercial production, requires that the investor establish a secure form of property right or right of use. Wildlife in Botswana remains a public resource but government can, to varying degrees, allocate custodial rights to users with property rights.

In Botswana, private leasehold and freehold land, on which long-term, individual property rights are possible, occupies only small, scattered areas. They cover less than ten percent of the country. The other forms of land tenure are better suited to wildlife use under concession-type leases. It is theoretically possible to establish ranching or farming in communal land through application to the district land boards for concessions, but this is more difficult than it is on private land. From the point of view wildlife ranching, the nature of the natural populations of wildlife (if any) occupying land to be used is very important. Also important,
is the availability of wild populations elsewhere, which can serve as sources of stock for ranches. Generally, the natural wildlife populations in ranching areas are of low density.

Promotion of wildlife ranching and farming has been unofficial policy since the early 1980s. It became official with the publication of the Wildlife Conservation Policy in 1986 (Government of Botswana, 1986) and is an integral part of the wildlife sector's strategy (FGU-Kronberg 1988a). Until recently, there was no legislative provision (in the Fauna Conservation Act of 1979) for wildlife ranching or farming. Landholders had a partially restricted right to use wildlife on their property but, in effect, this amounted to no more than a permit to cull for ration meat. Any venture into commercial wildlife ranching required a specific permit authorised by the Minister. This, generally, involved detailed project appraisal and was subject to bureaucratic delays. The legislation also imposed generally prohibitive export duties on wildlife products.

The new Wildlife Conservation and National Parks Act (of 1993) makes specific provision for game farming and ranching under long-term permit, issued by the Director of Wildlife and National Parks. It also makes provision for landowners to enjoy rights of ownership over wildlife when it is suitably confined. The new legislation will significantly reduce the bureaucratic obstacles of the past.

The domestic market potential for game meat is small (some 164 tonnes per annum) and dominated by demand for low quality, low priced products (FGU Consulting + Engineering, 1991). Up to P30 per kilogram can be obtained for high quality, packaged biltong in Gaborone, but in rural villages, the price for a low quality product may be as little as P3.50 per kilogram. It appears that the South African market could absorb significant quantities of high quality biltong from Botswana, and that veterinary restrictions on such exports can be overcome.

The market for fresh or frozen venison has been very limited within southern Africa (Steenkamp, 1982) and tends to be restricted to the local supply of restaurant outlets. There is a significant market in West Germany for venison, including South African produced springbok meat. Production for this is competitive, specialised and risky. Veterinary
restrictions in Europe and South Africa limit game meat imports to those processed or dried in
an approved facility. There are also restrictions on moving meat within Botswana.

Ostrich skins and meat are of moderately high value in overseas markets. Another moderately
high value product for which there appears to be a strong demand is zebra skin. Live game
animals, particularly certain key species such as sable and tsessebe, are in good demand at
auctions in South Africa. Development of production and a marketing channel from foot-and-
mouth disease-free zones in Botswana to these auctions is a possibility but veterinary
restrictions may prove prohibitive. Within Botswana, demand for live animals is poor except
in the case of ostrich, where demand is developing strongly due to the high overseas prices.
There is a high-priced and growing market for live ostrich eggs and birds in the United States
(USA) and elsewhere.

As mentioned in chapter six there appears to be potential for Botswana to increase its share of
the large, but fairly competitive international safari-hunting market. In this, game ranching
operations can play an important selective role in offering short hunts for plains game animals,
involving key species such as eland, or other antelope species typical of the Kalahari region.
There appears to be potential to integrate such hunts on ranches with hunts for the "big five"
in safari hunting concessions. Fee hunting, where clients are allowed to hunt by themselves
on the property in return for payment, appears to be in demand regionally, particularly among
South African recreational hunters. However, product value is currently not very high. The
same applies to game-viewing tourism on game ranches - unless key species are present and
the scenery spectacular.

7.3 Progress in game ranch development

Information on file in the Department of Wildlife and National Parks and the results of a field
survey of wildlife ranching producers in Central District (Kalikawe, 1991) were used to assess
progress in game ranch development. Despite ten years of unofficial promotion and five years
of official promotion, very few wildlife ranching enterprises have attained a state of full
production.
Exclusive use of ranchland for game occurs on some 20 properties, which vary in size from 6,000 hectares to 75,000 hectares. Some of these are surrounded by game-proof fencing and others are not. Only two of these may be described as having developed production systems with the capacity to allow significant recovery of capital inputs, both of which market tourism services, and are part of larger scale businesses. One is uniquely situated on land which contains highly valuable key species, including elephant.

Supplementary game use takes place on an estimated 250, primarily livestock, properties which vary in size from 3,000 to 100,000 hectares. Most of this game use is on a small scale for subsistence or recreation, with only a few truly commercial operations. One landholder has successfully developed a large-scale system, where culled/cropped game animals have been processed domestically and their venison exported both to South Africa and the European Union (EU).

7.4 Financial and economic viability

The question of whether ranching wildlife species in Botswana can be financially rewarding to the investor has been analysed in some detail. The important question of whether it can be economically beneficial to the nation has received less attention. Table 7.1 shows summarised data from financial and economic models for a mixed-species game ranch in the Kalahari region. The base-case assumptions associated with this model can be described as follows.

The production system involved safari hunting and biltong production with the option of live sales, on 10,000 hectares of Kalahari rangeland. It was stocked to 15 hectares per large stock unit equivalent (LSU) with a range of Kalahari plains species. Five, ten-day, plains game hunts per annum were sold to overseas clients. Biltong was sold within Botswana to packagers and distributors in larger towns. Water and phosphorus licks were provided. The ranch perimeter was fenced with a 2.2 metre high game-proof fence. Internal fencing was restricted to a 12 hectare training paddock only.

For the static model it was assumed that the operation was 25 percent loan-financed. The model included amortisation of this at ten percent interest over the life of the asset. It also included provision for capital replacement (depreciation) with regard to equity financed assets.
Working capital requirements were assumed to be 30 percent of operating expenditures. Interest on this was calculated at 15 percent. No land rental was assumed since the land in question was unused and zoned for game ranching, i.e., its financial opportunity cost was very low. A net cash income was arrived at after the deduction of variable costs, operating overhead costs, rentals, amortisation and depreciation.

For the dynamic cost-benefit model interest was excluded and asset depreciation or stock appreciation were accounted for by the inclusion of a residual value of assets in the final year. A financial rate of return and a financial net present value at a 12 percent discount rate were calculated over five, seven and ten years.

The value of the enterprises in economic terms, i.e. their value to society in Botswana, was determined by converting financial values in the models to economic ones through shadow pricing. Here transfers were ignored, interest was excluded, cross-border flows were taken into account, and values for tradable items and labour were adjusted to reflect opportunity cost. The social discount rate was assumed to be six percent. At this level of analysis the opportunity costs of land and government expenditures on the wildlife sector are excluded.

The results in Table 7.1 suggest that mixed-species fenced game ranching, with an unfavourable financial rate of return of six percent (cut-off rate is 12 percent), and a negative net present value, is unlikely to offer the investor a meaningful financial return. This model was subjected to sensitivity analysis and the financial and economic returns were found to be very sensitive to variation in range carrying capacity, herd off-take rates and product prices. Under Botswana conditions, carrying capacities tend to be low due to the paucity of, and high variability in, rainfall and poor soils. This in turn makes intensive herd management difficult, preventing improvements in off-take rates. Small domestic markets, veterinary constraints on export markets and generally poor market development result in relatively unfavourable market prices.

Further analysis was done to determine the existence, or not, of economies of scale. Models of larger-scale ranches, covering between 20,000 and 30,000 hectares in four different sites, resulted in financial rates of return ranging from negative to ten percent. These results are presented by Conybeare and Rozemeijer (1991). The high example of ten percent was sited
just inside the Okavango-Chobe wildlife utilisation region. It contained a small number of high-value, key species such as buffalo and sable, and it carried an assumption of rapid development which was somewhat unrealistic.

Table 7.1: Illustrative financial and economic characteristics for a mixed species game ranch in the Kgalagadi region, Botswana (pula '000, 1990)

<table>
<thead>
<tr>
<th>Item</th>
<th>Characteristic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land extent ('000 hectares)</td>
<td>10</td>
</tr>
<tr>
<td>Stock on hand (head '000)</td>
<td>2.2</td>
</tr>
<tr>
<td><strong>Financial analysis</strong></td>
<td></td>
</tr>
<tr>
<td>Initial capital investment</td>
<td>1,323</td>
</tr>
<tr>
<td>At stability (full production)</td>
<td></td>
</tr>
<tr>
<td>Annual gross income (sales)</td>
<td>241</td>
</tr>
<tr>
<td>less Variable costs</td>
<td>40</td>
</tr>
<tr>
<td>Gross margin</td>
<td>201</td>
</tr>
<tr>
<td>less Fixed costs</td>
<td>132</td>
</tr>
<tr>
<td>Annual net cash income</td>
<td>69</td>
</tr>
<tr>
<td><strong>Financial worth over ten years</strong></td>
<td></td>
</tr>
<tr>
<td>Financial rate of return</td>
<td>5.9%</td>
</tr>
<tr>
<td>Financial net present value (@ 12%)</td>
<td>-399</td>
</tr>
<tr>
<td><strong>Economic analysis</strong></td>
<td></td>
</tr>
<tr>
<td>Capital outlay</td>
<td>1,367</td>
</tr>
<tr>
<td>At stability</td>
<td></td>
</tr>
<tr>
<td>Annual revenues</td>
<td>266</td>
</tr>
<tr>
<td>less Operating costs</td>
<td>79</td>
</tr>
<tr>
<td>Annual gross value added</td>
<td>187</td>
</tr>
<tr>
<td><strong>Economic worth over ten years</strong></td>
<td></td>
</tr>
<tr>
<td>Economic rate of return</td>
<td>6.6%</td>
</tr>
<tr>
<td>Economic net present value (@ 6%)</td>
<td>58</td>
</tr>
</tbody>
</table>
Economies of scale apparently occur but these are small and not sufficient to offset the weak viability. Other work in Botswana (White, 1985; Barnes, 1988; Booth, 1988) has confirmed the conclusion that mixed-species wildlife ranching in Botswana, has poor financial profitability.

The illustrative figures in Table 7.1 suggest that the development of mixed-species game ranches can have a small but positive contribution in economic terms. The economic rate of return exceeds the six percent cut-off rate, and the net present value is positive. This suggests that mixed species wildlife ranching could justify some government support, but only to a very small degree. Use of springbok, gemsbok and kudu in supplementary harvesting enterprises alongside small and large livestock has been successful in Namibia (Brand, 1984). Similarly, supplementary use of impala alongside beef cattle can enhance profitability and total productivity (Collinson, 1979; Loxton, Venn and Associates and Rural Development Services (Pty.) Ltd., 1985).

Although there are no models for Botswana, indications are that, under poor resource conditions, supplementary game use is more capital efficient and significantly more profitable than game ranching. Springbok and gemsbok are of possible potential importance in this regard because they can be restrained within a normal small stock fence. Extensive ostrich breeding for egg or chick production also has potential.

Child (1985) showed that when buffalo were a component of game populations in the south-east lowveld of Zimbabwe, the net income from game use (mainly safari hunting) was Z$4.55 per hectare. This declined to Z$0.66 per hectare in areas without buffalo. This example illustrated the crucial role of the key species, buffalo, in game enterprise structure and viability. In Botswana key species include buffalo, eland, elephant, leopard, lion, ostrich, sable, sitatunga, tsessbe and zebra for consumptive use, and cheetah, giraffe, roan and rhino (both black and white) for non-consumptive use.

In Botswana only small portions of freehold/leasehold land contain populations of highly valuable key wildlife species. In these areas mixed-species game ranches can sell specialised tourism services, including both safari hunting and game viewing, to up-market clients. Enterprise models described in chapters 4 and 5 and by Barnes (1991a) illustrate the relatively
high financial and economic profitability of these land uses. It would seem that game ranching can be an attractive financial and economic investment in these limited cases. Elsewhere in southern Africa where game ranching has been shown to be profitable, it has commonly involved safari-hunting or wildlife-viewing tourism as primary enterprises (Johnstone, 1975; Varty, 1982; Child, 1988).

It is interesting to note that the financial rate of return for a beef ranching enterprise (breeding and rearing to slaughter) in the same environment was found (at five percent) to be similar to that for mixed-species game ranching. Detailed investigation in parts of Zimbabwe (Child, 1988; Jansen et al., 1992; Bond, 1992; Kreuter and Workman, 1994a) showed similar results. This topic is dealt with in detail below.

7.5 Constraints and advantages

Comparison of the results given above with evidence from other countries in the region (Brand, 1984; Berry, 1986; Child, 1988; Behr, 1988) results in the conclusion that the primary reasons for the generally poor financial and economic viability of mixed-species game ranching in Botswana are:

- the lack of natural populations of relatively high value game species in the ranching areas,
- low natural game densities which necessitate stocking land and entailing high investment in game capture or purchase, transport and fencing,
- low and highly unstable game carrying capacities resulting in low returns per unit of ranch investment, and
- poor domestic markets for game meat, live animals and fee hunting, and barriers to the export of game products.

A field survey of wildlife-ranching producers in Central District (Kalikawe, 1991) showed that few had attained full production. The apparent constraints were listed by Barnes and Kalikawe (1994) and, more or less in order of importance, include:

- poor market development,
- lack of management skills,
- bureaucratic obstacles,
- low natural densities of game,
- shortages of initial game stocks
- poor species diversity in ranching areas,
- veterinary obstacles to moving game,
- widely fluctuating game carrying capacities,
- poor financial profitability,
- high transport costs,
- scarcity of capital, and
- lack of land tenure security.

Advantages include the presence of an abundant rangelands resource, the availability of partial grant financing from government and the fact that the alternative, commercial livestock production, also has low profitability.

It would appear that a significant amount of investment in game farming/ranching in southern Africa has tended to be for reasons other than direct financial gain. Common motivating factors have been tax avoidance with respect to other businesses, desire for recreational pursuits and concern for conservation. There would appear to be a case for the capture of economic non-use and option values to compensate investors in wildlife ranching.

7.6 The relative economic value of cattle ranching

A more detailed comparative analysis between commercial mixed-species game ranching and commercial beef breeding and rearing has been made, based on 1993 price structures, but presented in 1991 prices. This shows the beef breeding and rearing enterprise with and without the specific domestic financial support presently available to livestock producers.

The beef production model assumed involves breeding for production of three-and-a-half year-old slaughter steers on a 10,000 hectare ranch in the Kgalagadi region. Steers were marketed direct to the Botswana Meat Commission (BMC) with provision being made in the model for a mix of trekking and transport to Lobatse. The calving rate was assumed to be 75 percent for heifers and 80 percent for cows, with mortality ranging from five percent in young stock to 2.5 percent in animals two years and older. It was assumed that 20 percent of cows were
replaced annually from heifers bulled at two years, and that bulls, at five percent of the herd, were replaced every three years. The rangeland carrying capacity assumed was the same as for the game ranch model (15 hectares per LSU). Other assumptions (for example, those regarding financing) were similar to those used for the game ranch model described above.

Commercial beef ranchers can obtain certain inputs through government at subsidised rates, or for nothing. These include veterinary inputs, feed supplements and bull purchases. To some extent transport costs are subsidised through the provision of trek route water points and grazing. Commercial beef producers also benefit from cross subsidisation which results from the carcass grade price differential of the Botswana Meat Commission (BMC). This is described below.

The results, presented in Table 7.2 confirm the general finding, noted above, that ranching-type enterprises offer low returns to investors. They also suggest that public transfers are necessary to make commercial beef breeding and rearing for slaughter attractive to the investor. When the subsidies referred to above are removed from the model they cause the financial internal rate of return to drop from nine percent to two percent.

McGowan International and Coopers and Lybrand (1987) illustrated how the BMC grade price differential undervalued lower quality carcasses and overvalued higher quality ones. Commercial beef breeding and rearing benefits from the higher grade prices (currently between eight and 16 percent above real value). Commercial beef finishing (which is generally more profitable than breeding and rearing) benefits directly from the distortion between (lower grade) purchase and (upper grade) sale prices. The present differential makes the difference between these some 16 percent to 32 percent. Without any distortion, the difference would be more like two percent to nine percent.

It is possible that removal of the grade price differential would seriously jeopardise the financial viability of the commercial beef production sector. The analysis above does not take into account the possible loss to Botswana which could arise if price support in beef importing countries is reduced. It is arguable whether this international transfer has an opportunity cost to Botswana or not. If (as is most likely) it cannot be transformed into other forms of aid to Botswana then (from Botswana’s point of view) it is simply an extraneous economic benefit.
Table 7.2: Comparative financial and economic characteristics for game ranching and beef breeding and rearing in the Kgalagadi region, Botswana, illustrating the effect of government subsidies on financial returns (pula '000, 1991)

<table>
<thead>
<tr>
<th>Item</th>
<th>Characteristic by type of enterprise</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Beef* subsidies</td>
</tr>
<tr>
<td>Ranch scale (’000 hectares)</td>
<td>10</td>
</tr>
<tr>
<td>Stock on hand (hectares per LSU)</td>
<td>0.93</td>
</tr>
<tr>
<td><strong>Financial analysis</strong></td>
<td></td>
</tr>
<tr>
<td>Initial capital investment</td>
<td>941</td>
</tr>
<tr>
<td>At stability (full production)</td>
<td></td>
</tr>
<tr>
<td>Annual gross income (sales)</td>
<td>221</td>
</tr>
<tr>
<td>less Variable costs</td>
<td>37</td>
</tr>
<tr>
<td>Gross margin</td>
<td>184</td>
</tr>
<tr>
<td>less Fixed costs</td>
<td>117</td>
</tr>
<tr>
<td>Annual net cash income</td>
<td>67</td>
</tr>
<tr>
<td>Financial worth over ten years</td>
<td></td>
</tr>
<tr>
<td>Financial rate of return</td>
<td>8.8%</td>
</tr>
<tr>
<td>Financial net present value (@ 12%)</td>
<td>-159</td>
</tr>
<tr>
<td><strong>Economic analysis</strong></td>
<td></td>
</tr>
<tr>
<td>Capital outlay</td>
<td>1,026</td>
</tr>
<tr>
<td>At stability</td>
<td></td>
</tr>
<tr>
<td>Annual revenues</td>
<td>216</td>
</tr>
<tr>
<td>less Operating costs</td>
<td>118</td>
</tr>
<tr>
<td>Annual gross value added</td>
<td>98</td>
</tr>
<tr>
<td>Economic worth over ten years</td>
<td></td>
</tr>
<tr>
<td>Economic rate of return</td>
<td>2.3%</td>
</tr>
<tr>
<td>Economic net present value (@ 6%)</td>
<td>-272</td>
</tr>
</tbody>
</table>

* Beef breeding and rearing for production of slaughter steers in Kalahari region
** Mixed-species game ranching for safari hunting and biltong production, Kalahari region
7.7 Chapter conclusion

In Botswana wildlife ranching systems should offer ways of giving value to wildlife in relatively disturbed areas where land is in demand for agricultural uses. However, growth in wildlife ranching has been limited and the prospects for expansion are somewhat restricted. Important constraints appear to have included lack of management skills, poor market development, bureaucratic obstacles, veterinary obstacles, low wildlife abundance and/or diversity and shortage of game available for initial stocking. These factors have tended to combine to increase investment risk dramatically. In the medium-term, it is likely that, as most of these constraints are overcome, the shortage of game for restocking will become the primary constraint to expansion.

Analysis suggests that a major disincentive is very low financial profitability, particularly in areas with relatively poor resource base (most of Botswana). Economic profitability is, however, only moderately low so that some government support could be justified. However, the justifiable amounts are unlikely to be sufficient to attract significant investments. Commercial beef production (breeding for slaughter steers) on the same land has slightly better financial profitability, but this largely due to financial subsidies available to commercial beef producers. The economic viability of beef production is lower than that of game ranching. This suggests that game ranching actually has a slight comparative economic advantage over beef production in these conditions.

It appears that mixed game ranching can yield good financial and economic returns in the few leasehold/freehold areas where high-value, key species occur and a high-value tourism product can be offered. Elsewhere, in areas of low potential, mixed game ranching entails high risk and should be promoted along lines where capital investments are minimised. This means minimising investments in enclosure and restocking and making as much use as possible of naturally occurring game populations. Supplementary game use enterprises, using wildlife on established livestock land, including communal land, should be promoted, where possible.

Steps should be taken to streamline bureaucratic procedures, and remove obstacles to rapid market development in wildlife ranching. Both importation of skilled management and
domestic manpower development should be encouraged. Government should aim to develop an efficient wildlife veterinary and extension service. It should also promote specific research into key problems in wildlife ranching. The possibilities of capture, and distribution to game ranch investors (i.e., those investing in wildlife stocks and biological diversity), of non-use values and option-use values could be investigated.

The compatibility of game ranching with wildlife, habitat and biological diversity conservation is moderate to moderately low, depending on the degree to which the natural habitats and populations on the land are manipulated. Where tourism activities are part of game ranching the tendency for destruction of conservation values will be lessened. Extensive commercial livestock ranching, which focuses on efficiency of meat production, tends to have a marginally greater negative effect on conservation than game ranching, which would make its compatibility with conservation moderately low.
Chapter 8

Ostrich farming

8.1 Introduction

This chapter focuses on that aspect of wildlife farming which involves production of ostrich, ostrich eggs and ostrich products. This is represented by a very well established industry in South Africa where some 80,000 birds are slaughtered each year (Erasmus, 1978). The relative scale of this is apparent when it is considered that, in Botswana, the total population of wild ostrich is only some 62,000 (Bonifica SpA., 1991), and the farmed ostrich population amounts to less than 5,000.

Other ostrich producing countries include Zimbabwe, Botswana and Namibia, all within the Southern African Development Community (SADC); and the United States (USA) and Israel. All these countries together are estimated to produce less than 20,000 birds of slaughter age per annum. Botswana produces less than 1,000. Outside southern Africa, especially in the USA, the tendency is for all sales to be of live birds.

The chapter draws partly on work reported by Barnes (1991d) and Barnes and Kalikawe (1994). First, the potential for, and the financial and economic viability of, ostrich breeding and rearing activities are investigated. This is followed by an analysis of the economic costs and benefits of policy which allows live ostrich exports from Botswana.
8.2 Resource and market considerations

Ostrich farming began in earnest in Botswana in 1987 with permits to breed and rear being granted to several entrepreneurs. The intention has been to employ the successful production systems developed in South Africa. These systems capitalise on the high reproductive potential of the species using intensive rearing methods to preclude the naturally very high mortalities of young birds.

The rearing systems require intensive feeding of fodder, mainly lucerne, and they are logically sited near feed sources, such as irrigation schemes or feed importers. The potential in Botswana is constrained by the availability of water resources for irrigation and the availability of imported feed. In addition, the techniques used in rearing are specialised and the skills involved are specific. Technical aspects of intensive ostrich production are described by Rogers (1987), Swart (1978a, 1978b) and Swart and Schneider (1978).

One section of the production chain is, however, applicable to extensive conditions. Breeding and egg production can be conducted in natural rangeland. Breeding pairs of ostrich, kept on livestock or game ranches, can be managed efficiently to produce eggs for sale, live to intensive rearing operations or, as shells to crafts manufacturers.

Theoretically, there should be significant potential for wild egg harvest in community managed wildlife areas. However, the technical feasibility of this is not yet well established. Analysis of data from Parker (1975), FGU-Kronberg (1988a) and Bonifica SpA. (1991) suggests that, in Botswana conditions, wild ostrich occur at densities of between 250 and 1,000 hectares per adult (breeding) pair. It appears that nest sites are not re-used each year and are somewhat difficult to locate. Practically, capture of young wild chicks has proven easier than wild egg collection. A research study is required on the feasibility of commercial wild egg collection within remote area communities.

Within the country all forms of product processing are currently, technically feasible. Ostrich can be slaughtered using mobile abattoir facilities such as those used for other game species, such as impala. Tanning capacity is available with one large-scale firm and there is also some capacity for manufacturing of high quality leather goods.
Meat-drying for biltong, and feather duster manufacture are both technically feasible. Egg shell decoration for the sale and manufacture of eggshell beads and bead crafts are all feasible, and these activities lend themselves to small scale, traditional production systems. Although facilities exist for much processing in Botswana, they tend to be monopsonistic and require further development before they can be considered adequate by farmers.

South Africa and Zimbabwe have banned the export of live birds. Bophuthatswana, (a previously autonomous region in North West Province of South Africa) and Namibia have allowed it without restriction. Botswana has only permitted exports of live birds in special cases. High prices, especially in the USA, have been the motivation for live bird exports. The desire to build up local producer flocks and restrict expansion in foreign production have been the reasons given by governments to restrict live bird exports.

Ostrich breeding and rearing operations produce animals which can be sold either live at any age, or slaughtered at around 14 months of age for their skins, meat and feathers. Skins are processed through tanning before sale and are used to manufacture leather goods of high quality. Meat has a potential market as domestically sold biltong. There is also potential to export meat to Europe but European Union (EU)-approved processing facilities would be required. Ostrich feathers are used to manufacture feather dusters. Economic Consultancies (1985) identified this potential and developed a project profile for small-scale duster manufacture.

Currently, the demand and prices for live ostriches outside Botswana are very high. The Department of Wildlife and National Parks has an ostrich management plan awaiting official approval which would allow producers free access to all export markets, including those for live birds. This has recently created a surge in domestic demand for live birds and the first active domestic live market for any wildlife species. The domestic prices for live birds appears to have risen three to four fold during 1992 and 1993.

Prices and demand for slaughtered ostrich products are lower than for live birds. Demand for ostrich skin products appears to be growing steadily but slowly. That for feathers appears to be growing very slowly. Skins, leather goods, feathers and dusters have primary markets
outside Botswana. Generally, the demand for meat products appears to be growing fairly rapidly.

J.M. Hutton (1992, pers. comm.) has described the changing international market conditions for ostrich farming. It is likely that the very high demand for live birds will slow or collapse in the medium term. At some point in the future, possibly following this, it can also be anticipated that expanded skin production will exceed demand. Recent experience with oversupply in the crocodile and alligator skin industry, and the fact that ostrich reproduce much faster than crocodile, makes it highly likely that a cyclical market will emerge. The high capital intensity and specialised nature of ostrich rearing suggests that supply should be relatively price-inelastic. Market cycles would therefore tend to be long.

8.3 Financial and economic profitability

In 1987 various concept financial models were developed for ostrich production enterprises including those for intensive breeding and rearing, intensive rearing only, extensive breeding for egg production on ranchland, and harvesting of wild populations for egg production. All of these showed attractive financial rates of return which are described in Barnes (1987) and Barnes (1988).

Later, in 1988, a further concept financial model was developed for a semi-extensive system (FGU-Kronberg, 1988c). This involved intensive early rearing (up to four months of age) and extensive use of ranchland for breeding and late rearing. This emerged as reasonably attractive from the financial point of view, but entailed relatively high risk due to the relatively untested nature of the production system. In 1989, the concept financial model of an intensive breeding and rearing enterprise was upgraded, using empirical data, to develop a financial and economic model. The assumptions associated with this model are described below.

The production system in the Limpopo region involves intensive breeding based on 42 females in an 80 hectare paddock, incubation of 2,000 eggs and the intensive rearing of slaughter birds in pens. Nearly all feed requirements would be purchased. Some 722 slaughter birds would be produced annually. Breeding stock would be acquired through direct capture or purchase
at capture prices. Infrastructure includes a 2.2 metre high perimeter fence, sheds, feedlots and a fully automatic incubator with capacity for 750 eggs.

It is assumed that it would be possible to harvest 50 eggs per breeding female. Breeding birds and followers would receive a diet consisting of 80 percent lucerne and 20 percent energy supplement, provided at 2.2 kilograms per bird per day. A hatching rate of 60 percent is assumed. Assumed stock mortality rates are 30 percent for birds between hatching and three months of age, ten percent for birds between three and six months of age and three percent per annum for birds older than six months. It is assumed that breeding birds will be culled and replaced at ten percent.

Hatched chicks would be kept in rearing pens with unrestricted meal diets consisting of 75 percent lucerne and 25 percent energy supplement, fed at a rate of 1.1 kilogram per slaughter bird produced per day. All ostrich would be frequently dosed for wireworm and tapeworm. The product (722 live, 14-month-old slaughter birds per annum at full production) would be sold at farm gate prices of P550 per bird. The project is designed to attain stability in three years and would necessitate the employment of a highly experienced manager.

For the static model it is assumed that the operation is 25 percent loan financed. The model includes amortisation of this at ten percent interest over asset life. It also includes provision for capital replacement (depreciation) with regard to equity financed assets. Working capital requirements are assumed to be 30 percent of operating expenditures. Interest on this is calculated at 15 percent. No land rental is assumed since the land in question is unused and zoned for game ranching, i.e., its opportunity cost in this case is very low. For the static model a net cash income is arrived at, after the deduction of variable costs, operating overhead costs, rentals, amortisation and depreciation.

For the dynamic cost-benefit model, interest is excluded and asset depreciation or stock appreciation are accounted for by the inclusion of a residual value of assets in the final year. A financial rate of return and a financial net present value at a 12 percent discount rate are calculated over five, seven and ten years.
The value of the enterprises in economic terms, i.e. their value to society in Botswana, was determined by converting financial values in the models to economic ones through shadow pricing. Here, transfers were ignored, interest was excluded, cross-border flows were taken into account, and values for tradable items and labour were adjusted to reflect opportunity cost. The social discount rate was assumed to be six percent. An annual net economic benefit, a ten-year economic rate of return and a ten-year economic net present value are the result. This financial and economic model has been upgraded and adjusted to reflect changing income-cost structures in 1991 and 1993.

Table 9.1 indicates how the main financial and economic characteristics of the enterprise have changed over time. The values in the table have been inflated or deflated to 1991 levels. A feature of the results are consistently attractive financial rates of return. These, for ten-year investments ranged from 19 percent in 1989, through 12 percent in 1991, to 18 percent in 1993.

The apparent decline in profitability between 1989 and 1991 is considered to be largely due to changed assumptions regarding initial capital requirements and feed requirements. The apparent rise in profitability between 1991 and 1993 is considered to be a real one and primarily due to changes in relative prices.

The main things that changed between 1991 and 1993 were the market price for birds and the price of feed: both rose. While in 1991 sales were for slaughter, they were assumed to be as live birds to other domestic producers in 1993. In addition, while stock could be captured at relatively low cost in 1991, in 1993 reduced capture quota and increased demand meant that stock had to be purchased at market (live bird) prices. Clearly, the effects of rising product price between 1991 and 1993 have outweighed the effects of higher costs of feed and of stocking farms.

In terms of economic value, or value to society, the enterprise also shows consistently positive returns. The economic rates of return over ten years range from 15 percent in 1989, through 13 percent in 1991, to 19 percent in 1993. An interesting observation from the data in Table 8.1 is that in 1989 the economic value appears to be lower than the financial value. In 1993
this is reversed, suggesting that changes in the income - cost structure may have favoured national interests over those of the individual producer.

### Table 8.1: Illustrative financial and economic characteristics for an intensive ostrich breeding and rearing operation in the Limpopo region, Botswana, during 1989, 1991 and 1993 (pula '000, 1991)

<table>
<thead>
<tr>
<th>Item</th>
<th>Characteristic by year of analysis</th>
<th>1989</th>
<th>1991</th>
<th>1993</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scale (skins per annum '000)</td>
<td></td>
<td>0.7</td>
<td>1.4</td>
<td>1.4</td>
</tr>
<tr>
<td>Stock on hand (head '000)</td>
<td></td>
<td>1.5</td>
<td>3.6</td>
<td>3.6</td>
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<tr>
<td><strong>Financial analysis</strong></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Initial capital investment</td>
<td></td>
<td>509</td>
<td>914</td>
<td>2,360</td>
</tr>
<tr>
<td><em>At stability (full production)</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual gross income (sales)</td>
<td></td>
<td>488</td>
<td>1,046</td>
<td>1,560</td>
</tr>
<tr>
<td><em>less</em> Variable costs</td>
<td></td>
<td>236</td>
<td>696</td>
<td>860</td>
</tr>
<tr>
<td>Gross margin</td>
<td></td>
<td>252</td>
<td>350</td>
<td>701</td>
</tr>
<tr>
<td><em>less</em> Fixed costs</td>
<td></td>
<td>129</td>
<td>187</td>
<td>249</td>
</tr>
<tr>
<td>Annual net cash income</td>
<td></td>
<td>123</td>
<td>163</td>
<td>452</td>
</tr>
<tr>
<td><em>Financial worth over ten years</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Financial rate of return</td>
<td></td>
<td>18.5%</td>
<td>12.0%</td>
<td>17.9%</td>
</tr>
<tr>
<td>Financial net present value (@ 12%)</td>
<td></td>
<td>171</td>
<td>1</td>
<td>771</td>
</tr>
<tr>
<td><strong>Economic analysis</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Capital outlay</td>
<td></td>
<td>533</td>
<td>959</td>
<td>2,423</td>
</tr>
<tr>
<td><em>At stability</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual revenues</td>
<td></td>
<td>488</td>
<td>1,151</td>
<td>1,716</td>
</tr>
<tr>
<td><em>less</em> Operating costs</td>
<td></td>
<td>360</td>
<td>867</td>
<td>1,074</td>
</tr>
<tr>
<td>Annual gross value added</td>
<td></td>
<td>128</td>
<td>284</td>
<td>643</td>
</tr>
<tr>
<td><em>Economic worth over ten years</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Economic rate of return</td>
<td></td>
<td>14.5%</td>
<td>13.2%</td>
<td>18.5%</td>
</tr>
<tr>
<td>Economic net present value (@ 6%)</td>
<td></td>
<td>382</td>
<td>543</td>
<td>2302</td>
</tr>
</tbody>
</table>
The 1993 breeding and rearing model was subjected to some changed assumptions to test sensitivities. It was found that enterprise viability is fairly sensitive to the rate at which the project is developed. Any pace of development slower than that for the base case reduces financial and economic profitability. This highlights the critical role of efficient management in this system.

Table 8.2 shows the results of further sensitivity analyses. The feed price was varied since it is affected by drought and demand and also with locality. The product price and the purchase price of stock were tested as variables because they have shown high variability. The results suggest that financial and economic returns are sensitive to changes in feed and product prices. Profitability is not as strongly affected by changes in the cost of stocking (stock purchase price). However the cost of stocking does make up a large proportion of the capital requirements.

Table 8.2: Results of sensitivity analyses on ostrich farming model (internal rates of return, financial and economic model, Botswana, 1993)

<table>
<thead>
<tr>
<th>Case</th>
<th>Internal rate of return</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Financial</td>
</tr>
<tr>
<td>Variation in feed price</td>
<td></td>
</tr>
<tr>
<td>Price 30 percent below normal</td>
<td>28.3%</td>
</tr>
<tr>
<td>Price normal</td>
<td>17.9%</td>
</tr>
<tr>
<td>Price 30 percent above normal</td>
<td>8.3%</td>
</tr>
<tr>
<td>Variation in product (live bird) price</td>
<td></td>
</tr>
<tr>
<td>Price 30 percent below normal</td>
<td>1.8%</td>
</tr>
<tr>
<td>Price normal</td>
<td>17.9%</td>
</tr>
<tr>
<td>Price 30 percent above normal</td>
<td>34.0%</td>
</tr>
<tr>
<td>Variation in stock purchase price</td>
<td></td>
</tr>
<tr>
<td>Price normal</td>
<td>17.9%</td>
</tr>
<tr>
<td>Price 75 percent of normal</td>
<td>21.9%</td>
</tr>
<tr>
<td>Price 50 percent of normal</td>
<td>27.2%</td>
</tr>
</tbody>
</table>
It can be concluded that intensive ostrich production is currently a very attractive proposition for investors and has potential to contribute significantly to economic growth. Investment, however, requires a long-term perspective, incorporating the anticipated cyclical market trends, described in more detail above.

8.4 Economic analysis of live ostrich exports

As stated above, the prices for live ostrich outside Botswana are very high, while those for the slaughtered products are lower. The policy in Botswana of only allowing live exports in exceptional circumstances has been reviewed, and it is possible that in the future export will be allowed, unhindered. What follows is an analysis of the economic value of differing policy on the export of live ostriches from Botswana. This is in an attempt to ensure that policy on this issue is rational.

Terms of trade and ostrich products

The less developed countries have commonly experienced declining terms of trade for their exported primary products, relative to those of their, importer trading partners in the more developed countries. The reasons behind this are complex. An important reason is that the price elasticity of supply for primary products tends to be low while the price elasticity of demand for these products in developed countries tends to be high.

Sound development strategy requires that Botswana avoids situations where its products are subjected to declining terms of trade. As noted above, ostrich breeding and rearing is capital intensive and it takes several years to attain full production. It is not easy to switch in and out of production and this suggests that supply should be price inelastic. Similarly, the associated processing is capital intensive and also likely to be fairly price inelastic. Ostrich skins and their processed products are luxury goods, which are easily substituted, and international demand for them is likely to be relatively price elastic. Since demand for live ostriches is a derived demand (from the demand for the slaughter products), it is likely to have similar or slightly lower price elasticity. It is not clear whether there would be any difference between slaughter products and live birds in terms of vulnerability to declining terms of trade. Another consideration, however, is that prices for breeding stock would be likely to drop
more sharply than those for the slaughter products themselves, when market saturation occurs (again because demand for breeding stock is derived from that for the products).

Need for industrialisation

The poor non-mineral resource base in Botswana makes it important for the country to reinvest incomes from the exhaustible mineral stocks in sustainable uses of the available non-mineral resources. In addition, the country needs to capture the value of these optimally. It can be calculated that for Botswana to attain the per capita income levels prevalent in developed countries (for example the USA), the economy would need to grow at least seven percent per annum in real terms for the next 50 years. This illustrates the basis of the pressure for development in Botswana. It also suggests that economically feasible, vertical integration of primary production into secondary processing should be vigorously promoted. Policy allowing live ostrich exports would work against this.

Development of productive capacity

The farmed ostrich resource has economic value in terms of both the income from production or the annual turnover of sales, and the residual value of the ostrich farming stock and production facilities. It is policy to develop ostrich farming capacity so as to maximise the overall economic return from the resource. Generally, raising income from production, reduces the residual value of stock through consumption. Maximising the residual productive value of the stock means reducing the amount of consumptive production.

Cash flow analysis of ostrich farm development, described above, indicates that, generally, the most profitable strategy for farm development is to stock up as fast as possible in order to achieve full production as soon as possible. This is because income from sales during the stocking up period can generally only partially service the relatively inflexible fixed cost structure, and excessive debt accumulation results. Sound management of the aggregated farmed ostrich resource would seem to require a similar strategy. Consumption of stock should be avoided before production capacity is achieved. This does not preclude live exports but means that returns should be managed to match investments most profitably.
**Competition**

Prohibition of live ostrich exports has generally been aimed at preventing importing countries from developing competitive ostrich industries. Those advocating prohibition expect over-supply to rapidly follow unrestricted live exports, especially in view of the short life cycle and high reproductive capacity of ostrich. Large, lucrative, breeding and dispersal industries have already sprung up in countries such as the USA. Internationally, it would seem that massive over-supply of ostrich products is inevitable in the medium term. Botswana, however, as a very small participant, cannot hope to influence this significantly by withholding exports. A more appropriate approach for the ostrich industry in Botswana would seem to be to develop and reinforce their comparative advantages, if any, over international competition.

**Economic value of live ostrich exports**

Live ostrich exports can achieve a certain economic benefit for Botswana. This is enhanced by the very high prices attainable. However, for every bird exported there is an opportunity cost in terms of production value forgone. An economic cost-benefit analysis has been conducted to measure the net present value of limited or continuous exports of adults, juveniles or chicks. This compares the income from exports with the cost in terms of net benefits from production and stock accumulation which would be forgone as a result of exports. The period of analysis is ten years and the discount rate assumed is six percent.

The enterprise financial and economic model for a medium-scale intensive ostrich farm producing 1,400 slaughter birds per annum (the 1991 model referred to above) was used to determine the likely stock projections, production costs and benefits forgone for various options. Different export to domestic price ratios were applied to the cost-benefit model to determine the effect of this on the net present values.

Table 8.3 shows the results of this analysis. It is based on the assumption that there is demand and capacity within the domestic industry for expansion in production to between some 6,000 to 18,000 slaughter birds per annum. Given the resources (other than stock) available and the current demand for permits to farm ostrich, this seems reasonable. It can be seen from this table that at the price ratio of 3:1 exports of all age groups would result in an
economic loss for Botswana. With chick exports this remains the case up to a price ratio of 21:1, but with adult exports, economic return becomes negative around the 15:1 price ratio. With slaughter-age juvenile exports the economic return becomes positive at around the 9:1 price ratio.

Table 8.3: The effect of different export to domestic price ratios on the economic net present values (over ten years @ six percent) of live ostrich exports from Botswana showing, limited* and continuous** exports, and exports of different age groups (pula'000, 1990)

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Export: domestic price ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Limited chick exports</td>
<td>-3,107</td>
</tr>
<tr>
<td>Continuous chick exports</td>
<td>-3,662</td>
</tr>
<tr>
<td>Limited adult exports</td>
<td>-7,226</td>
</tr>
<tr>
<td>Continuous adult exports</td>
<td>-11,518</td>
</tr>
<tr>
<td>Limited juvenile exports</td>
<td>-3,922</td>
</tr>
<tr>
<td>Continuous juvenile exports</td>
<td>-3,541</td>
</tr>
</tbody>
</table>

* Limited exports refer to export of 200 per annum for three years only
** Continuous exports refer to export of 200 per annum throughout period (for ten years)

Generally positive economic return is possible, and maximised with exports of slaughter-age birds. At lower export to domestic price ratios the least economic loss is made with exports of rearing birds (aged between 0 and 14 months).

The above analysis does not include any cost to Botswana in terms of reduced prices resulting from increased competition. This cost is not, as yet, quantified. Projection shows that if the exported 800 birds are used for breeding and dispersal over the next ten years, it can result in an external flock with potential to produce 70,000 slaughter birds. It is considered that such an increase in competitive production could significantly affect product prices.
There are possible advantages of live ostrich exports with regard to terms of trade, but these are likely to be temporary. Development pressure provides an important incentive for rapid domestic ostrich stock build-up for production and product processing. This creates a general incentive to restrict live exports. However, the cost-benefit analysis shows that live exports can be economically rational, or not, depending on the specific conditions pertaining at the time.

The analysis indicates that the immediate benefits of live exports exceed the longer term opportunity costs of these exports when one or more of the following two conditions pertain:
- when there is a large enough price differential between export and domestic prices,
- when domestic capacity to absorb retained birds for competitive production is lacking.

The conditions in Botswana at present are such that the disparity between live-bird export prices and domestic slaughter/live bird prices (without exports) is great enough to make an export policy economically rational. In addition, there is evidence to suggest that, without the income incentive of live exports, domestic investment has been insufficient to absorb all retained birds.

8.5 Chapter conclusion

It can be concluded that intensive ostrich production is currently a very attractive proposition for investors and has potential to contribute significantly to economic growth. Investment, however, requires a degree of opportunism within the long-term perspective, with consideration being given to anticipated cyclical market trends. The production system involved is relatively well proven and carries less risk than other forms of wildlife farming or ranching. The main constraint to the expansion of the domestic ostrich industry will tend to be the supply of feed for rearing. The intensive nature of ostrich farming as a land use, gives it low compatibility with conservation of wildlife, habitat and biological diversity. Extensive ostrich breeding on ranchland, a likely feasible component of ostrich production in Botswana, would have moderate to moderately low compatibility, as does game ranching.

Cost-benefit analysis results indicate that whether or not live exports are economically desirable depends on, the degree of the price differential between export and domestic prices,
or the amount of domestic capacity to absorb retained birds, for competitive production, or the age class of birds to be exported, or all of these factors. For live ostrich exports to be economically efficient in 1990, the price of exports needed to be nine to 21 times higher than the domestic price. Exports of juvenile birds were most likely to be economically efficient, while those of chicks were least likely to be so. The export:domestic price differentials which have existed since 1990 have been higher than 15:1 and mostly higher than 21:1, making a policy allowing exports economically sound. There is also some evidence to suggest that, without the cash flow incentive of live exports, domestic investment in ostrich farms, which can absorb retained birds, tends to be retarded. Demand for live birds is expected to fall sharply in the medium term, along with the economic viability of live exports.

Clearly policy needs to be flexible to take account of changing conditions. The degree of flexibility required is such that only the private sector, unfettered, can respond adequately. Government policy therefore should not be one of regulation, but rather one of promotion, whenever a particular strategy is seen to be in the economic interest.
Chapter 9

Crocodile farming and ranching

9.1 Introduction

The draft policy of the Botswana Department of Wildlife and National Parks for the conservation and management of crocodile has the following objectives:

- to preserve crocodile populations within appropriate areas as unexploited examples of Botswana’s fauna,
- to promote crocodile conservation through sustainable utilisation in accordance with the Wildlife Conservation Policy of 1986 and,
- to reduce conflict between crocodiles and humans.

Elements of the proposed policy include the following:

- "3.5. The removal of eggs or very young crocodiles from the wild for ranching will be promoted over other forms of utilisation",
- "3.7. Licensed egg collectors will make available to the government for restocking purposes a number of crocodiles equivalent to 5% of the harvest" and,
- "3.9. Live crocodiles will not normally be allowed to be exported for commercial means".

This chapter provides an economic analysis of the policy elements for crocodile management in Botswana. Financial and economic enterprise models are used to assess the relative economic merits of:
(a) crocodile ranching, which involves the harvesting of eggs from the wild, incubation and hatching of these, and rearing the hatchlings to juvenile age for slaughter to produce skins, tail meat or live animals, and
(b) crocodile farming, which involves both on-farm production of eggs and incubation, and hatching and rearing as in (a).

The farming model is used as a base for an analysis to determine under what conditions (if any) the export of live crocodiles would be in the economic interest of the country. This work has also been reported elsewhere by Barnes (1992b).

9.2 Background to policy

Graham (1976) described the history of crocodile utilisation in Botswana. Between 1957 and 1969 the Okavango crocodile were hunted (cropped) extensively for skins. The numbers reportedly declined during this period but recovered later after hunting was stopped. The need was recognised for crocodile-use systems which were both less vulnerable to over-exploitation and more productive than cropping. Medem (1981) developed plans for a government or parastatal operated crocodile rearing operation (or ranch), using eggs collected from the wild, in the Okavango area.

Development has, in fact, been concentrated in the private sector with the commencement, since 1985, of two medium-scale farming operations, one in Maun and the other in Kasane, and one medium-scale ranching operation in the Tuli Block. None of these have, as yet, attained full production. The Nile crocodile is listed in Appendix II of the Convention for International Trade in Endangered Species (CITES). Botswana has been recognised by CITES as a country where ranching is acceptable.

Hutton and Child (1985), Child (1987) and Hutton (1987a) describe the Zimbabwean crocodile industry which has a number of fully operative ranching operations. It has been policy there to maintain these as rearing stations or ranches in order that rural people, who have to cohabit with crocodile, can see them as having some value. The intention is that rural people should derive income from harvesting wild eggs and thus feel more inclined to conserve the crocodile.
FGU-Kronberg (1988a) reviewed all wildlife utilisation in Botswana and recommended that activity in the crocodile industry be maximised within the framework of any physical limitations. Thus, it was recommended that operations beginning as ranches should be developed into farms, deriving only occasional, limited infusions of new stock from the wild population. Maximum production in the industry would primarily involve ranching based on egg harvesting to the maximum biological potential of the wild population, and, secondarily involve as many farm systems as could be supported before limiting factors constrain expansion.

Simbotwe and Matlhare (1987) described the status of crocodile in Botswana, and this formed the basis of the first draft of a crocodile management plan and, also, the draft policy described above.

9.3 Markets for crocodile products

Although it has not been formally studied, there appears to have been, until recently, a high demand for live crocodiles, particularly breeding animals, in South Africa. This was the result of a shortage of wild stocks to supply some twenty producers who generally had access to abundant, cheap feed, based on carcasses from large-scale chicken and pig production systems. To illustrate the extent of this demand, the price for a live animal at slaughter age was approximately twice the value of the slaughtered animal. There were indications that the market for live animals within Zimbabwe was also growing. Demand for live crocodiles appears to have collapsed during 1991. International prices for crocodile skins produced in Botswana dropped severely around 1992 (J. Seaman, 1992, pers. comm.; Revol, 1995) apparently due to oversupply. It would seem that the crocodile industry has already entered a price cycle, as anticipated for the ostrich industry (chapter 8). There are, however, indications of a growing market for crocodile meat as a luxury product in the restaurant trade within southern Africa.

The International Alligator/Crocodile Trade Study (IACTS), based in Florida, USA, has documented historical trade in classic crocodilian skins. Preliminary results of this study were described by Ashley (1987). The IACTS project was initiated to investigate the "stimulation of trade" argument that promotion of legal skin production and trade stimulates more illegal
traffic to stimulate demand, and also because of the significant long-term investments in crocodile production.

Ashley (1987) presented some initial conclusions for the study, namely:

- International trade in classic crocodile skins has decreased substantially in the last 15 years. Total trade at the time was estimated to be 150,000 classic skins per year. This was half the 300,000 classic skins traded each year in the early 1970s, and less than a third of the peak trade in the 1950s which may have reached 500,000 skins per year.
- Current (1987) legal trade amounted to 80,000 skins or 40 percent of the total trade. The trend was toward better management and regulated trade. It would seem that increasing volume in the legal trade does not stimulate illegal trade.

There appears to be no information on the elasticities of supply and demand in the crocodilian skin trade. Ashley and David (1987) in describing the market for skins suggest that the exotic leather industry has a tendency to move from one species to the next based solely on availability, tastes and prices. This would suggest relatively high demand elasticities due to the availability of substitutes. Ashley and David (1987) provided a complete list of bids, with prices and volumes sold, for alligator skin sales in Florida between 1977 and 1984. Analysis of these data suggests that, over this period, skin footage sold increased by an average of 13.8 percent while price remained the same in real terms.

Hollands (1987) plotted crocodile skin exports from Papua New Guinea in terms of standard unit (inches of grade one Crocodylus novaeguineae belly skin, in the 18-23 centimetre range) for the period 1976 to 1984. He also presented the values, in Papua New Guinean kinas, for skins exported during the period. Analysis of these data suggests that quantity exported increased by 6.5 percent over the period and that price remained the same (if adjusted for an assumed inflation rate of 6.3 percent). Lack of variation in price makes it difficult to infer price elasticities from these data. If, as suggested, demand is elastic, increased supplies from farming and ranching will not markedly depress prices and thus will tend not to affect illegal use of wild populations. The apparently strong tendency in the past for over-utilisation by crocodile hunters would seem to confirm this.
9.4 The feed constraint

Experience in Botswana suggests that one dominant factor, feed availability, will constrain the expansion of crocodile ranching or farming. Crocodiles require to be fed on mixtures of meat, offal and pluck. This must be free of excessive fat and not dried, salted or putrefied. A pure diet of red meat is thought to result in problems with gout so that fish or a mixture of fish and red meat is desirable. Given the high value of much meat and fish as a luxury source of protein for human consumption, it becomes clear that only waste meat, fish and offal will be available at a low enough price for successful crocodile production.

A 5,000-skin breeding and rearing production unit (farm) requires an estimated 466 tonnes of feed per annum. This amounts to roughly the (whole) carcass equivalent of 2,070 cattle, 133,000 rabbits, 3,200 zebra, 770 female or young elephant (from culling of cow herds) or 180 male elephant (from culling of bulls). It also represents the equivalent of fish produced at five tonnes per hectare on 80 hectares of fish ponds, or offal produced from a chicken farm producing 3.2 million chickens.

As will be indicated below, the 466 tonnes of feed needs to be available at a cost of less than P1.50 per kilogram for the operation to be viable. It is not possible to produce meat economically primarily to feed crocodile. There has to be a more profitable reason to produce the meat, for example, beef, rabbit, fish, chickens for human consumption, chicken eggs for human consumption, sheep wool for export and elephant ivory and hides for export. Meat and offal, available as wastes or as supplementary products from these enterprises are commonly cheap enough to make their purchase for crocodile production worthwhile.

It is important to note that more than 90 percent of the feed requirement, above, is needed for the rearing component of the farm. The breeding component requires less than ten percent of the total. It is also important to note that captive breeding appears to be successful only in the north of Botswana because of low winter temperatures elsewhere. Rearing is possible throughout the country.

Initial investigation of the possible large sources of cheap feed for a crocodile industry in northern Botswana suggests that there are none at present. Introduction of an elephant culling
programme in the north would change this. In the south there appears to more potential in the form of waste, offal and condemned carcasses which result from the Botswana Meat Commission abattoirs, municipal abattoirs, private livestock slaughter facilities, poultry farms and fish canneries. A detailed study is still required but it is thought that the total potential for crocodile rearing in the south is currently limited by feed to not more than three 5,000-skin production units.

9.5 Financial analysis

A financial model for a crocodile farm has been developed with empirical data from Botswana producers, and data from Foggin (1987), Child (1987) and Hutton (1987b). The result is a static financial model at full production, and this has been extended into a dynamic ten-year cash flow model and subjected to sensitivity analysis. In addition, for comparative purposes, a static financial model and a cash flow model have been developed for a crocodile ranch.

With the farming model different sizes of operation were investigated and it was found that, because of the very high initial investment, there were marked economies of scale. Table 9.1 shows this. The break-even point was in the region of 2,000 to 3,000 skins. This finding is supported by van der Riet (1987) who pointed out that economies of scale were important.

<table>
<thead>
<tr>
<th>Scale of operation</th>
<th>Financial profitability Annual return on investment*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit producing 1,000 skins</td>
<td>-19.49%</td>
</tr>
<tr>
<td>Unit producing 5,000 skins</td>
<td>19.35%</td>
</tr>
<tr>
<td>Unit producing 10,000 skins</td>
<td>38.96%</td>
</tr>
</tbody>
</table>

* Measured as annual net cash income per P100 of total initial capital investment

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Farming model

The financial farming model is based on a closed-farm production system involving captive breeding and intensive rearing of crocodile for skins, tail meat and live animals. Skins would be exported wet-salted, meat was to be sold locally and exported. Rearing was undertaken in artificially warmed tanks.

At full production, 5,000 skins were to be produced per annum. Feed requirements would be obtained a cost of P1.00 per kilogram from abattoirs, meat and fish processors, etc. Feed requirements were assumed to range from 7.5 kilograms per annum for hatchlings to 120 kilograms per annum for adults. Egg production was assumed to average 50 eggs per adult female over nine years of age. Hatching success was assumed to be 85 percent. Mortality rates assumed were 27 percent in the first year and 2.7 percent per annum thereafter. Breeding animals on the farm were to be replaced with new, captured stock after they reached 18 years of age, and adult mortality was assumed to be compensated for by the retention of reared stock.

Initial stock of 148 adults, 98 sub-adults and 8,220 eggs was to be captured from the wild. Restocking, to the wild, was assumed to be restricted to ten percent of the first batch of eggs. Juveniles were assumed to be slaughtered at between two and three years of age and their assumed slaughter value was P403. Staff requirements included three managers and 25 labourers. Veterinary and heating costs were assumed to be P4.60 and P11.50 per animal, respectively. An export duty of P6.20 per skin was assumed payable.

For the static financial model it was assumed that the operation was 25 percent loan-financed. The model includes amortisation of this finance, at ten percent interest, over the life of the asset. It also included provision for capital replacement (depreciation) with regard to equity-financed assets. Working capital requirements were assumed to be 30 percent of operating expenditures. Interest on this was calculated at 15 percent. A land rental of P45,000 was assumed. A net cash income was arrived at, after the deduction of variable costs, operating overhead costs, rentals, amortisation and depreciation. For the dynamic cost-benefit model, interest was excluded, and asset depreciation or stock appreciation were accounted for by the
inclusion of a residual value of assets in the final year of project life. A financial rate of return and a financial net present value at a 12 percent discount rate were calculated over five, seven and ten years.

The results indicate that for the 5,000-skin crocodile farm a total capital investment of P2.4 million is required to attain an annual gross income of P2.0 million and an annual net cash income of P0.75 million. The financial rate of return for the 5,000-skin crocodile farm model is 18 percent after ten years. The financial net present value at 12 percent discount rate is P1.07 million after ten years.

Ranching model

The base case financial ranching model involves the annual collection of eggs from the wild and intensive rearing of crocodile along the same lines as for the farming system for skins, tail-meat and live animals. The same assumptions used for the farming system apply, with the following exceptions. No capital investment was required in breeding stock and breeding ponds. Hatching success was assumed to be 80 percent. Initial collection of eggs was assumed to resemble that for the farming model in costs, numbers and restocking percentage (ten percent of the eggs collected). Thereafter, egg collection costs were assumed to amount to P11.10 per egg, and a restocking regime involving five percent of all the resulting juveniles of slaughter age was followed. Staff requirements included three managers and 21 labourers. A land rental of P38,250 was assumed.

The results show that for the 5,000-skin crocodile ranch a total capital investment of P2.1 million is required to attain an annual gross income of P2.0 million and an annual net cash income of P0.66 million. The financial rate of return for the 5,000-skin crocodile ranch model is 18.1 percent after ten years. The financial net present value at 12 percent discount rate is P1.00 million after ten years.

9.6 Economic analysis

Analysis of the economic worth of both the crocodile farming and ranching enterprises above was undertaken by converting the financial values into economic ones. A static model and a
ten-year, discounted, economic model were developed for both. The economic analyses appraised the enterprises in terms of economic values but did not include the economic costs to government in support of the crocodile resource and conservation. They give an idea of the degree to which the enterprise was deserving of government support. For analysis in terms of economic values, the assumptions set out under methodology in chapter 2 were employed. Foreign financing was assumed to amount to 25 percent of long-term loan requirements. Repatriation of interest and loan principal was thus assumed to amount to 25 percent. It was assumed that 25 percent of profits were lost through leakage.

The static economic model at full production took into account domestic and tradable economic costs, including foreign interest, lease, rental, and net income payments to arrive at a net economic benefit. In the dynamic economic model, foreign inflows and outflows, with the exception of interest, were taken into account and depreciation and appreciation were accounted for in a terminal asset value. An economic rate of return and an economic net present value at a six percent discount rate were calculated over five and ten years.

Farming model

The results show that in the model for the 5,000-skin crocodile farm, the economic value of the capital investment was P2.4 million. Annual gross income is P2.2 million and an annual net economic benefit of P0.92 million results. The economic rate of return for the 5,000-skin crocodile farm was 11.6 percent after ten years. The economic net present value at six percent discount rate was P1.28 million after ten years.

Ranching model

The results show that in the model for the 5,000-skin crocodile ranch the economic value of the capital investment was P2.2 million. Annual gross income was P2.2 million and an annual net economic benefit of P0.84 million resulted. The ranch had an economic rate of return of 11.6 percent after ten years. The economic net present value at six percent discount rate was P1.32 million after ten years.
9.7 The comparative viability of farming and ranching

The financial and economic results given above for farming and ranching show remarkably little difference. This is confirmed with sensitivity analyses performed on the enterprise models. Generally, as can be seen below, the responses of the farming and ranching models to changing assumptions are similar, confirming that there is little to choose between the two.

Both farm and ranch models show a lower economic return than financial return. This is, possibly, because of the high proportion of tradable inputs (which carry a foreign exchange premium), in particular the requirement for feed. It suggests that there may be hidden subsidies in crocodile production which enhance its profitability for the resource user. The positive economic return, however suggests that the industry is worthy of promotion and some government support.

The models are insensitive to changes in the manpower complement of the farms and ranches. This is shown in Table 9.2. The financial rate of return only becomes unattractive if the manpower complement is increased to more than 120 (some five times that required). The economic and financial returns are similar when some 110 unskilled labourers are employed. This would indicate that government’s financial assistance policy (FAP) incentive to employ unskilled labour is well directed to crocodile production.

The models are relatively insensitive to changes in the capital cost. The latter can almost double before the enterprises become non-viable, both financially and economically. This is also shown in Table 9.2. The effect of different average clutch sizes on the viability of farming was investigated and the results suggest lower sensitivity at below 50 eggs and a relatively dramatic positive response at above 50 eggs. The effect of different hatching rates on the viability of ranching was also investigated. The viability was found to be affected very little by changes in the hatching rate.

The effect of changes in product prices on the viability of both farming and ranching was investigated. The financial and economic rates of return coincide when product prices are around 80 percent of those of 1990. They both tend to become unattractive at these levels. This result is shown in Table 9.2. There is a linear response in the viability of the farming
and ranching models to changes in the feed price. This is also shown in Table 9.2. The feed price needs to remain below P1.50 per kilogram for the enterprise to remain strongly viable.

Table 9.2: Results of sensitivity analyses on crocodile ranching and farming models (internal rates of return, financial and economic models, Botswana, 1990)

<table>
<thead>
<tr>
<th>Variation in number employed</th>
<th>Financial</th>
<th></th>
<th>Economic</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ranch</td>
<td>Farm</td>
<td>Ranch</td>
<td>Farm</td>
</tr>
<tr>
<td>Normal (21 or 25)**</td>
<td>18.1%</td>
<td>18.0%</td>
<td>11.7%</td>
<td>11.2%</td>
</tr>
<tr>
<td>+40 (61 or 65)</td>
<td>14.5%</td>
<td>14.7%</td>
<td>11.2%</td>
<td>10.7%</td>
</tr>
<tr>
<td>+80 (101 or 105)</td>
<td>11.2%</td>
<td>11.7%</td>
<td>10.7%</td>
<td>10.3%</td>
</tr>
<tr>
<td>Variation in capital cost</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-30%</td>
<td>22.6%</td>
<td>22.8%</td>
<td>14.1%</td>
<td>13.9%</td>
</tr>
<tr>
<td>Normal</td>
<td>18.1%</td>
<td>18.0%</td>
<td>11.7%</td>
<td>11.2%</td>
</tr>
<tr>
<td>+30%</td>
<td>14.7%</td>
<td>14.5%</td>
<td>9.8%</td>
<td>9.2%</td>
</tr>
<tr>
<td>Variation in product prices</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>+20%</td>
<td>27.3%</td>
<td>25.7%</td>
<td>15.5%</td>
<td>14.0%</td>
</tr>
<tr>
<td>Normal</td>
<td>18.1%</td>
<td>18.0%</td>
<td>11.7%</td>
<td>11.2%</td>
</tr>
<tr>
<td>-20%</td>
<td>7.7%</td>
<td>9.8%</td>
<td>7.1%</td>
<td>8.2%</td>
</tr>
<tr>
<td>Variation in price of feed</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>+30%</td>
<td>13.8%</td>
<td>14.3%</td>
<td>9.4%</td>
<td>9.3%</td>
</tr>
<tr>
<td>Normal</td>
<td>18.1%</td>
<td>18.0%</td>
<td>11.7%</td>
<td>11.2%</td>
</tr>
<tr>
<td>-30%</td>
<td>22.5%</td>
<td>21.2%</td>
<td>13.9%</td>
<td>12.2%</td>
</tr>
</tbody>
</table>

* Units producing 5,000 skins  
** Normal number of persons employed is 21 for ranching and 25 for farming

The effect of doubling the percentage of the slaughter-age juveniles, which are given to government, for restocking the wild (from five to ten percent) was investigated in the ranching model. An increase in the number of harvested eggs which are set aside for restocking of the
wild from five percent to ten percent was also investigated. The viability of the enterprise is relatively insensitive to changes in this. The results are shown in Table 9.3. It can be seen that a ten percent restocking rate reduces the viability of the enterprise only slightly and the ten-year financial rate of return is reduced from 17.0 percent to 16.9 percent.

If the number of juveniles given to government for restocking in the wild is taken to be a percentage of the actual number of eggs collected (and not of the surviving slaughter-age juveniles) then the viability declines faster with increasing restocking percentage. This is evident from Table 9.3. It would seem unwise to insist on a restocking rate of more than five percent of eggs or slaughter-age juveniles.

The viability of the ranching system is moderately sensitive to changes in cost of egg collection. In ranching, there is, perhaps, greater risk associated with not having an "in-house" supply of eggs and being dependent on others for access to the wild population. On the other hand, successful captive breeding of large numbers of crocodile may be vulnerable to disease outbreak or technical problems.

| Table 9.3: Internal rates of return over ten years for different rates of restocking to the wild (as percentage of slaughter-age juveniles or eggs collected) in crocodile ranching* | Restocking rate |
| --- |
|  | 0% | 5% | 10% |
| **Restocking rate as percentage of juveniles** |  |  |  |
| Financial rate of return (10 years) | 19.1% | 17.0% | 16.9% |
| Economic rate of return (10 years) | 12.1% | 11.1% | 11.1% |
| **Restocking rate as percentage of eggs** |  |  |  |
| Financial rate of return (10 years) | 19.1% | 17.2% | 15.1% |
| Economic rate of return (10 years) | 12.1% | 11.3% | 10.3% |

* Units producing 5,000 skins per annum
It can be concluded that there is little to choose between farming and ranching crocodiles, from either the economic or the financial point of view, in Botswana. The farming system is only very slightly more robust in the face of changing economic conditions. The policy decision as to which system to promote can be left to the consideration of factors such as those outlined by Hutton (1987b). Here it is shown that ranching is more flexible as a management tool. As stated above, it is likely, also, to have an advantage in conservation.

9.8 Economic analysis of live crocodile exports

Until recently, the demand and prices for live crocodiles outside Botswana has been high in relation to demand and prices for the slaughtered products. This has resulted in persistent demands from producers to be able to export live crocodile. The need for a national policy on this has prompted the analysis below.

The discussion around terms of trade, the need for industrialisation, the development of productive capacity and competition in the chapter on ostrich (chapter 8) is directly applicable here. The reader is referred to section 8.4 in chapter 8.

The economic value of live crocodile exports

As with those for ostrich, live crocodile exports can achieve and could have achieved a certain economic income for Botswana. This is enhanced by the very high prices attainable. However, for every crocodile exported there is potentially an opportunity cost in terms of production value forgone.

Financial and economic values for various live crocodile export strategies have been determined by weighing the financial and economic return of live exports against the financial and economic opportunity costs of exports over a certain time period. The opportunity costs include the forgone production value (in crocodile products) over the period and the final value of stock at the end of the period, less the production costs required to achieve this.

The farming system described above was used as a base. The period of analysis was ten years. The discount rate assumed was six percent. The effects of limited exports (200 each
year for three years) or continuous exports (200 each year for ten years) are measured for exports of adults (nine to 18 years old), juveniles (two to three years old) and hatchlings (less than one year old).

To assess the opportunity cost, two stock projections, using the assumptions for herd growth used in the crocodile farming model, were developed for each scenario above. The two options involved minimum stock dispersal (i.e. production for slaughter whenever possible) and maximum dispersal (i.e. breeding and dispersal of live animals only). Relative value was measured as financial and economic net present value.

In all cases, the maximum dispersal scenarios resulted in stock numbers which exceeded the likely capacity for crocodile production in Botswana. This, and cash flow constraints suffered by producers, make minimal dispersal the more realistic scenario. Sensitivity analyses were performed on the models using different export to domestic price ratios and different discount rates.

Six examples of the model, viz:

- minimally dispersed adults/limited export,
- minimally dispersed adults/continuous export,
- minimally dispersed juveniles/limited export,
- minimally dispersed juveniles/continuous export,
- minimally dispersed hatchlings/limited export, and
- minimally dispersed hatchlings/continuous export,

are considered to represent possible scenarios for Botswana. Table 9.4 shows the results for hatchlings, juveniles and adults at the different price ratios. The results suggest that exports of live hatchlings have a positive net present value if the export to domestic price ratio is more than one. From the same table, it can be seen that the same applies to exports of juveniles. In the case of both hatchlings and juveniles continuous export results in higher returns than limited export.

The results for adults in Table 9.4 suggest that the export of adults is undesirable economically. In all cases a negative net present value exceeding P5 million is obtained. A
favourable economic return could be obtained, with continuous exports, if the export price for adults rose to above seven times the domestic price. In the case of limited adult exports the export price would have to rise to over 15 times the domestic price for this to become economically desirable.

The choice of discount rate was found to have almost no effect on the economic net present value for hatchling exports. It has a more dramatic effect on the negative economic net present value associated with adult exports but even at very high discount rates (more than 20 percent) the economic net present value remains negative.

Table 9.4: The effect of different export to domestic price ratios on the economic net present values (over ten years @ six percent) for limited* and continuous** exports of live hatchling, juvenile and adult crocodile from Botswana (pula '000, 1990)

<table>
<thead>
<tr>
<th>Scenario</th>
<th>1.75</th>
<th>3.50</th>
<th>5.25</th>
</tr>
</thead>
<tbody>
<tr>
<td>Limited hatchling exports</td>
<td>27</td>
<td>63</td>
<td>97</td>
</tr>
<tr>
<td>Continuous hatchling exports</td>
<td>27</td>
<td>133</td>
<td>235</td>
</tr>
<tr>
<td>Limited juvenile exports</td>
<td>184</td>
<td>606</td>
<td>1,014</td>
</tr>
<tr>
<td>Continuous juvenile exports</td>
<td>594</td>
<td>1,843</td>
<td>3,051</td>
</tr>
<tr>
<td>Limited adult exports</td>
<td>-7,372</td>
<td>-6,367</td>
<td>-5,396</td>
</tr>
<tr>
<td>Continuous adult exports</td>
<td>-8,081</td>
<td>-5,105</td>
<td>-2,228</td>
</tr>
</tbody>
</table>

* Limited exports refer to export of 200 per annum for three years only
** Continuous exports refer to export of 200 per annum throughout period (for ten years)

The cost to Botswana in terms of reduced prices resulting from increased external competition is not included in the analysis and is not, as yet, quantified. Projection shows that if the continuously exported 2,000 hatchlings were to be used for breeding and dispersal (maximally dispersed) over the ten years, they could result in external stock numbering 7,900 with potential to produce 1,000 slaughter animals per annum. Exporting 2,000 adults, over ten years, could result in external stock numbering 381,000 with potential to produce 39,700
slaughter animals per annum. Such an increase in competitive production could significantly affect product prices, and thus the viability of production in Botswana. It is concluded that live exports of adults are potentially undesirable.

9.9 Chapter conclusion

Studies have indicated that Botswana can increase the commercial production of crocodile, while reducing the threat of crocodile over-exploitation, with the promotion of ranching or farming systems. A start has been made with three medium-scale production units. The world classic crocodile skin industry is currently beset by excess supply and/or poor demand. It is thought that the product has entered a price cycle. If Botswana is to successfully exploit this it is essential that the local industry be viable and resilient.

Comparison of ranching and farming models suggests that they are equally desirable both financially and economically. Optimal size for production units is in the region of 5,000 skins per annum. The most significant factor limiting expansion in the industry is the supply of cheap, high quality feed. This needs to be available at prices of less that P1.50 per kilogram. Because ranching offers more flexible management and has greater conservation potential, it should take precedence over farming.

The enterprise models indicate higher financial return than economic return. The higher financial return suggests that there may be a hidden subsidy for crocodile producers. Since product prices are not subsidised, it is possible that input prices are distorted from their true economic value. A possible cause of this is the heavy reliance on tradable inputs which carry a foreign exchange premium. Given that production units need to be able to withstand periodic market collapse, this situation may be considered desirable. However, care is required to ensure that the economic cost of government support services does not exceed the economic return for the industry.

In conditions of lower profitability, the financial return tends to coincide with the economic return. With both the ranch and farm models, this occurs when the manpower complement is tripled, when product prices are 20 percent below normal, when capital requirements almost double, or when the feed price almost doubles. Botswana crocodile ranches are financially
capable of providing up to ten percent of collected eggs for restocking. A restocking percentage of five percent is considered most suitable.

Export of live adult crocodile was economically unsound in 1990. This is likely to be so at any time unless export prices rise to more than seven times those of domestic ones. On the other hand, export of crocodile hatchlings and, especially, juveniles was economically desirable in 1990 (when export to domestic price ratios were around 2:1). The existence of any export to domestic price differential is likely to make this worthwhile. It appears that policy should permit the export of crocodile up to slaughter age.

Cost-benefit analysis as applied in this chapter provides us with a useful tool in deciding the shape of policy on live exports. As was found with the ostrich, three factors emerge as important in analysis, and these are:

- the magnitude of any export to domestic price differential,
- the capacity of the domestic industry to use retained stock in an economically efficient manner, and
- the age class of the animals being exported.

Clearly, as found with ostrich, government should not regulate on this issue, but should have a flexible strategy of promoting the economically desirable options of the time. The primary need is for a competitive, robust crocodile industry within the limits of potential. All policy, planning and research should be geared toward this. A research programme is recommended into the economics of the supply of crocodile feed. This will enable effective planning of the industry and permit accurate planning of cost-effective government support. There is a need for information on the characteristics of international demand for crocodile products and their substitutes. More research on this is recommended.

The small Botswana crocodile industry has potential to be financially and economically profitable in the face of a cyclical international market. However its expansion as a viable industry is limited by a feed constraint. Care should be taken to ensure that economic saturation is not exceeded. The intensive nature of crocodile farming and ranching activities indicates that they are not generally compatible with conservation of habitats and biological
diversity. The ranching option can, however, result in some incentive among local communities for conservation of wild breeding stock.
Chapter 10

Elephant utilisation

10.1 Introduction

As a developing country, Botswana has policy which encourages sustainable utilisation of all its natural resources, including wildlife (Government of Botswana, 1986, 1990). Wildlife, including a very large population of elephant (Loxodonta africana), occupies land which has an opportunity cost in terms of traditional livestock and crop production. The policy aims to give land, which is occupied by wildlife, economic value that contributes to national development and justifies its existence.

In this chapter, changes in the economic worth of elephant use values, between 1989 and 1992 are documented. A discussion is presented on the implications of these for Botswana's elephant population and the requirements for a sound international strategy for elephant conservation. The economic environment for elephant use changed dramatically in 1989, due to a ban on trade in elephant products which followed the Appendix I listing of the species by the Convention on International Trade in Endangered Species of Fauna and Flora (CITES).

The analysis, which follows, deals with direct utilisation values, realisable for Botswana. Cost-benefit analysis models are used to derive use values for different elephant management and policy options. The work builds on that of Barnes (1990a) and has been published elsewhere (Barnes 1996b). Economic preservation values, derived from the preservation of the option to use the resource or from the preservation of the existence of the resource, which are part of total economic value, described by Fisher and Krutilla (1985) and Pearce and Turner (1990), have not been included in the models. Similarly, indirect use values, for
example, any possible ecological value in terms of habitat and/or biological diversity protection associated with controlling growth of the elephant population, have not been included.

10.2 Possibilities for elephant utilisation in Botswana

Botswana has a large and healthy population of elephant, indeed, one of the largest in Africa. Aerial survey counts undertaken between 1989 and 1992 (Craig, 1990; Republic of Botswana, 1992) resulted in population estimates of 54,700 (±15 percent confidence limits) and 60,935 (±12 percent confidence limits). Over that time herd structure data indicated a population growth rate of between three and five percent. More recent aerial survey results confirm the assumption of population growth (chapter 1 of this thesis; Gibson, 1995). The wet and dry season surveys of 1993/94, referred to by Said et al. (1995), yielded a population estimate of 70,755 (±12 percent confidence limits), and those of 1994, referred to by Gibson (1995), had an estimate of 71,589 with the same confidence limits. It is likely that the number of elephant in Botswana has increased by some 29 percent since 1989. Poaching levels have been low, relative to the elephant population. Records suggest that the levels have ranged between 40 and 150 animals per year and have increased with time (K. Mogatle, 1992, pers. comm.). Anti-poaching effort has also increased in intensity over time. Some 99 percent of the elephants occur in the north, in an environment of semi-arid savanna, sandy soils, and limited surface water. There is a small separate population of between 500 and 700 in the east.

The northern Botswana population is contiguous with those in north-west Zimbabwe, Namibia’s Caprivi and, apparently, with remaining populations in south-east Angola and south-west Zambia. Within Botswana, it disperses over a wet season range of some 7.3 million hectares made up of land gazetted as national park (14 percent), game reserve (seven percent), forest reserve (six percent), wildlife management area (59 percent), communal grazing land (13 percent) and cultivated crop land (one percent). In the dry season the population becomes concentrated around permanent water and occupies some 4.3 million hectares, consisting of national park (24 percent), game reserve (12 percent), forest reserve (seven percent), wildlife management area (44 percent) and communal grazing land (13 percent).
Human settlement within this range is sparse, limited to some 15,000 people, mostly in communal land. Scattered around the periphery of the range, on the west and south, is a rural population of some 110,000 people. Veterinary cordon fences, erected for livestock disease control, separate most of these communities from the elephant range. Wildlife, generally, and elephant, in particular, have been treated as a national resource, managed by central government. However, since 1989, communities living in the wildlife areas are being empowered with common property rights to manage and directly benefit from their wildlife. In addition, some benefits (rentals and/or royalties) derived from wildlife use on unoccupied public land are being returned to the broader community through local district authorities.

Since 1983, non-consumptive wildlife-viewing tourism has been the only way in which use values of elephant have been obtained in Botswana. Before this, there were consumptive uses including safari hunting, where elephant were included on a quota for trophy hunting by tourists. Hunting under licences by individual citizens (citizen hunting) was also practised in the past. There are currently plans to reintroduce safari hunting.

In Zimbabwe and South Africa, successful elephant utilisation has involved large-scale, consumptive culling (cropping) of excess animals and the marketing and processing of their products. Hall-Martin (1981, 1990), de Vos et al. (1983), Child and Child (1986), Child and Nduku (1986) and Martin (1990a) describe successful elephant cropping operations, producing ivory, skins, meat and live calves, conducted by specialised parastatal or government culling units in South Africa and Zimbabwe. The high, and rapidly increasing, prices for ivory and elephant skin prior to June 1989 made elephant cropping profitable under almost any conditions. Although never practised in Botswana, cropping has been considered at various times as a possible option. Recently, in Zimbabwe, a technique for the capture and translocation of live elephant in family groups has been successfully developed.

In 1991, The Department of Wildlife and National Parks drew up a management policy statement on elephant management in Botswana (Seeletso, 1990). An objective of this policy was the maintenance of the northern elephant population at around 52,000, the estimate of the time. The rationale was to stem the growth in elephant pressure on habitat in dry season concentration areas, although the ecological case for this has never categorically been made (Lindsay, 1990). It was also to reduce elephant pressure on human activities in and around
the range. An implication of this was that a culling programme would be necessary. The management policy made provision for the introduction of consumptive uses of elephant, including safari hunting, citizen hunting, cropping of surplus animals and secondary product processing involving hide tanning and carcass meal production.

10.3 Markets for elephant products

Before July 1989, there were well-developed markets for consumptive elephant products. Prices and demand were generally growing (Child and White, 1988; Parker, 1990). Econometric analyses of legal ivory trade data for Hong Kong and Japan (Barbier et al., 1990) suggest that the demand for both raw and carved ivory was price-inelastic and that, in Japan, it was positively income-elastic, i.e., positively related to rising incomes. There was a strong market for elephant hides as a luxury product, notably in north America. There were domestic and regional markets in Africa for elephant meat, mostly dried, for consumption by rural communities. In addition, there was potential for using elephant meat, within Botswana, as a feed source for commercial crocodile breeding and rearing enterprises.

The Ivory Trade Review Group (1989a, 1989b), in a detailed study, also described by Milner-Gulland and Mace (1991), concluded that dramatic reductions in most African elephant populations had taken place in the preceding decade, and that these were caused by poaching to supply the international ivory trade. This conclusion prompted western consumer countries to ban imports of ivory in July 1989. In October 1989, the biennial meeting of the CITES parties in Lausanne, Switzerland, made the now famous decision to place elephant in Appendix I of that convention, effectively banning commercial trade in elephant products between member states. All the countries which had historically consumed significant quantities of elephant ivory and skins closed their doors to trade. Under CITES, the number of states able to trade in elephant products was reduced to members which opted to take reservations, or to non-members of the convention.

The Appendix I listing was upheld in two subsequent biennial meetings of the CITES parties (in March 1992, at Kyoto, Japan, and again in November 1994 at Fort Lauderdale, Florida, USA). A group of southern African range states, including Botswana, objected to the decision and took reservations on elephant, which exempted them from the ban. Most of these had
healthy populations of elephant and considered the ban to be retrogressive. They formed a cartel, the Southern African Centre for Ivory Marketing (SACIM), which aims to provide a legitimate, tightly controlled outlet, or exchange, for legally produced elephant products (de la Harpe and Booth, 1991; Sugg and Kreuter, 1994). The exchange has yet to function, partly because, up until recently, it consisted only of producers and lacked members who are buyers.

In addition to the CITES ban, there was a strong campaign, among preservationist organisations and animal rights movements, particularly in North America and Europe, which had the effect of suppressing demand for consumptive elephant products. In 1990 the market for hides as a luxury product in the USA had been eliminated. Reports by Caldwell and Luxmoore (1990) and O’Connell and Sutton (1990) suggested that, immediately after imposition of the ban, the continuing illegal supply of ivory exceeded demand in most of the world. This oversupply applied, in particular, to Europe and the United States (USA). The only instance where these authors reported an apparent increase of price was for certain processed ivory products in Japan. In Africa they quoted various unpublished sources reporting price decreases for illegal raw ivory. These sources suggested that prices dropped sharply, in some areas to where supply was no longer viable. The recent, June 1997, meeting of the CITES parties, in Harare, Zimbabwe, approved the downlisting of the specific elephant populations in Botswana, Zimbabwe and Namibia, for sale of part of the national ivory stocks to Japan, suspended for two years. Also agreed was the optional, possible sale of the full stocks to donors, not for use, but for destruction.

Without legal trade during the ban, it has become difficult to detect changes in the demand and prices. By 1992, it appeared that ivory, in the quantities that could be produced by Botswana, did not have regional or legitimate international markets. Hides had a regional market but, given high volumes, the price was that of utility leather. Low quality, sun dried meat had some value in northern Zimbabwe and elsewhere in southern Africa, but prices were low. There was a regional market for carcass meal but the market price for this product (P0.75 per kilogram) was lower than the cost of culling the elephant (P1.40 per kilogram). Processing elephant meat, as feed, through crocodile farms was unprofitable during 1992 due to a collapse in prices for crocodile skins. This use for elephant meat was, in any case, apparently threatened by preservationist pressure (P. Sheller, 1992, pers.comm.).
Tourism use values have not been directly affected by the CITES trade ban. International demand for wildlife-viewing tourism, involving elephant, has continued to grow throughout the period before and after the ban. The same applies to international demand for elephant as hunting trophies. However, markets for safari-hunting tourism involving elephant appear to be vulnerable to pressure from animal rights and preservationist groups, who may wish to close them (Hutton, 1995).

Despite the likelihood of some ivory sales in the future, there are no clear indications about future trends in the markets for consumptive elephant products. Demand suppression remains the primary force in the markets. Any legal sales of ivory to users will be small. Any legal sales of ivory to donors for destruction will be larger, but will obviously not affect the illegal demand or price for ivory. Certain segments of the illegal ivory market (mainly those in rapidly developing, eastern economies) seem less responsive to suppression than others (such as those in developed western countries). It is possible that these will remain resilient and, after surplus stocks in the world market have cleared, begin to drive up prices (Barbier et al., 1990). Hide markets, as they existed, mostly in suppression-sensitive western countries, have probably been irreversibly destroyed, but could probably be developed elsewhere. Meat markets will most likely remain local and of low value. There is demand for live elephant, mostly in the southern African region, for stocking private ranches and protected areas, but little is known about volumes, trends and prices.

10.4 The economic setting

Trade prohibition, as a tool for conservation, as espoused in the CITES convention, appears to be based implicitly (Swanson, 1994) on the assumption that the wildlife resources in question are characterised by low productivity, open access to consumptive users, and high net value for products. Low productivity (or low reproductive rate) results in a tendency to "mine" the resource. Open access results from an inability to exclude users and results in unregulated competitive use with the resource being exploited either to extinction, or to an equilibrium point of low biomass and low productivity. High net value for products attracts resource users to participate and stimulates even greater rates of use. These principles are well documented and form the basis for much analysis in resource economics; for example, the work of Clark (1985, 1990), based primarily on marine fisheries. These conditions lead to
resource depletion and the most effective conservation response is seen to involve suppression of demand for the products (including prohibition), which pushes the net value of products low enough to stop use.

Swanson (1994) analysed this open access model and concluded that its application to terrestrial resources such as the elephant was flawed. This was because it did not account for the opportunity cost of existence of the resources. To exist, elephant need both land, which has alternative potential uses, and investment in protection. Demand suppression does not address this and indeed can, by eliminating use values, reduce incentives for investment in elephant existence. The conservation solution is seen instead (Barbier et al., 1990; Sugg and Kreuter, 1994) as one of controlling access through appropriate property rights and investment in resource existence. Demand suppression (including trade prohibition) is seen as having either negative value (in that it penalises investors), or short-term value (in cases where open access prevails). Even in these cases it can be found ineffective where user opportunity costs are low or where segments of the market are resilient.

Examination of African elephant range states reveals a wide disparity in conditions. At one extreme are states such as Angola, Moçambique, Somalia and Sudan, where war and economic collapse, have resulted in an almost complete disintegration of capacity to enforce property rights at any scale. There is little prospect of investment in elephant resources. Until this becomes possible, the trade ban and other demand suppression strategies offer the only hope of slowing elephant poaching off-take rates. At the other extreme are states such as South Africa, Zimbabwe, Namibia, Botswana and Kenya, where property rights and enforcement of these, either at central government, district or local level have been sufficient to result in growing elephant populations. Apart from Kenya, which has not allowed consumptive uses, these countries have been against the trade ban. In all of them the realisation of elephant use values has been considered important in motivating investment in the resource. Most other elephant populations and range states in Africa have conditions which approach the first extreme, i.e. they tend towards having poor enforcement capacity, towards having de facto open access for elephant, and they have supported the ban.

Much international support for trade prohibition as a conservation policy appears to be driven by ethical considerations rather than scientific principles. Hawley (1993) edited a collection of
essays, on commercialisation and wildlife management, which illustrate this point. The arguments of some of these authors (Geist, 1993; Bunnell, 1993), against commercial use of wildlife, are implicitly based on the open access model, described above, but they are backed up by the premise that it is unethical to use, especially kill, animals for gain. Animal rights and the symbolic sanctity of wildlife (Hanks, 1995) are issues used to provide strength to the argument for prohibition of trade in wildlife parts.

For many, the trade ban has not been seen as a temporary measure to be lifted when active investment is possible, but a permanent fundamentally correct solution (Pagel and Mace 1991; Maas, 1995). Support for the ban tended to become hardened between October 1989 and recently, when, in June 1987, there has been a softening. Caldwell and Luxmoore (1990), O'Connell and Sutton (1990), Dublin and Jachmann (1992) and Dublin et al. (1995) all provide evidence of marked decreases in poaching, ivory prices and illegal ivory trade in Africa since the ban was introduced. Ongoing, rigorous research, analysis and evaluation is needed to investigate the ban's efficiency, or not, as a tool in elephant conservation. Its long-term value has not been unequivocally determined, as points made by Barbier and Swanson (1990) and Dublin et al., (1995) suggest. Detailed objective, scientific study is also needed on the effects that the proposed reintroduction of controlled legal marketing of ivory will have on elephant conservation.

In northern Botswana, two potential threats exist for the large elephant population. First, it could be reduced if poaching were to increase to levels above which it could be contained by government or communities. Although poaching for ivory and illegal trade has continued at a low level even after the ban, the effect on the population has been negligible. Intensive poaching for ivory in southern Africa has so far tended to accompany more lucrative, rhinoceros horn poaching activities. The fact that Botswana has almost no rhinoceros may explain why poaching pressure has been low. It is possible that the trade ban has helped prevent ivory poaching in Botswana from developing into a larger problem.

The second way the elephant resource could be lost, is if society in Botswana perceives that it has low value, ceases investing land and budgetary resources in it, and ultimately converts the land it occupies to other uses. So far this has not happened. The northern, expanded wet season elephant range is primarily devoid of human settlement, is primarily (86 percent)
gazetted for non-agricultural use, and has so far been able to absorb the apparent expansion of the elephant population. Government policy has firmly supported the development of this land for wildlife-based tourism. The land has been shown to have relatively high economic value for non-consumptive wildlife-viewing tourism and complementary safari-hunting tourism (Barnes, 1994a).

Alternative use options for the land occupied by elephant in northern Botswana include traditional, subsistence livestock keeping, or extensive, commercial livestock production. Only small parts have soils that could be used for crop production, either rain-fed or irrigated, and/or for either subsistence or commercial purposes. In any case, because of transport costs, the economic viability of arable agriculture in northern Botswana, except for subsistence or for very small local markets, has yet to be demonstrated (Edwards et al., 1989). Commercial livestock production has been shown, in chapters 7 and 12 of this thesis, to have poor economic value relative to tourism in the northern wildlife areas. Its relative value is expected to decline even further in future, with implementation of the General Agreement on Tariffs and Trade (GATT).

Traditional livestock keeping, although its comparative economic value has not been determined, is the one form of land use that is likely to pose a threat to the northern wildlife lands. There is high social demand in Botswana for ownership of livestock which has value in production of milk, meat, draft power and as a store of value. Livestock ownership provides communal land users with apparently attractive returns on investment and appears to result in positive net returns per unit of land (Bailey, 1982; Flint, 1986; Abel, 1993). A high proportion of the value of traditional livestock keeping is attributable to non-market consumption and standing stock, making it much less affected by transport costs and market price changes, than commercial livestock systems. It is socially important as the most significant and reliable source of non-wage income for rural households (Flint, 1986). The northern elephant range contains relatively high quality habitat for livestock keeping.

Data from Arnzen and Veenendaal (1986) have been used to calculate that around 640,000 cattle and some 230,000 goats are currently associated with the rural human population, of some 110,000, resident in and around the elephant range. This human population is expected to increase by 2.2 percent per annum, over the next 15 years, to 150,000 (CSO, 1987b).
Land presently allocated to these communities for communal livestock keeping amounts to some 5.2 million hectares. If average communal land stocking rates (6.4 hectares per large stock unit), recorded by Bailey (1982) and Abel (1993), prevail, then some 80 percent of this must already be being used to ecological capacity.

The national livestock herd has grown steadily, except during droughts and periods of disease, since 1904 (Arntzen and Veenendaal, 1986). The average rate of increase over this period has been some 3.8 percent per annum. So far this expansion has occupied grazing land outside designated wildlife areas. However, if livestock herds in the northern districts continue to grow at this rate (and there are no effective mechanisms to prevent this), then within 15 years, at ecological carrying capacity, they will need to occupy some 5.0 million hectares of land presently allocated to wildlife. This will mean conversion of some 68 percent of the present wet season dispersal range of the elephant population. Simple amendments to the regulations by the relevant cabinet minister could make this possible on 85 percent of the elephant range. Presidential de-proclamation would be required for only 15 percent (the national park). In democratic Botswana, political forces for the required policy change will be powerful.

Clearly, continued investment in land and management resources for elephant, and associated wildlife, in Botswana, over the next 15 years, will depend on its value, as realisable by Botswana society, relative to the value of investment in more livestock. Specifically, the value of wildlife will have to be directly realised by the people who would otherwise expand livestock herds in the north. The total economic value of wildlife includes direct use values, non-use values as well as indirect use values. As stated previously, the analysis, which follows, incorporates only direct use values. It is worth considering the nature of the other elephant values, and assessing their relative significance.

Indirect use values of elephant could be associated with uncontrolled growth of the elephant population, and could include ecological costs (in terms of habitat and/or biological diversity losses) or social, or economic costs (in terms of loss of agricultural land use). Despite apparent, continued growth of the Botswana elephant population, such costs have not yet emerged as clearly significant. Evidence from elsewhere suggests, however, that they will become more so with time (Taylor and Cumming, 1993; Parker and Graham, 1989a, 1989b).
Non-use, preservation values for Botswana's elephant could be reflected in willingness to pay for investment in elephant. Within Botswana, pressure for development results in high discount rates. Attitudes to wildlife are largely utilitarian, particularly in the relatively poor, rural society (Mordi, 1991), and there are no notable ethical or religious values associated with elephant. Preservation values are thus likely to be insignificant within Botswana but they could be significant in developed countries, from where much international concern for elephant welfare emanates. Willingness to pay for the existence of, or option to use, elephant could be manifested through increased or decreased international transfers. If such values are significant then it would seem that mechanisms which enable their capture for investment in elephant, must be lacking. Budget records in Botswana show that the donor financed proportion of government expenditure on the wildlife sector (some 35 percent) has not changed significantly between 1986 and 1995. Kenya and to a lesser extent Tanzania, both captured, at least temporarily, significant influxes of aid for elephant management (Sugg and Kreuter, 1994; Dublin et al., 1995), but other range states have not (Dublin and Jachmann, 1992; Dublin et al., 1995). The bulk of Botswana's elephant values appear to be direct use values.

### 10.5 Specific methods

In June 1989, before markets began to close, a 15-year discounted cost-benefit model was developed, on computer spreadsheet, to investigate the relative economic value, for Botswana, of its different options for elephant use (the 1989 analysis). Definitions and methodology conformed with those of Gittinger (1982). The basic "building blocks" for the model were enterprise budgets for each activity which involved or included elephant use. At first, these were measured in financial values and were not shadow priced. They determined the annual returns to internal factors of production (labour and capital), after subtraction of the cost of external factors (intermediate inputs). As defined, they provided a measure of the value added by the activity to national income.

Each option analysed involved an elephant use activity or a combination of elephant use activities, and for each option a stream of all expected incremental value added was computed over 15 years. Each option stream was discounted and summed to arrive at its present value. The first management option investigated was the status quo, i.e. continuation of the current
situation, with no consumptive uses of elephant and with all benefits the result of projected growth in elephant-viewing tourism. All other options involved the introduction of various consumptive uses to the first option (status quo) situation. The second involved the introduction of elephant safari hunting by quota. The third option involved introduction of licensed hunting by Botswana citizens for elephant, also by quota, and the fourth involved the introduction of an elephant cropping (culling) programme. The fifth option involved the introduction of all these consumptive uses, and the sixth option involved all uses except citizen hunting.

In October 1990, to assess the effects of the ban, a comparable follow-up analysis of options was undertaken (the first 1990 analysis). This time, options involving citizen hunting were excluded as this use was considered incompatible with the new economic environment, in which tight control over ivory production was required. Further work, also in 1990 (the second 1990 analysis), involved the inclusion of additional empirical data in the models and application of more shadow pricing criteria, so that values more closely reflected opportunity cost to the economy. In addition, the second 1990 analysis involved inclusion, in the models, of the cost of government expenditures on elephant management, also shadow priced. In 1992 these cost-benefit models were reworked once again, with revised assumptions based on 1992 conditions (the 1992 analysis).

In all analyses, the streams of net benefits from different options were assumed to take place in the context of implementation of policy on wildlife utilisation and tourism (Government of Botswana, 1986, 1990), proposals for the development of the wildlife sector (FGU-Kronberg, 1988a), and relevant district land-use plans (Ministry of Finance and Development Planning, 1991). Streams of value were incremental over the base of existing net benefits of the time of analysis. These base values were derived from an empirical study on the contribution of wildlife to the economy (FGU-Kronberg, 1988b) in which value added had been estimated from financial statements and licence records.

Elephant-viewing tourism benefits were based on a generalised enterprise budget model for wildlife tourism in northern Botswana, described by Barnes (1991a), appropriately inflated. There is no information on the proportion of these benefits that are attributable to elephant. However, this species is the dominant of the key species associated with wildlife viewing in
Botswana and it is logical to calculate the proportion using the biomass ratio (elephant made up 41 percent of the ungulate biomass in tourism areas). The projected growth in benefits was 12.5 percent per annum over the period, in accordance with sectoral development plans (Hartle, 1988). These plans involved re-allocation of northern wildlife management areas, within a new land-use plan and allocation system. It was projected that the tourism carrying capacity of the elephant range would be filled within 15 years.

For safari hunting, an annual off-take of 200 trophy bulls (0.04 percent of the population) was assumed. This was considered sustainable by wildlife biologists attached to the Department of Wildlife and National Parks (G. Craig, D. Lawson and C. Spinage, 1990, pers. comm.), and was well within rates shown to be sustainable in Zimbabwe (Bond, 1994). It was considered that the market could easily absorb this number without significant change in price. Calculation of value added was based on an enterprise budget model for safari hunting in northern Botswana, described by Barnes (1991a) and in chapter 5, above. The proportion of enterprise value added attributable to elephant was calculated to be 34 percent.

The 1989 analysis included an option involving hunting by citizens and here the same quota of 200 bulls was assumed. For options involving both citizen hunting and trophy hunting 100 bulls were allocated to each use. Citizen hunting in the past was almost exclusively done for ivory (K. Mogale, 1991, pers. comm.), with hides and meat not being recovered. Past experience in Zimbabwe (G. Child, 1988, pers. comm.) confirms that hides from hunting were not recovered and were difficult to sell in small quantities. It was assumed that there would be 30 kilograms of ivory taken per elephant and also that most (72 percent) of this would be sold by hunters and processed within Botswana, in ivory carving enterprises.

Elephant cropping benefits, for all analyses, were calculated from a specific elephant cropping enterprise model, initially developed in 1988. It was assumed that 2,500 elephant from cow herds could be cropped per annum (between 4.1 and 4.6 percent of the total population), using appropriate, specialised techniques to minimise disturbance. The off-take rate is in line with those applied sustainably in Zimbabwe and South Africa (Martin, 1990a; Hall-Martin, 1990). The June 1989 cropping option involved some important forward linkages. It was assumed that only 20 percent of dry-salted hides produced in cropping would be exported and the remainder (80 percent) would have had ten percent of its value added to it, within the country,
by a large-scale tanning firm. Capacity was available for this at the time. It was assumed that only 20 percent of the ivory from cropped elephant would be exported and the rest (80 percent) would be available for use in medium- and small-scale ivory carving enterprises within the country. An enterprise model for ivory carving was used as the basis for calculating the value added.

In the 1989 analysis it was assumed that meat from 2,000 of the cropped elephant would be recovered and sold, as feed, at a price of P1.00 per kilogram, for the production (breeding and rearing) of crocodile. At an average of 600 kilograms of meat per elephant cropped, this would have supplied the annual feed requirement for five crocodile production units producing a total of some 25,000 skins per annum. At the time crocodile ranching and farming were in a state of rapid expansion but were being constrained by a shortage of suitably cheap feed. The value added for this was calculated from an enterprise model for a crocodile farm producing 5,000 skins per annum, described by Barnes (1992b). Another product of cropping was assumed to be live elephant calves, between six months and two years of age, sold in the regional and international live game market.

Immediately after the trade ban, (in the first and second 1990 analyses), forward linkages associated with cropping were found to be impossible. There was no market for elephant hides or meat as crocodile feed. Ivory carving within the country was precluded, owing to the nature of the SACIM ivory exchange system. Benefits from cropping were assumed to be restricted to the direct sale of sun-dried meat to rural communities, sale of live elephant calves and sale of ivory through SACIM. Raw ivory would be sold through SACIM for a price 60 percent of that in July 1989. This price was derived from information given by Caldwell and Luxmoore (1990) and O’Connell and Sutton (1990). Because some might have considered 60 percent too high, an alternative of 20 percent was also applied, in sensitivity analysis. Dried meat, amounting to 50 kilograms per animal cropped, would have been sold within the northern Ngamiland and Chobe Districts for P2.92 per kilogram.

At the time of the 1992 analysis, the Department of Wildlife and National Parks held a workshop to reassess the feasibility of cropping. The cropping enterprise model was revised and subjected to sensitivity and break-even analysis. It was found that ivory from cropping could not be sold, due to a lack of markets, but that the sale of carcass meal, utility leather
and live calves would be possible within the southern African region. It was estimated that the value of all dry, salted hides sold could have two percent added to it, within the country, by an existing large-scale tanning company, producing utility leather. It was found that carcass meal production could break even financially, if partially supported by the hide processing. In order that the private sector could be induced to participate, income support from government, amounting to a transfer of some P540,000, would have been required.

In all analyses the assumption was made that introduction of consumptive uses would have an effect on the growth of elephant viewing tourism as a result of displacement and/or disturbance. Citizen hunting, to a lesser extent trophy hunting, and to an even lesser extent cropping (if at all), have some mutual spacial exclusivity with wildlife viewing. Examination of land resources and their likely allocation if all consumptive uses were introduced, enabled a picture to emerge of the displacement effect. Opinions vary on the degree to which (if at all) the different consumptive uses cause disturbance which reduces the value of elephant viewing. The opinions of 16 Botswana tour operators were solicited to arrive at a subjective estimate of this effect.

The resulting base-case assumption was that introduction of cropping would, through displacement/disturbance, reduce the anticipated growth in tourism benefits from 12.5 percent to 12 percent per annum. Introduction of safari hunting would have a greater effect, reducing growth to 11.5 percent and introduction of citizen hunting would have the highest effect of all, reducing the anticipated growth to 11 percent per annum. Because of uncertainty regarding these estimates, sensitivity analyses (with no effect and double effect) were conducted.

Net present value calculations, in the second 1990 analysis and the 1992 analysis, included the economic cost of government expenditures attributable to elephant management. In 1990 the annual expenditure (which the Department of Wildlife and National Parks was spending specifically on elephant protection and management) was estimated to be P12.75 (US$6.12) per square kilometre of elephant range. For all options it was projected that this would rise at an average of 20 percent per annum over the following 15 years to something like P198 (US$95) per square kilometre. This was based on extrapolation of planned growth for departmental expenditures during the seventh National Development Plan (Ministry of Finance and Development Planning, 1991). At the time there were also some Botswana Defence Force
expenditures on elephant protection, but these were considered to have no opportunity cost, and were excluded.

In the 1992 analysis, the economic costs were revised to reflect levels of that year. They were P15.67 (US$7.52) per square kilometre of elephant range, projected to rise to P242 (US$116) per square kilometre over 15 years. This level was deemed necessary to prevent increased poaching losses in Botswana. In Zambia and Zimbabwe, expenditure amounting to P417 (US$200) per square kilometre has been empirically determined as being necessary to control high intensity poaching for elephant (Leader-Williams and Albon, 1988; Leader-Williams et al., 1990; Martin, 1990b). To cover a possible worst case scenario for Botswana, sensitivity analysis was conducted using this target level of expenditure (it was P510 per square kilometre in 1992). The effects on net present value of increasing expenditures to this high target level over five, ten and 15 years were tested.

Net present values calculated for the first 1990 and 1992 analyses involved full shadow pricing. Criteria for this were standard, used by the central planning authorities (Ministry of Finance & Development Planning, 1986; Matambo, 1988, pers. comm.). They conform with the approach of Gittinger (1982). Transfers within Botswana, where these affected market prices, were removed. The only necessary adjustments, here, were for licence fees, duties, rentals and transfers related to financing. Foreign inflows were counted as benefits and foreign outflows were counted as costs. The market values of all tradable goods and services were adjusted up by a foreign exchange premium of ten percent to reflect short term overvaluation of the currency. Calculation of this adjustment was based on estimated net tariff effects of the Southern African Customs Union (SACU) of which Botswana was a member (O. Matambo, 1988, pers. comm.). Because of unemployment among unskilled labour, its market price was adjusted down by 50 percent to arrive at opportunity cost. For skilled labour the wage cost was assumed to reflect the shadow price and no adjustment was made.

In all analyses a 6 percent real discount rate was applied to constant price, net benefit streams. This was based on the private opportunity cost of capital and also the long-term cost of funds to the state (O. Matambo, 1988, pers. comm.). The economic opportunity costs of land were assumed to be zero for all options in the analysis (financial land rentals were treated as transfers). None of the estimated benefits from elephant use reflected any changes in
consumer surplus. This was because only tourism benefits (viewing and safari hunting) were believed to involve any consumer surplus. This accrued to foreigners, and did not affect national income.

10.6 Results

Table 10.1 compares the present values of option benefits from the 1989 and first 1990 analyses, i.e. before and after the Appendix I listing by CITES. The results suggest that, with conditions pertaining at the time, non-consumptive use of the elephant resource had a potential value of some P109 million. With the introduction of safari hunting the total value of the resource could be enhance by some 41 percent to P153 million. In 1989, use of the same quota for citizen hunting had lower value and could only result in a 20 percent increase. With the conditions pertaining before June 1989, the introduction of a cropping programme (along with the associated forward linkages), would have made it possible for Botswana to realise a significant increase in the use value of elephant. In this case, potential value could have

<table>
<thead>
<tr>
<th>Scenario (option)</th>
<th>15-year present value @ 6 %* (pula '000,000, 1989)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>June, 1989</td>
</tr>
<tr>
<td>1. Viewing only with no consumptive uses</td>
<td>108.9</td>
</tr>
<tr>
<td>2. Viewing with safari hunting only</td>
<td>153.2</td>
</tr>
<tr>
<td>3. Viewing with citizen hunting only</td>
<td>130.7</td>
</tr>
<tr>
<td>4. Viewing with cropping (culling) only</td>
<td>248.7</td>
</tr>
<tr>
<td>5. Viewing, safari and citizen hunting and cropping</td>
<td>282.3</td>
</tr>
<tr>
<td>6. Viewing, safari hunting and cropping</td>
<td>293.5</td>
</tr>
</tbody>
</table>

* Cumulative contribution to gross national income by year 15, after discounting at six percent per annum and after partial shadow pricing
increased by some 128 percent to P249 million. The most valuable combination of uses, in 1989, would have been viewing with safari hunting and cropping and this would have meant an increase in value of some 170 percent over the non-consumptive option.

By 1990, only one consumptive use had any potential to increase value and this was safari hunting. Citizen hunting was no longer a realistic option and cropping could only add one or two percent to the economic use value of the resource. The international ban on the trade of elephant products had, in effect, reduced the potential economic contribution of elephant utilisation over 15 years by some P138 million, or 47 percent.

Table 10.2 shows results from the second 1990 analysis: a cost-benefit model, shadow priced, and including government expenditure on elephant management. The effects of different assumptions regarding the displacement/disturbance effect of consumptive uses on non-

<table>
<thead>
<tr>
<th>Use option (scenario)</th>
<th>None</th>
<th>Moderate</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Viewing only with no consumptive uses</td>
<td>106.7</td>
<td>106.7</td>
<td>106.7</td>
</tr>
<tr>
<td>2. Viewing with safari hunting only</td>
<td>165.9</td>
<td>153.8</td>
<td>142.7</td>
</tr>
<tr>
<td>3. Viewing with cropping only (20%)***</td>
<td>111.8</td>
<td>105.7</td>
<td>99.8</td>
</tr>
<tr>
<td>4. Viewing with cropping only (60%)****</td>
<td>118.6</td>
<td>112.4</td>
<td>106.5</td>
</tr>
<tr>
<td>5. Viewing, safari hunting + cropping****</td>
<td>170.9</td>
<td>153.2</td>
<td>137.7</td>
</tr>
</tbody>
</table>

* Gross value added over 15 years to national income, net of government expenditures, after discounting at six percent and after shadow pricing (October 1990)

** Displacement/disturbance effect of safari hunting and cropping on viewing activities (see text)

*** Ivory marketed through SACIM; price 20 percent of that obtainable in June, 1989

**** Ivory marketed through SACIM; price 60 percent of that obtainable in June, 1989
consumptive elephant viewing are depicted. In addition, the results show two outcomes for the viewing with cropping options (3 and 4) in which the SACIM ivory price varied between 20 and 60 percent of the pre-ban price. The results confirm those of Table 10.1, namely: that cropping had little or no economic use value. However, introduction of safari hunting could have increased the value of elephant by between 34 and 55 percent. This finding was in general agreement with that of Martin (1990a) who indicated that, in Zimbabwe, sport hunting (safari hunting) was an important contributor to elephant use values.

Table 10.3 shows the results of the 1992 analysis. This also shows the degree to which the results are affected by different assumptions about displacement/disturbance due to consumptive use. The findings of 1990 were again confirmed, even more strongly. Introduction of safari hunting could increase elephant use values by between 34 and 59 percent. The introduction of cropping, on the other hand, could be expected to actually decrease the economic use value of elephant or, at best, if it caused no displacement or disturbance, result in a very small value increase.

<table>
<thead>
<tr>
<th>Use option (scenario)</th>
<th>15-year net present value @ 6%* (pula'000,000, 1992)</th>
<th>Degree of displacement/disturbance assumed**</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>None</td>
<td>Moderate</td>
</tr>
<tr>
<td>1. Viewing only with no consumptive uses</td>
<td>123.5</td>
<td>123.5</td>
</tr>
<tr>
<td>2. Viewing with safari hunting only</td>
<td>196.1</td>
<td>181.5</td>
</tr>
<tr>
<td>3. Viewing with cropping only</td>
<td>130.1</td>
<td>122.6</td>
</tr>
<tr>
<td>5. Viewing, safari hunting and cropping</td>
<td>202.3</td>
<td>181.2</td>
</tr>
</tbody>
</table>

* Value added over 15 years to national income, net of government expenditures, after discounting at six percent and after shadow pricing (April 1992)

** Displacement/disturbance effect of safari hunting and cropping on viewing activities (see text)
Table 10.4 shows the results of a sensitivity analysis on the 1992 model in which the flow of government expenditure on elephant management was varied. Different rates of increase in expenditure were tested for the different use combinations. The first expenditure category was the base case for the model and the others involved expenditures increasing to the level of P510 per square kilometre at different rates (over five, ten and 15 years). The analysis provides an idea as to what extent the potential use values for elephant can justify possible increases in government expenditure on elephant management. The results suggest, as expected, that the options with safari hunting stand a much better chance of justifying high expenditures on elephant protection.

Table 10.4: Effect of different scenarios for government expenditure on elephant management on economic net present values* of different options for elephant utilisation in Botswana in the 1992 analysis

<table>
<thead>
<tr>
<th>Expenditure category***</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Base case (costs rising from P16 to P242 per km² over 15 years)</td>
<td>123.5</td>
<td>181.5</td>
<td>122.6</td>
<td>181.2</td>
</tr>
<tr>
<td>2. Slow increase (costs rising from P16 to P510 per km² over 15 years)</td>
<td>84.0</td>
<td>142.0</td>
<td>83.2</td>
<td>141.8</td>
</tr>
<tr>
<td>3. Medium increase (costs rising from P16 to P510 per km² in first 10 years)</td>
<td>-1.5</td>
<td>56.5</td>
<td>-2.3</td>
<td>56.3</td>
</tr>
<tr>
<td>5. Fast increase (costs rising from P16 to P510 per km² in first 5 years)</td>
<td>-20.0</td>
<td>37.8</td>
<td>-20.9</td>
<td>37.6</td>
</tr>
</tbody>
</table>

* Value added over 15 years to national income, net of government expenditures, after discounting at six percent and after shadow pricing (April, 1992)
** Use options, one to three and five, as listed in Table 10.3
*** Different patterns of increase to a stable maximum for government expenditure on elephant management over the northern range (49,000 square kilometres)
It is of interest to know what the contribution of the different products of elephant use made to the overall value. To get an idea of this, the proportional value attributable to each product within the total was determined for each management option analysed. Table 10.5 shows this for the management options which included viewing, safari hunting and cropping in 1989, 1990 and 1992. Notable in Table 10.5 is the high proportion of elephant-use value attributable to cropping (39.4 percent) in the 1989 valuation. The values resulting from cropping had dropped to 3.9 percent of total use value in 1990 and 2.2 percent of the total in

<table>
<thead>
<tr>
<th>Table 10.5: Proportional contributions of different use categories to the economic present values of elephant use* in Botswana in the 1989, first 1990 and 1992 analyses</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Year of analysis</strong></td>
</tr>
<tr>
<td><strong>1989</strong></td>
</tr>
<tr>
<td>Total present value** (pula '000,000)</td>
</tr>
<tr>
<td><strong>Use Category</strong></td>
</tr>
<tr>
<td>Tourism - viewing</td>
</tr>
<tr>
<td>Tourism - safari hunting</td>
</tr>
<tr>
<td>Cropping - raw ivory</td>
</tr>
<tr>
<td>Cropping - ivory carving</td>
</tr>
<tr>
<td>Cropping - fresh or dried meat***</td>
</tr>
<tr>
<td>Cropping - Meat processing****</td>
</tr>
<tr>
<td>Cropping - dry salted hides</td>
</tr>
<tr>
<td>Cropping - hide tanning</td>
</tr>
<tr>
<td>Cropping - live sale (calves)*****</td>
</tr>
<tr>
<td><strong>Total</strong></td>
</tr>
</tbody>
</table>

* Management options including viewing, safari hunting and cropping for each year of analysis
** Present values for June 1989 and October 1990, and net present value for April 1992; all at 1989 prices
*** Carcass value after field recovery and field dressing
**** Including (in 1989) use of meat as feed in crocodile breeding and rearing for production of skins and meat, and (in 1992) production of carcass meal
***** Sale of calves between six months and one year old
1992. Various forward linkages into processing were important in 1989. Product processing made up 23.2 percent of total use value, and 59 percent of cropping value, in 1989. Hides from cropping made up 10.3 percent of total value in June 1989, when international markets were open. In 1990, with demand for hides limited to that for utility leather in regional markets, this had dropped to 0.8 percent. The value of raw ivory from cropping dropped from 8.7 percent of total use value in 1989, to 2.3 percent in 1990 and to nothing in 1992. In 1989 the value of raw ivory could be enhanced by some 48 percent through carving. It is notable that even in 1989, the total value of ivory was not more than 16.6 percent of total use value.

10.7 Chapter conclusion

Resources such as the elephant of Botswana have value (or not) at global, national and local levels of society. In the international community it is perceived as a global resource. Non-use values have relevance here, but in attempting to prevent loss of elephant, the international community has tended to use prohibition and sanctions rather than to invest. National governments of elephant range states see elephant as a national resource and invest in it (or not) depending mainly on elephant values as perceived by the national society. Lack of religious or ethical elephant values, poverty and development pressure in Africa ensure that these are dominated by use values. Elephant management at national scale has tended to fail, due to weak property rights and government. The value of elephant for district and local communities, in elephant areas, is crucial to the existence of elephant. Such communities, are poor, lack basic needs and, of necessity, aspire to tangible use values. Lack of common property rights over elephant has meant that this species has had little long-term use for communities. Except in a few countries, ivory poaching and land-use conversion have been the rule.

Elephants in Africa are threatened in two main ways: poaching for ivory and displacement by people. The CITES Appendix I listing and resulting prohibition on trade in products of the African elephant, combined with other forms of demand suppression have reduced poaching, ivory prices and illegal ivory trade in Africa. This has helped slow the species decline, particularly in countries where investment in elephant existence has been inadequate, and where de facto open access poaching prevails. By itself, the trade ban cannot save elephant.
With rural human populations doubling every 30 years, wildlife areas which contribute little to human development, will be converted to uses which do. Unless there is a long-term competitive role for wildlife and elephant in the development of African countries, they will continue to disappear.

In Botswana poaching levels have been low and investment in land for, and management of, elephant have been adequate enough to result in increasing numbers. Here, in the next 15 years, most of the elephant range will be occupied by expanding human and livestock populations unless wildlife, dominated by elephant, can contribute use values in excess of those of livestock. The bulk of elephant values which can be captured in Botswana are direct use values. The CITES trade prohibition reduced these to half (53 percent) of what they were in 1989. It thus jeopardised the future of elephant in Botswana. This most likely also applies in Zimbabwe, Namibia and South Africa.

The results above show that, before the ban, 44 percent of the potential use value of elephant was that of non-consumptive use. After the ban 70 percent of the total value was attributable to this. The results in Table 10.4 suggest that these values are insufficient to justify increased investments in elephant protection, let alone to counteract the opportunity costs of land involved. Norton-Griffiths and Southey (1995) found, in Kenya, that non-consumptive use values are insufficient to meet the opportunity costs of the land set aside for wildlife.

It is likely that elephant in Botswana will need to generate higher values than at present, if they are to survive. Introduction of safari hunting tourism will help. The results in Table 10.4 show that safari hunting tourism, which made up 26 percent of the post-trade ban potential use value, could be important in providing economic justification for dramatically increased investment in elephant. The possibility (since June 1997) for Botswana to sell small amounts of its ivory stocks to users in Japan (or all its ivory stocks to donors for destruction) in future, will also help. However, Botswana should continue to examine all ways of fully regaining use values lost as a result of the trade ban. The latter has often been referred to as the "ivory ban" since it is targeted at reducing demand for poached ivory. But ivory made up only 42 percent (and raw ivory only 28 percent) of the economic use value which was lost in Botswana as a result of the ban (Table 10.5). Even the full resumption of ivory marketing through SACIM would involve direct, raw ivory sale and thus recover only eight percent of
original total use value. The bulk (58 percent) of use values lost relate to products which cannot be poached on large scale.

Proposals which have been made for lifting trade prohibition on non-ivory products, clearly have merit for Botswana. They would allow renewed development of markets and possible recovery of a significant portion of lost resource value. They would also not result in poaching elsewhere. If, for example, the 1989 value of processed hides alone could have been realised in 1992, then the total use value (Table 10.3) could have been enhanced by 16 percent. Botswana should also investigate ways of developing market mechanisms through which elephant non-use values (if they are found to be significant) can be captured sustainably.

Communities in Africa could invest in elephant existence if assisted by national governments and the international community. Governments should give local communities rights, and apply funds, to assist them to control poaching of (access to) elephant. They should also create a policy and investment environment to ensure that local communities derive use values from natural populations of elephant. The international community should assist governments and local communities with funds and expertise to develop sustainable systems to invest in and use elephant. The findings above are in agreement with those of Barbier et al. (1990).

Much research and analysis should focus on the ways in which economic value can be maximised. The preceding analysis provides several pointers for this. Use values for communities should be maximised, and priority should be given to developing complementary combinations of uses, including non-consumptive values as well as age-specific consumptive uses (safari hunting). Where they can be controlled and managed sustainably, consumptive uses derived from cropping, for management reasons, should be included. Research and analysis should also be focused on non-use, existence and option values, if and where they exist. These should be directed as positive transfers from the international community, via local communities, into investment in natural elephant populations. The use of elephant as a key species within natural populations generally has a high positive impact on conservation.

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Chapter 11

Wildlife product processing

11.1 Introduction

A commonly held view is that much potential value added is being lost because there is not sufficient processing of wildlife products in Botswana. The feeling is that government needs to embargo or tax the export of raw products to force the development of processing industries. There is, however, little information on the financial and economic viability of wildlife product processing.

The analysis presented previously in chapter 10 on elephant use values showed that while, in the past, processing of elephant hides and ivory could have contributed significant value added, it no longer can, owing to international trade prohibition. The analyses in chapters 8 and 9, on policy for live ostrich and crocodile exports, have illustrated that rigid policies are unwise. Government intervention in the promotion, or not, of processing should be flexible, able to respond to changing economic conditions, and limited to the provision of incentives.

11.2 Review of financial and economic viability

Meat processing

Westcott (1984), Joubert et al. (1983) and Drew and Schwarting (1994) described commercial production of venison in South Africa and Namibia for export to Europe. This generally involves mobile abattoir and centralised jointing or chilling facilities. It is restricted to European Union (EU) beef export veterinary zones and, even then, requires sophisticated
techniques and relatively well-developed infrastructure, to be able to meet the stringent EU veterinary health restrictions. FGU-Kronberg (1988a) concluded that due mainly to the poor transport conditions in most of Botswana, this type of production would be restricted to commercial farms, notably those in the Tuli Block in the Limpopo region. This has been borne out with experience (J. de Ryckman de Berz, managing director, Eximbo (Pty) Ltd., pers. comm.).

Generally, movement and export of ostrich and crocodile meat should be relatively unrestricted since they do not carry the diseases responsible for movement restrictions. They fall into the category of "other species" of Foggin (1989). The development of an ostrich abattoir in Botswana has been proposed a number of times. However, the ostrich industry, described in chapter 8, is constrained by the small local market for ostrich meat and the prerequisite of a relatively specialised, sophisticated abattoir for meat exports. The lucrative export market for live ostrich is expected to decline in the future, making such facilities imperative.

The Department of Industrial Affairs (DIA, 1990) studied the market for processed meat in Botswana and found that no permits had ever been given by Department of Veterinary Services for the export of processed meats. The reason for this is not clear, but there appear to be no technical reasons why it should not be possible to pass (or upgrade and pass) existing plants for export. DIA also found considerable excess capacity in local meat processing, which is complementary to slaughter and marketing of meat, mostly red meat. This suggests that the industry, some four firms, could readily be modified to accommodate ostrich slaughter for export in Botswana. A new facility for ostrich, appears not to be necessary or appropriate. Drew and Schwarting (1994) have analysed the markets for, and financial viability of, export of high value venison from Namibia to Germany. The markets are somewhat specialised but significant relative to the amounts Botswana or Namibia could produce. The profitability of meat processing for export tends, however, to be low.

The crocodile industry, described in chapter 9, has an important product in tail meat. However, given the constraints on expansion in the industry, it is considered that much of this production can be absorbed within the local tourism and restaurant industry. Where this is not
possible, export markets need to be established with approval from the Department of Veterinary Services.

A consulting firm, (GITEC, GmbH., 1984), in assessing the potential for agro-industrial development in Botswana, identified a single medium-scale cannery enterprise for promotion. This would cut costs of game meat for export to a limited gourmet market in Europe. FGU-Kronberg (1988a) developed a concept financial model for this and found it financially attractive. This is a potential market for crocodile meat. As mentioned in chapter 10, elephant meat from an elephant culling programme would provide a large source of meat which could be dried for sale in neighbouring Zimbabwe, or used to produce carcass meal. Both would be financially unattractive and provide little in the way of value added.

Much wildlife meat produced in Botswana is low quality dried meat which is either home consumed or sold locally within or between villages. As discussed above, there is little chance of upgrading this for marketing in the modern sector or for export. FGU Consulting + Engineering (1991) surveyed the commercial market for dried game meat products in Botswana and estimated the potential at 164 tonnes per annum, of which 80 tonnes was low quality for local sale. Economic Consultancies (Pty.) Ltd. (1985) assessed the financial viability of small scale, high quality, beef biltong manufacturing in eastern Botswana for the modern sector market and found it financially attractive. Bronson (1990) assessed the market and financial attractiveness of small-scale production of lower quality beef biltong for rural markets. Again this was financially attractive. The use of game meat in this type of enterprise is feasible in the community-based wildlife use projects described in chapter 6.

Medium- to large-scale chemical tanning and taxidermy

There exists a long established chemical tanning and taxidermy industry involving medium and large businesses based in the larger rural centres in Botswana. This developed largely as a result of the safari hunting sector and the licensed hunting system (von Richter, 1969), but later expanded to make use of imported raw materials particularly elephant, zebra and buffalo hides and skins. Kaye (1982) pointed out that, in 1982, the quality of products produced was competitive in export markets although the imposition of prohibitive export taxes limited the
industry to so-called luxury products. Thus, concentration was focused on elephant, zebra, ostrich, predator and decorative antelope skins and their associated products.

FGU-Kronberg (1988a) considered that this type of specialisation should be encouraged as these higher value skins are devalued if processed by small producers using less sophisticated techniques. However, due to the international ban on trade in elephant hides (chapter 10) the industry was left with much unused capacity. It was also recommended at the time, that export duties for wildlife products be removed, since they were prohibitive. It was proposed that chemical tanning and taxidermy be promoted in fields or aspects that were not likely to block development of smaller-scale tanning and craft production enterprises in remote settlements.

Small-scale tanning and craft production

Opportunities for the development of rural industries in the more remote rural settlements tend to be limited due to a paucity of resources, and the reliance is heavily on crafts production, commonly involving wildlife products. Small group tanneries and crafts production projects were initiated at various sites in Botswana and parastatal marketing channels established. These appear to have been characterised by a high incidence of failures. Reasons commonly given for failure have been raw material shortages and management collapse. As pointed out by Kaye (1982) and White (1986b), products of rural enterprises, which use vegetable tanning techniques (improved bush tanning) are inferior to those of the larger-scale urban chemical tanners.

FGU-Kronberg (1988a) developed a concept financial model representative of a small-scale tanning and crafts manufacturing enterprise making use of data from Environmental Services, Botswana (1986) and Brown (1983b). The enterprise modelled, would utilise raw materials from community-based wildlife cropping activities (chapter 6). The system was found to have notably lower profitability for users than the associated game cropping. It was concluded that the activity was risky and tended to be squeezed between the raw materials producer and the larger, more sophisticated urban tanneries, who compete for the raw materials. It is likely that this competition underlies the financial difficulties experienced by enterprises of this type in Botswana.
FGU-Kronberg (1988a) concluded that activities in small-scale tanning and crafts production should be promoted wherever possible. This was in view of the desperate need for productive employment in the remote settlements, the importance of these activities in community-based, rural institution development and the fact that these activities required little capital. It was considered that efforts should be concentrated on products which did not compete directly with those of the large urban enterprises, for example, decorated ostrich eggs, fly-whisks, utility leathers and leather clothing for local sale, bushman hunting kits, and leather thongs.

Infield (1986a, 1986b) developed financial models for tanning and leatherwork with wildlife skins from a protected area in KwaZulu-Natal, South Africa. Tanning at the scale possible was not profitable but the manufacture of leather products was. Combining tanning, leatherwork, crafts manufacture and meat sales in one enterprise resulted in a weak profit as leatherwork cross-subsidised the other activities.

Terry (1997) has used a methodological approach almost identical to that used in this thesis to determine financial and economic worth of various crafts producing activities. Activities examined included medium-scale group leatherwork in an urban setting, and small-scale skin work in a rural village setting in Kalahari region. The leatherwork involved purchase of imported, chemically tanned, cow leather to make bags, sandals, belts and other items. This resulted in a high financial and economic return. The skinwork model involved small-scale use of vegetable-tanned game or goat skins for production of bags, skirts, mats and bushman hunting sets. Here the financial rate of return over ten years was 35 percent, higher than all other small-scale crafts activities except wood-carving. Skinwork was also very economically efficient. A financial and economic model is presented below for a rural group tanning and leatherwork enterprise.

*Ivory and other jewellery production*

Botswana’s ivory carving industry, centred around Francistown began in 1975. This initially concentrated on the manufacture of beads, bangles and lighters but later began manufacturing carved figurines. As described in chapter 10, this continued to 1989. A financial and economic enterprise model was developed for ivory carving which showed it to be of relatively high profitability, a finding confirmed by another study (Economic Consultancies,
Martin (1984) and Shrestha (1988) pointed out, that the industry was constrained by a shortage of raw material since the elephant population of Botswana was not being utilised. Due to the 1989 ban on international trade in ivory the industry has completely collapsed, and, as described in chapter 10, would almost certainly not be revived, even if ivory marketing was resumed.

Terry (1997) has developed several financial and economic models for small-scale traditional jewellery production. Ostrich eggshell beadwork, to produce necklace strands, bracelets and belts, by women is a fairly common cash-earning activity in wildlife areas. With a financial rate of return, over ten years, of 26 percent, this activity was clearly financially attractive, and compared well with others such as basketry and wood-carving. It was also found to be very economically efficient.

11.3 A financial and economic model

A financial and economic enterprise model has been developed of a group tanning and leatherwork enterprise in a rural village setting in Kalahari region. This is a group activity involving about 25 small-scale women tanners and leather workers. The model involves vegetable tanning, where the root of the suffrutescent shrub, mositsane (Elephantorrhiza elephantina), is applied to livestock and game skins. Only one quarter of the skins involved are from wildlife, the rest are from sheep and goats. Lockhart-Smith and Elliot (1974) and Infield (1986a, 1986b) both demonstrate the clear economies of scale with tanning of non-luxury leather. For this reason the enterprise model is structured to include not only livestock skins but also small-scale, roadside-inn and restaurant activities, which contribute 17 percent of turnover in the base-case. The main leather items produced in the model are traditional aprons and trousers for marketing to schools, bags, belts, hats, mats, chair leathers and karosses.

In the base case for the model throughput was around 2,700 skins per annum, or 225 per month. Since this typical example involved some slack capacity, a sensitivity analysis was done with increasing throughput.
Table 11.1 shows the financial and economic characteristics of the model. It is clear that the enterprise project has no financial viability and even when the throughput of skins is almost doubled it only breaks even. However, when values are converted to economic ones, the activity contributes positively in terms of gross value added. When throughput is almost doubled, the enterprise becomes truly economically efficient resulting in annual gross value added, and economic rate of return of 12 percent and an economic net present value of P43,064. Economic viability as shown is due, primarily, to the project’s value as an employment creator.

The base case model, as developed, would require to buy raw skins from at least one third of the Kalahari region, and from both livestock keepers and producers a well as community-based wildlife utilisation projects in the wildlife management areas. If throughput were to be increased the catchment area for skins would increase proportionally. These findings confirm those of Infield (1986a, 1986b) described above, and those of Schotthoefer (1991) who evaluated a tanning and leatherwork enterprise of the type described in the model.

11.4 Chapter conclusion

Wildlife product processing has shown significant potential for generating contributions in value added in the cases of elephant hide tanning and ivory carving. These development options have now been eliminated by the ban on international trade in elephant products. There appears to be potential for expansion of processing in ostrich meat production for export, crocodile meat production for export, small-scale biltong manufacture and sale within community wildlife use projects, small-scale tanning and leather work, and small-scale jewellery manufacture, notably ostrich eggshell beadwork and decorated ostrich egg production. Some of these activities, notably the small scale ones, appear to have good financial profitability, but some are not financially viable. However, all appear to have economic viability, particularly small-scale tanning and leatherwork. They are all worthy of promotion, primarily because of their role in job creation in the rural areas. The main constraint to the expansion of product processing will be the availability of sufficient raw materials. Since product processing is best sited near to markets in urban or peri-urban settings, and involves the most intensive land use of all activities, it is not associated with the preservation of wildlife habitats and biological diversity.
Table 11.1: Illustrative financial and economic characteristics for a group, small-scale tanning and leatherwork enterprise in the Kgalagadi region, showing the effect of doubling throughput, Botswana (pula ’000, 1990)

<table>
<thead>
<tr>
<th>Characteristic by variation in throughput of skins</th>
<th>2,700 skins*</th>
<th>4,500 skins</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Item</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Financial analysis</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Initial capital investment</td>
<td>274</td>
<td>282</td>
</tr>
<tr>
<td><em>At stability (full production)</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual gross income (sales)</td>
<td>117</td>
<td>178</td>
</tr>
<tr>
<td>less Variable costs</td>
<td>51</td>
<td>76</td>
</tr>
<tr>
<td>Gross margin</td>
<td>66</td>
<td>102</td>
</tr>
<tr>
<td>less Fixed costs</td>
<td>101</td>
<td>102</td>
</tr>
<tr>
<td>Annual net cash income</td>
<td>-35</td>
<td>0</td>
</tr>
<tr>
<td><em>Financial worth over ten years</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Financial rate of return</td>
<td>-**</td>
<td>-</td>
</tr>
<tr>
<td>Financial net present value (@ 12%)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Economic analysis</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Capital outlays</td>
<td>286</td>
<td>295</td>
</tr>
<tr>
<td><em>At stability</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual revenues</td>
<td>129</td>
<td>196</td>
</tr>
<tr>
<td>less Operating costs</td>
<td>104</td>
<td>131</td>
</tr>
<tr>
<td>Annual gross value added***</td>
<td>25</td>
<td>65</td>
</tr>
<tr>
<td><em>Economic worth over ten years</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Economic rate of return (%)</td>
<td>-</td>
<td>12.2%</td>
</tr>
<tr>
<td>Economic net present value (@ 6%)</td>
<td>-</td>
<td>43</td>
</tr>
</tbody>
</table>

* Throughput of 2,700 skins per annum represents the base case
** Rate of return or net present value is negative
*** Gross value added to national income
Part III

The whole wildlife sector
Chapter 12

Economic characteristics of the wildlife sector as a whole

12.1 Introduction

Chapters 4 to 11 in this thesis deal with values for specific wildlife utilisation activities. In this chapter, the economic characteristics of the whole sector are addressed.

First information on the aggregate values for the whole sector is reviewed and presented. Then the different components of the sector are compared using data and results drawn from chapters 4 to 11. Here, nine wildlife use activities and one livestock production activity are compared.

12.2 Specific methods

Aggregate values for the sector

Several approaches were used to arrive at estimates of the value added by the wildlife sector to the national income. These are described in detail in FGU-Kronberg (1988b). For the tourism, commercial production and the secondary trade sectors, a list of 156 firms involved in, and associated with, wildlife use, mostly wildlife viewing, was compiled from various sources. These sources included the licensing office in the Department of Wildlife and National Parks, the National Accounts Division in the Ministry of Finance and Development Planning and The Hotel and Tourism Association of Botswana. A sample of 70 audited financial statements (balance sheets and income statements) for 1986, from among these firms was obtained. The statements were used to derive mean values for fixed assets, turnover,
wages and salaries, directors emoluments, amortisation, interest, depreciation, tax, licences, duties and rentals. This provided the components of value added (returns to labour, to management and to and of capital). Because they are not incremental, the values presented in this section, "aggregate values for the sector", are not shadow priced, as is the case for all other value added calculations presented in this thesis. Thus, they conform with conventional national accounting aggregates. Notably they are also only attributable to first-round spending within the wildlife sector. Indirect value added, resulting from forward and backward linkages, and induced value added, resulting from multiplier effects, are not included.

The means derived from the sample were then applied to extrapolate values for the whole sector using estimates of the numbers of enterprises. Variation in firm size and structure necessitated adjustment for this during extrapolation. The Hotel and Tourism Association of Botswana assisted with a subjective assessment of relative size and level of activity for all firms in the industry. In addition, the proportion of turnover attributable to wildlife use was considered for various activities. In the case of tourism the following proportions were applied: safari-hunting firms, 100 percent; mobile safari firms, 100 percent; game lodges/camps, 100 percent; safari motels, 30 percent; other town hotels, ten percent; travel agents, 20 percent; airlines, ten percent; air charter firms, 20 percent; restaurants, ten percent; bars/bottle-stores, five percent. The proportions assumed are listed above with the sub-sector and these are partly based on questionnaire results obtained by Fowkes (1985) and assumptions made by Thusty (1987). The attributable portions were further split, where necessary, between wildlife-viewing tourism and safari-hunting tourism.

The 1986 values were converted to 1991 estimates by simply adjusting for growth and inflation. Inflation was assumed to be 10.85 percent, the average rate in Botswana at the time (CSO, 1987c). Growth rate was assumed to be eight percent, i.e., the real growth rate of the economy as a whole.

To ascertain the contribution of licensed and subsistence hunting, the well established hunting licence system was used as a base. Here, various records and estimates of the numbers of different species taken under different licences, and the proportion taken illegally were multiplied with estimates of carcass value for the various species. Information from Ngami
Data Services (1986), Murray (1976, 1978), Lee (1979) and Silberbauer (1981) was used to assist with the calculations, which are described in detail in FGU-Kronberg (1988b).

The relative proportions of value added and intermediate consumption in licensed and subsistence hunting were derived using concept models developed in the Department of Wildlife and National Parks, as well as information from Murray (1978), Fleming (1976) and von Richter (1976). As a result it was assumed that 19 percent of the gross output is attributable to intermediate consumption (ammunition, transport, etc.).

For comparison, a corresponding estimate was made of the gross value added for wildlife-viewing tourism using expenditure data directly from tourists themselves - the 1992 tourism expenditure survey described in chapter 4. Here tourists’ trip expenditures made within Botswana were elicited from a sample of 212 wildlife-viewing tourists. The total number of wildlife-viewing tourists visiting Botswana was estimated at 64,000 in 1989 by Borge et al. (1990), which when adjusted for eight percent general growth to 1991 becomes 74,650. The mean expenditure made by wildlife-viewing tourists within Botswana in 1992 was P3,114. This was deflated for growth and inflation to 1991 and multiplied by the total number of tourists (75,000) to get aggregate gross output.

Comparison of wildlife and livestock land uses

Representative examples of financial and economic models for wildlife-viewing tourism (chapter 4), safari-hunting tourism (chapter 5), community wildlife use (chapter 6), game ranching and beef production (chapter 7), ostrich farming (chapter 8), crocodile farming/ranching (chapter 9), elephant cropping (chapter 10) and wildlife product processing/craft manufacture (chapter 11) were compared using various criteria. First, their financial and economic internal rates of return, and their economic net present values per unit of land or unit of initial capital were extracted for comparison. Second, a policy analysis matrix, was developed, as applied by Jansen et al. (1992). In this case financial and economic values for turnover, domestic and tradable costs and net benefits (net cash income and net value added) were compared. The degree to which they differ and some likely reasons involving market imperfections and/or policy were discussed. Other data extracted from the models for comparison included their relative use of capital per unit of land, their production
of gross value added per unit of capital, their use of labour resources per unit of capital and their use of management resources per unit of capital. Finally, the relative effects that each activity has on biological diversity conservation was subjectively estimated. It is noteworthy, however, that traditional livestock keeping, as opposed to commercial livestock production (ranching), has not been modelled in this thesis.

The thesis deals only with direct use values and (as stated in chapter 2) a basic rule for sustainability in the wildlife sector must be that there is no net loss of indirect use and non-use values in the allocation of resources. Thus, an important consideration is the degree to which various wildlife use activities reduce or enhance non-use values. The subjective assessments on this, made in preceding chapters, were extracted and used to provide rationale for zoning of land uses. Here, hypothetical land rent triangles (as described by Barlowe, 1986) were plotted for various wildlife-based land uses, along a gradient reflecting all of the following changes: high to low wilderness quality, high to low biological diversity, and remote to urban.

12.3 Results and discussion

Aggregate values for the sector

Table 12.1 shows the results of the operator/owner study on aggregate values for the contribution to national income in the wildlife sector, made in 1986 and adjusted for general growth and inflation to 1991. A total gross output of P124.5 million contains gross value added amounting to P53.0 million and net value added amounting to P49.0 million. Wildlife viewing dominates, contributing 55 percent of gross output, 38 percent of gross value added and 35 percent of net value added. For the whole sector the proportions of the annual gross value added and net value added to gross output were 42.6 and 39.4 percent respectively. In the case of wildlife viewing these proportions were 29.7 and 25.2 percent, respectively.

In a different study, undertaken in 1989, Borge et al. (1990) also investigated operators/owners involved in wildlife viewing. When their 1989 estimate of gross output is adjusted to 1991 for general inflation and growth in the same way, it is P50.2 million. The proportion of wildlife-viewing gross output in Table 12.1 which accrues to travel agencies, air
transport and other enterprises (i.e., is not attributable directly to operators) is 27.76 percent. Removing this leaves P49.0 million, which is reassuringly close to P50.2 million.

Borge et al. (1990) also surveyed operators to estimate gross output for safari hunting. Their gross output adjusted to 1991 in the same way is P14.8 million. The proportion of safari-hunting gross output in Table 12.1, which is not attributable directly to operators, is 4.8 percent. When this is subtracted, P15.0 million is left; again very close to the adjusted estimate of Borge et al. (1990).

Table 12.1: Aggregate values for the wildlife sector in Botswana, estimated from the operator/owner study (1996, adjusted* to 1991 values, pula '000)

<table>
<thead>
<tr>
<th>Wildlife use category</th>
<th>Economic aggregate</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Gross output</td>
<td>Gross</td>
<td>Net</td>
</tr>
<tr>
<td></td>
<td></td>
<td>value added**</td>
<td>value added***</td>
</tr>
<tr>
<td>Wildlife viewing</td>
<td>67,856</td>
<td>20,176</td>
<td>17,079</td>
</tr>
<tr>
<td>Safari hunting</td>
<td>15,795</td>
<td>8,317</td>
<td>7,811</td>
</tr>
<tr>
<td>Licensed and subsistence hunting</td>
<td>21,403</td>
<td>17,336</td>
<td>17,336</td>
</tr>
<tr>
<td>Commercial wildlife production</td>
<td>2,632</td>
<td>1,365</td>
<td>1,299</td>
</tr>
<tr>
<td>Secondary trade and processing</td>
<td>13,194</td>
<td>5,274</td>
<td>5,034</td>
</tr>
<tr>
<td>Government (excluding revenue)</td>
<td>3,625</td>
<td>521</td>
<td>500</td>
</tr>
<tr>
<td>**Totals</td>
<td>124,506</td>
<td>52,989</td>
<td>49,060</td>
</tr>
<tr>
<td>Percentage of gross output</td>
<td></td>
<td>42.6%</td>
<td>39.4%</td>
</tr>
</tbody>
</table>

* Adjusted for inflation (10.85 percent per annum) and general economic growth (eight percent per annum)
** Gross value added to national income (gross output less intermediate consumption)
*** Net value added to national income (gross value added less depreciation)

The corresponding gross output estimate for wildlife-viewing tourism in 1991, derived from tourists themselves (the 1992 tourism expenditure survey described in chapter 4) is P194.2 million, or 2.9 times the operator-based estimate in Table 12.1. It is also 4.0 times the "pure"
operator gross output of P49.0 million. Borge et al. (1990) also surveyed tourists themselves. Their estimate of total wildlife-viewing tourist expenditures within Botswana, adjusted to 1991, is P124.7 million. This is 2.48 times their estimate of operator gross output (P50.2 million).

The wide differences between estimates based on operators and those based on tourists can be partially explained from studies which provide more detailed analysis of tourists’ expenditures. Borge et al. (1990) found that 42 percent of tourists’ expenditures made within Botswana were made on items such as airfares, food/beverages, park fees, transport, lodging, curios, clothes, film/cameras and camping equipment, which were not part of holiday packages paid to operators. In neighbouring Namibia in 1992, a survey of 850 tourists by Hoff and Overgaard Planning Consultants (1993) found that among holiday tourists only 40 percent of expenditure made during the stay in Namibia was for accommodation (including food and drinks). The remaining 60 percent was spent on domestic air transport, other transport, independent restaurants, organised tours and excursions, handicrafts and shopping. An even more recent survey of tourists arriving by air in Namibia involved 7,500 respondents (Deloitte & Touche Consulting Group, 1997) and found that only 28 percent of tourists’ in-country expenditures was made on accommodation, food and drinks.

Thus, tourist-based surveys of gross output could be expected to yield 1.7 to 3.6 times as much as operator-based surveys. This helps explain the differences found above. Two other possible explanations exist. Tourists may have over-estimated their expenditures, and/or operators, for tax avoidance/evasion reasons, may not have declared all of their Botswana income, which would have been lost through leakage.

The results in Table 12.1 for value added owing to wildlife viewing are clearly underestimates in terms of contribution to the national economy. They are, instead, primarily measures of wildlife use enterprise activity. As such, however, they are appropriate as the base for costbenefit models, as applied in this thesis.

The contribution of the wildlife sector to gross national income (P53 million in Table 12.1) can be equated roughly with that for gross domestic product. It can also be adjusted to incorporate a corresponding estimate for value added for wildlife viewing based on tourist expenditures. This results in an estimate of the contribution of the wildlife sector to gross
domestic product of P91.3 million, which, in 1991, amounted to 1.6 percent of the total gross domestic product. This result can be compared with those from an almost identical exercise carried out by myself in Namibia in 1996 (Barnes and Ashley, 1996), where the wildlife sector is estimated to have contributed 2.8 percent of the gross domestic product.

Comparison of different wildlife and livestock land uses

Table 12.2 shows the financial and economic internal rates of return over ten years for base-case models for the different activities. For the land uses which involve tourism in the high-value northern areas of the country, economic rates of return are consistently much higher than financial ones. For land uses in the less well-endowed parts of the country, the tendency is for rates of return to be lower and for economic rates to be only slightly higher than financial ones. As already established in chapters 7 and 9, in the cases of cattle ranching and crocodile farming, the financial rates of return are in fact higher than the economic ones. In the case of crocodile ranching this is due to the heavy reliance on tradable inputs (feed), the economic prices of which carry a foreign exchange premium. In the case of cattle ranching, it is due to the effects of subsidies described in chapter 7. Cattle ranching and product processing have economic rates of return below the six percent economic discount rate.

Table 12.2 also shows the economic net present values (over ten years at six percent discount rate) per unit of land required and per unit of initial capital (for those activities which had positive economic net present values). Where wildlife viewing is possible, it shows relatively high economic returns per square kilometre of land. Community wildlife use projects in the Kalahari region have particularly low economic returns per unit area (although higher than commercial cattle ranching which has a negative economic net present value). The intensive animal production systems make very efficient use of land since they require very little of it. The economic net present value per thousand pula of initial capital is relatively high for the land uses involving tourism in the north. Among the other land uses, game ranching shows up as being inefficient in use of capital.
Table 12.2: Comparative results from financial and economic cost-benefit models for typical wildlife/rangeland use enterprises in Botswana (1991 prices)

<table>
<thead>
<tr>
<th>Wildlife/rangeland use</th>
<th>Financial (percent)</th>
<th>Economic (percent)</th>
<th>per square kilometre of land</th>
<th>per P'000 initial capital</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wildlife viewing</td>
<td>18</td>
<td>28</td>
<td>10,177</td>
<td>1,551</td>
</tr>
<tr>
<td>Safari hunting</td>
<td>16</td>
<td>38</td>
<td>694</td>
<td>2,230</td>
</tr>
<tr>
<td>Community use, high-value area*</td>
<td>26</td>
<td>67</td>
<td>589</td>
<td>5,225</td>
</tr>
<tr>
<td>Community use, low-value area*</td>
<td>15</td>
<td>17</td>
<td>22</td>
<td>931</td>
</tr>
<tr>
<td>Game ranching</td>
<td>6</td>
<td>7</td>
<td>600</td>
<td>44</td>
</tr>
<tr>
<td>Cattle ranching</td>
<td>9</td>
<td>2</td>
<td>&lt;0**</td>
<td>&lt;0</td>
</tr>
<tr>
<td>Ostrich farming</td>
<td>18</td>
<td>19</td>
<td>2,301,548</td>
<td>950</td>
</tr>
<tr>
<td>Crocodile farming</td>
<td>18</td>
<td>11</td>
<td>2,565,398</td>
<td>525</td>
</tr>
</tbody>
</table>

* Community-based wildlife use projects in high-value area (Chobe enclave project, chapter 6) and low-value area (Ngwaketse project, chapter 6)
** Net present value negative

Table 12.3 shows the results of the policy analysis matrix. The analysis is done on the static, annualised component of the financial and economic models. In the table, "community use, high value and low value", refer to community-based wildlife use projects in high-value areas (Chobe enclave project, chapter 6) and low-value areas (Ngwaketse project, chapter 6) respectively, and "product processing" refers to a medium-scale tanning enterprise (Mabutsane project, chapter 11). The analysis is done from the point of view of the owner or operator of the enterprise or activity. It shows that the enterprise benefits from policy effects and/or price distortions only with regard to their tradable costs. This is almost entirely due to the distortion which results from under-valuation of foreign exchange. With domestic factor
Table 12.3: Effects of policy and/or market imperfections on the income, costs and net benefits associated with ten typical wildlife/rangeland use activities in Botswana, derived using policy analysis matrices

<table>
<thead>
<tr>
<th>Wildlife use</th>
<th>Income or cost component of use activity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Gross income</td>
</tr>
<tr>
<td><strong>Wildlife viewing</strong></td>
<td></td>
</tr>
<tr>
<td>Effect of policy/market imperfections**</td>
<td>-153,573</td>
</tr>
<tr>
<td>% deviation from economic value***</td>
<td>-9.1%</td>
</tr>
<tr>
<td><strong>Safari hunting</strong></td>
<td>-71,401</td>
</tr>
<tr>
<td>% deviation from economic value</td>
<td>-9.1%</td>
</tr>
<tr>
<td><strong>Community use, high-value area</strong></td>
<td>-54,126</td>
</tr>
<tr>
<td>Effect of policy/market imperfections</td>
<td>-9.1%</td>
</tr>
<tr>
<td>% deviation from economic value</td>
<td></td>
</tr>
<tr>
<td><strong>Community use, low-value area</strong></td>
<td>-10,194</td>
</tr>
<tr>
<td>Effect of policy/market imperfections</td>
<td>-9.1%</td>
</tr>
<tr>
<td>% deviation from economic value</td>
<td></td>
</tr>
<tr>
<td><strong>Game ranching</strong></td>
<td>-24,178</td>
</tr>
<tr>
<td>Effect of policy/market imperfections</td>
<td>-9.1%</td>
</tr>
<tr>
<td>% deviation from economic value</td>
<td></td>
</tr>
<tr>
<td><strong>Cattle ranching</strong></td>
<td>-19,681</td>
</tr>
<tr>
<td>Effect of policy/market imperfections</td>
<td>-9.1%</td>
</tr>
<tr>
<td>% deviation from economic value</td>
<td></td>
</tr>
<tr>
<td><strong>Ostrich farming</strong></td>
<td>-156,040</td>
</tr>
<tr>
<td>Effect of policy/market imperfections</td>
<td>-9.1%</td>
</tr>
<tr>
<td>% deviation from economic value</td>
<td></td>
</tr>
<tr>
<td><strong>Crocodile farming</strong></td>
<td>-201,389</td>
</tr>
<tr>
<td>Effect of policy/market imperfections</td>
<td>-9.1%</td>
</tr>
<tr>
<td>% deviation from economic value</td>
<td></td>
</tr>
<tr>
<td><strong>Elephant cropping</strong></td>
<td>-87,783</td>
</tr>
<tr>
<td>Effect of policy/market imperfections</td>
<td>-9.1%</td>
</tr>
<tr>
<td>% deviation from economic value</td>
<td></td>
</tr>
<tr>
<td><strong>Product processing</strong></td>
<td>-19,807</td>
</tr>
<tr>
<td>Effect of policy/market imperfections</td>
<td>-9.1%</td>
</tr>
<tr>
<td>% deviation from economic value</td>
<td></td>
</tr>
</tbody>
</table>

* Comparison of the financial net cash income with the net value added to national income
** Deviation from economic values from the investor's point of view. For gross income and net benefits, the economic value is subtracted from the financial one. For costs, the financial value is subtracted from the economic one
*** The effect as a percentage of the economic value
costs, financial values are much higher than economic ones primarily due to taxes on production but also because of costs associated with loan financing. This is reflected in the net benefits, where financial net cash income is always lower than economic net value added. The distortion here is lowest in the case of crocodile farming. This is to be expected considering the results described in Table 12.2 for economic rates of return derived from ten-year cost-benefit models. One would expect the same with cattle ranching but here, the high capital financing costs and the generally low profitability make the deviation larger in percentage terms.

Table 12.4 shows the intensity of capital use per unit of land required. As expected, this is very high for the intensive animal farming systems and the product processing. It is low for safari hunting and elephant cropping, very low for community wildlife use and relatively high for game ranching, cattle ranching and wildlife viewing. Also in Table 12.4 the return in gross value added per unit of initial capital (the efficiency of capital use) is high for community wildlife use projects in high value areas. Capital use efficiency is low for cattle ranching, game ranching and product processing and it is moderate for the other activities.

Column four in Table 12.4 shows a measure of labour intensity, and this is particularly high for community wildlife use projects and product processing. These all represent community projects with a wide participatory base so the finding is to be expected. The last column in the table shows a measure of management intensity. Here, the community wildlife use projects and elephant cropping have relatively high values while the wildlife farming and ranching activities have relatively low values.

Figure 12.A, based on concepts outlined by Barnes (1993), shows a hypothetical plot depicting land rent triangles for various wildlife-based land uses along a gradient reflecting all of the following changes: high to low wilderness quality, high to low biological diversity, and remote to urban. As can be seen from the figure, the highest values that can be captured in the most remote sites, where biological diversity is high, are likely to be non-use values. The Okavango delta is well known internationally and it is likely that international willingness to pay for its preservation is significant. Next to these, the net economic values of wildlife viewing (which is profitable only in sites of high quality) are the highest per unit of land as
seen in Table 12.2. Safari hunting can make profitable use of less valuable land but still requires a reasonable diversity of species for hunting.

Table 12.4: Comparative resource use efficiencies and requirements for typical wildlife/rangeland use enterprises in Botswana (1991 prices)

<table>
<thead>
<tr>
<th>Wildlife/rangeland use</th>
<th>P'000 capital* /square km.</th>
<th>Gross value added**/P'000 capital</th>
<th>Labour hours/ P'000 capital</th>
<th>Management hours/ P'000 capital</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wildlife viewing</td>
<td>6.56</td>
<td>462</td>
<td>50.15</td>
<td>4.18</td>
</tr>
<tr>
<td>Safari hunting</td>
<td>0.31</td>
<td>512</td>
<td>41.76</td>
<td>6.96</td>
</tr>
<tr>
<td>Community use, high value***</td>
<td>0.11</td>
<td>1,066</td>
<td>114.79</td>
<td>17.22</td>
</tr>
<tr>
<td>Community use, low value***</td>
<td>0.02</td>
<td>418</td>
<td>235.19</td>
<td>35.28</td>
</tr>
<tr>
<td>Game ranching</td>
<td>13.78</td>
<td>137</td>
<td>7.17</td>
<td>1.43</td>
</tr>
<tr>
<td>Cattle ranching</td>
<td>7.61</td>
<td>95</td>
<td>12.90</td>
<td>2.58</td>
</tr>
<tr>
<td>Ostrich farming</td>
<td>2,422.61</td>
<td>265</td>
<td>12.94</td>
<td>0.81</td>
</tr>
<tr>
<td>Crocodile farming</td>
<td>4,884.85</td>
<td>378</td>
<td>20.06</td>
<td>2.41</td>
</tr>
<tr>
<td>Elephant cropping</td>
<td>0.60</td>
<td>660</td>
<td>43.51</td>
<td>10.88</td>
</tr>
<tr>
<td>Product processing****</td>
<td>2,904.79</td>
<td>153</td>
<td>168.69</td>
<td>6.75</td>
</tr>
</tbody>
</table>

* Initial capital requirements in economic prices
** Gross value added to the national income per annum
*** Community-based wildlife use projects in high-value area (Chobe enclave project, chapter 6) and low-value area (Ngwaketse project, chapter 6)
**** Medium-scale tanning enterprise (chapter 11)

Further along the gradient, human populations appear and increase while wildlife diversity declines. Safari hunting becomes less profitable but other, generally relatively low-value, primarily consumptive uses (such as community-based, small scale, wildlife cropping for local markets) remain viable. Wildlife and cattle ranching are capital-intensive and involve varying degrees of restocking, so they can be developed in areas which have relatively high disturbance and low wildlife diversity and numbers. These enterprises tend to be profitable closer to urban markets. Their profitability, as investments, is generally low, but it can be
reasonably high per unit of land. Finally, as one approaches urban sites of highest disturbance and lowest biological diversity, intensive wildlife farming (ostrich and crocodiles) take over as being relatively highly profitable. These capital intensive enterprises (the category includes product processing) are dependent for profitability on being close to markets for both high-value products and high-cost inputs. Thus, there tends to be a distinct sequence of zones along the gradient, best suited to different land uses.

Figure 12.B takes this concept a little further in including all non-use and indirect use values (not just the better known non-use values likely to be captured). It shows them diminishing along the same gradient. This could just as well be the inverse of the effect that the land uses have on non-use and indirect use values. Allocation of land for wildlife and other rangeland uses along the gradient in the sequence indicated will, thus, tend to maximise use values as well as ensure no net loss of non-use and indirect use values. Site suitability is a dominant influence in land allocation within the wildlife sector. The zones described are economically appropriate, but they also tend to be necessary in terms of the site requirements of the various wildlife and rangeland use activities. Although the characteristics of uses and resources are such that there is little overlap in physical site suitabilities, zones should not be rigid in prescribing permissible uses. The primary criteria for zoning should be safe minimum standards, to ensure no net loss of indirect use and non-use values.

12.4 Chapter conclusion

Based on the operator/owner study done for 1986, the total gross output in the wildlife sector in Botswana in 1991 was estimated to be P124.5 million, of which 42.6 percent (P53.0 million) was gross value added, and 39.4 percent (P49.0 million) was net value added, to the national income. Another study of operators (Borge et al., 1990) estimated gross output for wildlife viewing and safari hunting. These results, also adjusted to 1991, are remarkably similar to mine. Studies based on expenditure surveys of tourists themselves, give much higher estimates of the gross output resulting from wildlife-viewing tourism. This is at least partly because much tourist expenditure is not through the enterprises of tourism operators, but it could also be because of leakage or survey bias (over-estimation). The operator-based study results are best suited to be the base for cost-benefit analysis models such as those in chapters 10 and 13. An estimate, based on the findings, above, indicates that, in 1991,
Figure 12.A: Hypothetical land rent triangles for different Botswana wildlife and rangeland use activities, along a gradient of environmental quality, showing zones where specific activities can be given priority.
Figure 12.B: Hypothetical spread of different Botswana wildlife and rangeland use activities, along a gradient of environmental quality, showing the relationship with likely non-use and indirect use values for wildlife.
wildlife contributed 1.6 percent of total gross domestic product. A comparable estimate for Namibia in 1996 shows the wildlife sector to have contributed 2.8 percent of gross domestic product.

The various wildlife uses which have potential on land designated for wildlife, as well as commercial livestock (cattle) ranching, in Botswana, have particular places in terms of site suitability. A suite of resource allocation is appropriate, ranging from wilderness in the most remote, least disturbed areas, through tourism uses in less disturbed areas, to capital-extensive but people-intensive land uses in moderately disturbed areas, and further to capital-intensive ranching and farming systems in the most disturbed areas close to urban centres. Land-use zoning which embraces these considerations, within a set of safe minimum standards, is likely to result in optimal combinations of direct use values as well as no net loss of non-use and indirect use values.
Chapter 13

Allocation of resources in the wildlife sector

13.1 Introduction

Chapters 4 to 11 in this thesis deal with values for specific wildlife utilisation activities. In chapter 12, the whole wildlife sector and its various components were examined together. In this chapter the most appropriate allocation of resources within the sector, within a public policy land-use planning framework which allows no net loss of non-use and indirect use values, is addressed. The effect of a ban on the consumptive use of wildlife would have on optimal allocation and attainable direct use values is also determined.

First, a simple linear mathematical programming model is developed to determine the combination of wildlife use and livestock production activities which maximises income in the sector. Nine wildlife use activities and one livestock production activity are considered for all land in Botswana allocated to wildlife use. Second, a cost-benefit analysis model is developed to examine the returns (of direct use values) to ongoing and planned public investment in the sector.

Other studies on land resource allocation

The literature is replete with examples of where linear programming has been used for planning in agriculture and forestry. Linear programming models to optimise enterprise combinations on ranches and farms are illustrated by Jameson et al. (1974) in Colorado and Griffith and Zepeda (1994) in Costa Rica. Glover and Conner (1988) and Bernado et al. (1994) developed ranch level models in Texas and Oklahoma, which included deer utilisation
and habitat among the livestock production activities being examined. McBryde (1995) used a linear programming model at ranch level to determine optimal amounts of supplementary feeding and food plot provision for white-tailed deer in Texas. Dykstra (1984) illustrated, with case studies, the use of linear programming for minimising soil loss at local level, optimising forest harvesting in the United States (USA), optimising yield in deer harvesting in New Zealand, and optimising a municipal tax base through land-use planning at the local level in the USA.

In South Africa, Bosch and von Gadow (1990) used a linear programme to analyse the trade-off between afforestation and catchment run-off. Lyne et al. (1989) developed a fairly sophisticated linear programming model to illustrate farm household decision-making in the rural communal lands of KwaZulu-Natal. This incorporated stepped demand and supply functions. Davies (1994) described the method as a potential tool in game-ranch planning but, to date, no empirical studies applying the method to wildlife in Africa are known. Ortmann (1986, 1987, 1988) described various aspects of a regional linear programming planning model for all agricultural land dominated by the South African sugar industry. This was a sophisticated analysis incorporating stepped demand functions for crops and a stepped supply function for labour, as well as the effect of risk. It was used to determine the effects of policies, such as the introduction of a free market and the introduction of ethanol production from sugar, on the sugar industry. A similar study was undertaken by Meyer and van Zyl (1992), investigating the effects of a free market on the whole agricultural sector in Northern province, South Africa. My thesis apparently contains the first example of a linear programming analysis of a wildlife sector.

None of the studies, referred to above, entail shadow pricing and all are formulated in financial terms. White and Wadsworth (1994) used a dynamic simulation model to analyse the trade-off between sheep grazing and grouse shooting, and the tenure effects, in British heather moorland, but the values derived are financial, i.e., those of the resource user. Other studies where land-use trade-offs were analysed include that of Loomis et al. (1989) on Idaho public lands, who compared marginal wildlife values derived from a travel-cost model with values for livestock derived from linear programming. They also include that of Quigley et al. (1991) who compared various private land grazing strategies in Oregon, and Howard and Valerio (1996) who compared net present values in examining trade-offs between natural
forest management and agricultural land-use options in Costa Rica. Again, all of these studies are in financial values. In addition at least two of them (White and Wadsworth, 1994; Quigley et al., 1991) did not consider fixed costs in their comparison of different land uses. This is not essential with analyses at farm/ranch or household level but at a broader scale it is highly desirable. The linear programming model in this chapter optimises an economic measure; the addition to national welfare (national income) resulting from the use of wildlife resources/land, and it explicitly incorporates fixed costs.

I can trace no other examples where central government investments in wildlife sectors have been compared with attributable direct use-value benefits in a cost-benefit framework. The sectoral cost-benefit model in this chapter appears to represent the first explicit example of its kind. In the USA, US Secretary of the Interior (1988) used cost-benefit farm simulation models to evaluate the effects of federal policy on wetlands. This analysis was accompanied by coefficients of variation, characterising seasonal variation in farm production, which were measures of farming risk. This approach is not followed in my models but, as described in chapter 2, my financial discount rate incorporates a risk premium of six percent.

13.2 Specific methods

Linear programming maximises (or minimises) a linear function of variables that are subject to linear inequalities which must assume non-negative levels. Commonly the function to be maximised, the objective function, consists of the sum of income or net income from a combination of several activities. The linear inequalities, or constraints, are arranged as an input-output matrix of coefficients, representing the resources or constraints consumed or supplied per unit of activity. The computation starts with a situation where all resources are idle, and involves a logical iterative procedure introducing new activities and changing the levels of activity of previously introduced activities. Each iteration results in a new solution with an increase in total income or net income and this continues until no more positive gains can be made.

The linear programming method has the advantage over non-linear optimisation methods in that data requirements are generally limited to activity/enterprise models such as those applied in this thesis and a knowledge of the resource constraints for the activities involved. The
method is suited to, and has been used widely, in agricultural planning (Barnard and Nix, 1979; Doll and Orazem, 1984; Epplin and Stoecker, 1989). The limitations to the method include the necessary assumption that production functions are of fixed proportion and do not permit input substitution.

Representative examples of financial and economic models for wildlife-viewing tourism (chapter 4), safari-hunting tourism (chapter 5), community wildlife use (chapter 6), game ranching (chapter 7) cattle ranching (chapter 7), ostrich farming (chapter 8), crocodile farming/ranching (chapter 9), elephant cropping (chapter 10) and wildlife product processing/craft manufacture (chapter 11) were used in a linear programming model, based on 1991, and which was set up in a Quattro Pro version 2 computer spreadsheet system. The formal description of the model is given in chapter 2 and its specific structure is illustrated in Table 13.1. A spacial analysis of the extent of land suitable and available for each activity was made to incorporate the land constraints. The data in chapter 12, above, as well as that in chapters 4 to 11, were used to determine the dimensions of the other constraints to the activities.

The model maximised an objective function with ten activities, within a set of 24 constraints with capital as the numeraire. The constraints could be divided into those that were relatively rigid and easily delineated, and those that were expandable and less easily determined. Rigid constraints included, for example, availability of factors such as: suitable land/habitat, feed, initial stock, stock "on-the-hoof", raw materials, and off-take quotas. Effectively, the supply of these items in the model was assumed to be perfectly price-inelastic. The expandable and indeterminate constraints were capital, labour and management. Supply of these was, in effect, assumed to be perfectly price-elastic. Since the latter three tend to be linked, they were varied (increased) simultaneously as part of the sensitivity analysis carried out on the model. This sensitivity analysis brought an element of dynamism to the analysis. The framework of constraints was assumed to be that which would affect expansion of activities over a 15-year period. Since products tend to be price-inelastic (see chapter 4), expansion in the sector was assumed to be dependent on growth in overall demand. The model was run to
Table 13.1: The linear programming model of the wildlife sector in Botswana (1991)

Objective functions to be maximised:

<table>
<thead>
<tr>
<th>[GVA]</th>
<th>( Y ) = 462a + 512b + 1066c + 418d + 137e + 95f + 265g + 378h + 660i + 153j</th>
</tr>
</thead>
<tbody>
<tr>
<td>or:</td>
<td>[ENPV] ( Z ) = 1,551a + 2,230b + 5,225c + 931d + 44e + 0f + 950g + 525h + 0i + 0j</td>
</tr>
</tbody>
</table>

Subject to constraints:

<table>
<thead>
<tr>
<th>[Capital]</th>
<th>1a + 1b + 1c + 1d + 1e + 1f + 1g + 1h + 1i + 1j &lt;= 50,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>[Labour]**</td>
<td>50.15a + 41.76b + 114.79c + 225.19d + 7.17e + 12.90f + 12.94g + 20.06h + 43.51i + 168.69j &lt;= 2,940,000</td>
</tr>
<tr>
<td>[Mgmt]**</td>
<td>4.18a + 6.96b + 17.22c + 35.28d + 1.43e + 2.58f + 0.81g + 2.41h + 10.88i + 6.75j &lt;= 196,000</td>
</tr>
<tr>
<td>[Land a]**</td>
<td>0.15a + 0b + 0c + 0d + 0e + 0f + 0g + 0h + 0i + 0j &lt;= 38,371</td>
</tr>
<tr>
<td>[Land b]</td>
<td>0a + 0b + 8.87c + 0d + 0e + 0f + 0g + 0h + 0i + 0j &lt;= 11,981</td>
</tr>
<tr>
<td>[Land c]</td>
<td>0a + 0b + 0c + 41.51d + 0e + 0f + 0g + 0h + 0i + 0j &lt;= 132,991</td>
</tr>
<tr>
<td>[Land d]</td>
<td>0a + 0b + 0c + 0d + 0e + 0.07f + 0g + 0h + 0i + 0j &lt;= 62,800</td>
</tr>
<tr>
<td>[Land e]</td>
<td>0a + 0b + 0c + 0d + 0e + 0.1f + 0g + 0h + 0i + 0j &lt;= 4,774</td>
</tr>
<tr>
<td>[Land f]</td>
<td>0a + 0b + 0c + 0d + 0e + 0f + 0g + 0h + 0i + 0j &lt;= 3,000</td>
</tr>
<tr>
<td>[Land g]</td>
<td>0a + 0b + 0c + 0d + 0e + 0f + 0g + 0.0002h + 0i + 0j &lt;= 1,500</td>
</tr>
<tr>
<td>[Land h]</td>
<td>0a + 0b + 0c + 0d + 0e + 0f + 0g + 0h + 0i + 0.0003j &lt;= 2,000</td>
</tr>
<tr>
<td>[Land i]</td>
<td>0a + 0b + 0c + 0d + 0e + 0f + 0g + 0h + 0i + 0j &lt;= 13,800</td>
</tr>
<tr>
<td>[Land j]</td>
<td>0a + 0b + 0c + 0d + 1.61e + 0f + 0g + 0h + 0i + 0j &lt;= 30,000,000</td>
</tr>
<tr>
<td>[Stock e]</td>
<td>0a + 0b + 0c + 0d + 0e + 0f + 0g + 0h + 0i + 0j &lt;= 800</td>
</tr>
<tr>
<td>[Stock f]</td>
<td>0a + 0b + 0c + 0d + 0e + 0f + 0.95g + 0h + 0i + 0j &lt;= 4,000</td>
</tr>
<tr>
<td>[Stock g]</td>
<td>0a + 0b + 0c + 0d + 0e + 0f + 0g + 0h + 0i + 0j &lt;= 50,000</td>
</tr>
<tr>
<td>[Stock h]</td>
<td>0a + 0b + 0c + 0d + 0e + 0f + 0g + 0h + 0i + 0j &lt;= 1,398,738</td>
</tr>
<tr>
<td>[Stock i]</td>
<td>0a + 0b + 0c + 0d + 0e + 0f + 0g + 0h + 0i + 0j &lt;= 22,572</td>
</tr>
<tr>
<td>[Stock j]</td>
<td>0a + 0b + 0c + 0d + 0e + 0f + 0g + 0h + 0i + 0j &lt;= 328,000</td>
</tr>
<tr>
<td>[Feed k]</td>
<td>0a + 0b + 0c + 0d + 0e + 0f + 0g + 190.89h + 0i + 0j &lt;= 88,000</td>
</tr>
<tr>
<td>[Feed l]</td>
<td>0a + 0b + 0c + 0d + 0e + 0f + 0g + 0h + 0i + 0j &lt;= 40,000</td>
</tr>
<tr>
<td>[Raw mat. k]</td>
<td>0a + 0b + 0c + 0d + 0e + 0f + 0g + 0h + 0i + 0j &lt;= 190.89j</td>
</tr>
<tr>
<td>[Market l]</td>
<td>0a + 0b + 87.47c + 25.65d + 0e + 0f + 0g + 0h + 0i + 0j &lt;= 12.95j</td>
</tr>
<tr>
<td>[Market m]</td>
<td>0a + 0b + 0c + 0d + 0e + 0f + 0g + 0h + 0i + 0j &lt;= 12.95j</td>
</tr>
<tr>
<td>[Market n]</td>
<td>0a + 0b + 0c + 0d + 0e + 0f + 0g + 0h + 0i + 0j &lt;= 12.95j</td>
</tr>
<tr>
<td>[Market o]</td>
<td>0a + 0b + 0c + 0d + 0e + 0f + 0g + 0h + 0i + 0j &lt;= 12.95j</td>
</tr>
<tr>
<td>[Market p]</td>
<td>0a + 0b + 0c + 0d + 0e + 0f + 0g + 0h + 0i + 0j &lt;= 12.95j</td>
</tr>
<tr>
<td>[Market q]</td>
<td>0a + 0b + 0c + 0d + 0e + 0f + 0g + 0h + 0i + 0j &lt;= 12.95j</td>
</tr>
<tr>
<td>[Market r]</td>
<td>0a + 0b + 0c + 0d + 0e + 0f + 0g + 0h + 0i + 0j &lt;= 12.95j</td>
</tr>
<tr>
<td>[Market s]</td>
<td>0a + 0b + 0c + 0d + 0e + 0f + 0g + 0h + 0i + 0j &lt;= 12.95j</td>
</tr>
<tr>
<td>[Market t]</td>
<td>0a + 0b + 0c + 0d + 0e + 0f + 0g + 0h + 0i + 0j &lt;= 12.95j</td>
</tr>
<tr>
<td>[Market u]</td>
<td>0a + 0b + 0c + 0d + 0e + 0f + 0g + 0h + 0i + 0j &lt;= 12.95j</td>
</tr>
<tr>
<td>[Market v]</td>
<td>0a + 0b + 0c + 0d + 0e + 0f + 0g + 0h + 0i + 0j &lt;= 12.95j</td>
</tr>
<tr>
<td>[Market w]</td>
<td>0a + 0b + 0c + 0d + 0e + 0f + 0g + 0h + 0i + 0j &lt;= 12.95j</td>
</tr>
<tr>
<td>[Market x]</td>
<td>0a + 0b + 0c + 0d + 0e + 0f + 0g + 0h + 0i + 0j &lt;= 12.95j</td>
</tr>
<tr>
<td>[Market y]</td>
<td>0a + 0b + 0c + 0d + 0e + 0f + 0g + 0h + 0i + 0j &lt;= 12.95j</td>
</tr>
<tr>
<td>[Market z]</td>
<td>0a + 0b + 0c + 0d + 0e + 0f + 0g + 0h + 0i + 0j &lt;= 12.95j</td>
</tr>
</tbody>
</table>

Where:

- \( Y \) = Aggregate gross value added to national income for sector
- \( Z \) = Aggregate economic net present value for sector
- \( a \) = Wildlife viewing
- \( b \) = Safari hunting
- \( c \) = Community wildlife use - high value area****
- \( d \) = Community wildlife use - low value area****
- \( e \) = Game ranching
- \( f \) = Cattle ranching
- \( g \) = Ostrich farming
- \( h \) = Crocodile farming/ranching
- \( i \) = Elephant cropping
- \( j \) = Product processing****

*Labour and management measured in numbers of labourers and managers

**Land, measured in square kilometres, reflects the extent of suitable or available land/habitat

***Constraint in terms of limits to existing stock or availability of initial stock

****Community-based wildlife use projects in high value area (Chobe enclave project, chapter 6) and low value area (Ngwaketse project, chapter 6)

*****Medium scale tanning projects (chapter 11)
maximise either annual gross value added\(^1\) or ten-year net present value (where the latter was positive). It was also run, as stated previously, to optimise combinations involving either all wildlife uses or only non-consumptive uses.

The cost-benefit model for public investment was developed using the projected expansion of capital and recurrent expenditures to be made by the Department of Wildlife and National Parks, as initiated within the seventh National Development Plan (NDP7) (Ministry of Finance and Development Planning, 1991). The projected expenditures for six years from 1991 were extracted from the plan and extrapolated using various rates and patterns of growth over 15 and 30 year periods. These cost streams were compared with the incremental flow of net value added\(^2\) from the use of wildlife (and some livestock) on land designated for wildlife use, where uses were developed in combinations approaching those found to be optimal, above. The measure of benefits embraced only net value added resulting from first round spending within the sector. Neither value added associated with indirect impacts (forward and backward linkages), nor that associated with induced impacts (the multiplier) were included. The assumption was made that the expansion of private investment in these land uses would attain full utilisation of the capacity of the resources within 15 years. Thereafter, expansion in wildlife and livestock land uses would be limited to the possibilities for relaxation of some of the rigid constraints, described for the optimisation model above. In this regard, new market development and intensification of some activities could result in continued growth of the sector after year 15.

Growth rates in wildlife use for the initial 15 years were based on anticipated expansion as part of the implementation of new land-use allocation plans (N.D. Hunter, Director, Department of Wildlife and National Parks, 1992, pers. comm.) and the wildlife conservation and tourism policies (Government of Botswana, 1986, 1990). Of particular importance was the anticipated rate of expansion in overall demand for wildlife-viewing tourism since, in chapter 4, it was determined that demand tended to be price-inelastic.

---

1. Note the gross value added, as used here, is measured in terms of economic (shadow) prices and is thus an economic efficiency measure

2. All cost and benefit values in the cost-benefit model for the sector were measured in terms of economic or shadow prices
Because data showing trends and projections of tourist numbers are scarce, a combination of recorded growth rates for tourism from other sources were combined to derive a mean estimate of the rate of increase in overall demand. The sources were: Brown et al. (1995b), Ceballos-Lascurrán (1993), Blaza (1996), J. Scheepers (Statistician, Resorts Division, Directorate of Environmental Affairs, Ministry of Environment and Tourism, Namibia, 1996, pers. comm.), Bond (1996) and Ecotourism Society (1995). The mean value derived was 12.5 percent. The assumption was made that the demand for other wildlife products and services would also be price-inelastic, so that growth in income reflects growth in overall demand. Rates of demand growth for the other products were subjectively determined based on observed trends. These growth rates ranged between three and six percent per annum. It was assumed that expansion of livestock development on a small part of wildlife land could be rapid.

Because of uncertainty regarding future government expenditure patterns, sensitivity analysis was conducted on these. The base-case involved the assumption that after year six, annual capital expenditures would remain at the levels of the last year of NDP7, and recurrent expenditures would rise at four percent per annum. A low-cost model involved recurrent expenditure growth of two percent per annum after year six, while high-cost models involved this growth at six and eight percent per annum. The last high-cost projection (that with eight percent growth) represented current (NDP7) growth rates. The analysis was done involving either all wildlife use or only non-consumptive wildlife use.

13.3 Results and discussion

Optimal combinations of wildlife use

Table 13.2 shows results of the base-case linear programming analysis. Here the optimal allocation of capital on wildlife land is shown for all wildlife uses and livestock production, where gross value added is maximised and where levels of capital, labour and management are varied. The availability, in 1991, of capital, labour and management is not known exactly but estimated at around levels "2" or "3" in the table. As the economy expands over the following 15 years it is reasonable to assume that the levels "7" or "8" will be attained. This would mean a rate of expansion of availability of these resources of some eight percent.
The results suggest that in the early years of expansion, emphasis should be placed on the rapid expansion of just three activities: wildlife viewing, crocodile production and ostrich production. They also suggest that later on additional capital should be applied to safari

Table 13.2: Optimal allocation of capital to maximise gross value added in all wildlife use and/or livestock production on land allocated to wildlife in Botswana at different levels of availability of capital, labour and management (pula '000,000, 1991)

<table>
<thead>
<tr>
<th>Constraint or wildlife/rangeland use</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital (P'000,000)</td>
<td>50</td>
<td>100</td>
<td>150</td>
<td>200</td>
<td>250</td>
<td>300</td>
<td>350</td>
<td>400</td>
</tr>
<tr>
<td>Labour (number)</td>
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<td>3,000</td>
<td>4,500</td>
<td>6,000</td>
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<td>300</td>
<td>400</td>
<td>500</td>
<td>600</td>
<td>700</td>
<td>800</td>
</tr>
<tr>
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<td>88.81</td>
<td>134.95</td>
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<td>227.23</td>
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<td>12.15</td>
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<td>1.35</td>
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<td>Cattle ranching</td>
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<td>-</td>
<td>-</td>
<td>-</td>
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<td>52.63</td>
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<tr>
<td>Ostrich farming</td>
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<td>29.49</td>
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<td>7.33</td>
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<tr>
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<td>250.00</td>
<td>300.00</td>
<td>350.00</td>
<td>388.13</td>
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</tbody>
</table>

* Community-based wildlife use projects in high-value area (Chobe enclave project, chapter 6) and low-value area (Ngwaketse project, chapter 6)

** Medium scale tanning enterprise (chapter 11)
hunting, community wildlife-use projects and then to all the other uses. By year 15 at level "8" further development is impossible given the constraints in the model. Any further development in the sector will be dependent on relaxation of these constraints, for example, through intensification, market development and increased stock or raw material availability.

Table 13.3 shows the same model when economic net present value is maximised. In this case, commercial livestock production (cattle ranching), elephant cropping and product

<table>
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<tbody>
<tr>
<td>Capital (P'000,000)</td>
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<td>150</td>
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<td>250</td>
<td>300</td>
<td>350</td>
<td>400</td>
</tr>
<tr>
<td>Labour (number)</td>
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<td>4,500</td>
<td>6,000</td>
<td>7,500</td>
<td>9,000</td>
<td>10,500</td>
<td>12,000</td>
</tr>
<tr>
<td>Managers (number)</td>
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<td>109.68</td>
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<td>248.11</td>
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<td>255.81</td>
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<tr>
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<td>12.15</td>
<td>12.15</td>
<td>12.15</td>
<td>12.15</td>
<td>12.15</td>
<td>12.15</td>
</tr>
<tr>
<td>Community use, high*</td>
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<td>1.35</td>
<td>1.35</td>
<td>1.35</td>
<td>1.35</td>
<td>1.35</td>
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<td>1.35</td>
</tr>
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<td>3.20</td>
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</tr>
<tr>
<td>Game ranching</td>
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<td>-</td>
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<td>8.57</td>
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</tr>
<tr>
<td>Ostrich farming</td>
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<td>7.33</td>
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<td>300.00</td>
<td>332.86</td>
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</tbody>
</table>

* Community-based wildlife use projects in high-value area (Chobe enclave project, chapter 6) and low-value area (Ngwaketse project, chapter 6)
processing are excluded because their economic net present values are negative. These results suggest that in the early years of expansion, wildlife viewing, safari hunting, ostrich production, and community wildlife use in high-value areas, should be the focus of investment.

Table 13.4 is the same as Table 13.2 except that only non-consumptive wildlife uses are considered. Here, emphasis is almost exclusively on wildlife viewing which is (or can be) a component of some community wildlife uses or game ranching. Cattle ranching becomes

<table>
<thead>
<tr>
<th>Constraint or wildlife/rangeland use</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital (P’000,000)</td>
<td>50</td>
<td>100</td>
<td>150</td>
<td>200</td>
<td>250</td>
<td>300</td>
<td>350</td>
<td>400</td>
</tr>
<tr>
<td>Labour (number)</td>
<td>1,500</td>
<td>3,000</td>
<td>4,500</td>
<td>6,000</td>
<td>7,500</td>
<td>9,000</td>
<td>10,500</td>
<td>12,000</td>
</tr>
<tr>
<td>Managers (number)</td>
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<td>200</td>
<td>300</td>
<td>400</td>
<td>500</td>
<td>600</td>
<td>700</td>
<td>800</td>
</tr>
<tr>
<td>Wildlife viewing</td>
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<td>93.78</td>
<td>140.67</td>
<td>187.56</td>
<td>234.45</td>
<td>255.81</td>
<td>255.81</td>
<td>255.81</td>
</tr>
<tr>
<td>Community use, high*</td>
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<td>-</td>
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<td>-</td>
<td>0.81</td>
<td>0.81</td>
<td>0.81</td>
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</tr>
<tr>
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<td>-</td>
<td>-</td>
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<td>0.48</td>
<td>0.48</td>
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</tr>
<tr>
<td>Game ranching</td>
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<td>8.57</td>
<td>8.57</td>
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<td>Cattle ranching</td>
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<td>187.56</td>
<td>234.45</td>
<td>296.40</td>
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<td>296.88</td>
</tr>
</tbody>
</table>

* Community-based wildlife use projects in high-value area (Chobe enclave project, chapter 6) and low-value area (Ngwaketse project, chapter 6)
important as an investment later during expansion. Table 13.5 is the equivalent of Table 13.3 where only non-consumptive wildlife uses are considered. The result is identical to that in Table 13.4 except that livestock is excluded (having a negative economic net present value).

Table 13.5: Optimal allocation of capital to maximise net present value in non-consumptive wildlife use and/or livestock production on land allocated to wildlife in Botswana at different levels of availability of capital, labour and management (pula '000,000, 1991)

<table>
<thead>
<tr>
<th>Constraint or wildlife/rangeland use</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
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<tbody>
<tr>
<td>Capital (P'000,000)</td>
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<td>200</td>
<td>250</td>
<td>300</td>
<td>350</td>
<td>400</td>
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<tr>
<td>Labour (number)</td>
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<td>3,000</td>
<td>4,500</td>
<td>6,000</td>
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<tr>
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<td>93.78</td>
<td>140.67</td>
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<td>234.45</td>
<td>255.81</td>
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<td>255.81</td>
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<td>-</td>
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<td>0.48</td>
<td>0.48</td>
</tr>
<tr>
<td>Game ranching</td>
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<td>234.45</td>
<td>265.19</td>
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* Community-based wildlife use projects in high-value area (Chobe enclave project, chapter 6) and low-value area (Ngwaketse project, chapter 6)

Tables 13.6 to 13.9 all show results from models maximising gross value added. Table 13.6 depicts the increase in the total number of enterprises, land required and yield in gross and net value added over optimal expansion in the sector. Totals are extracted for the wildlife uses only and also for the whole sector (with wildlife and livestock activities together). This is intended for comparison with Table 13.7, where only non-consumptive wildlife uses have been
included in the model. It can be calculated from the tables, that a ban on consumptive uses of wildlife would result in 26 percent less wildlife use enterprises, 16 percent less gross value added from wildlife, 18 percent less net value added from wildlife, and would require 75 percent less land for wildlife use. The inclusion of livestock production in the suite of land uses would diminish these effects slightly.

Table 13.6: Total numbers of enterprise units, values generated and land required for optimal combinations of all wildlife use and/or livestock production, maximising gross value added, on land allocated to wildlife in Botswana at different levels of availability of capital, labour and management (1991)

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<th>Constraint or category</th>
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<td>200</td>
<td>250</td>
<td>300</td>
<td>350</td>
<td>400</td>
</tr>
<tr>
<td>Labour (number)</td>
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<td>4,500</td>
<td>6,000</td>
<td>7,500</td>
<td>9,000</td>
<td>10,500</td>
<td>12,000</td>
</tr>
<tr>
<td>Managers (number)</td>
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<td>300</td>
<td>400</td>
<td>500</td>
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<td>700</td>
<td>800</td>
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<table>
<thead>
<tr>
<th>Number of enterprises</th>
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<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Wildlife only</td>
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<td>68</td>
<td>102</td>
<td>136</td>
<td>171</td>
<td>212</td>
<td>253</td>
<td>261</td>
</tr>
<tr>
<td>Wildlife and livestock</td>
<td>274</td>
<td>330</td>
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</table>

<table>
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<tbody>
<tr>
<td>Wildlife only</td>
<td>22.49</td>
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<td>89.56</td>
<td>111.92</td>
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<tr>
<td>Wildlife and livestock</td>
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<td>148.88</td>
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</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Net value added (P'000,000)</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Wildlife only</td>
<td>17.94</td>
<td>35.59</td>
<td>53.22</td>
<td>70.85</td>
<td>88.49</td>
<td>106.27</td>
<td>114.61</td>
<td>115.02</td>
</tr>
<tr>
<td>Wildlife and livestock</td>
<td>115.56</td>
<td>118.20</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Land required (hectares '000,000)</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Wildlife only</td>
<td>0.65</td>
<td>1.35</td>
<td>2.05</td>
<td>2.76</td>
<td>3.46</td>
<td>7.03</td>
<td>20.89</td>
<td>26.31</td>
</tr>
<tr>
<td>Wildlife and livestock</td>
<td>21.10</td>
<td>27.01</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Tables 13.8 and 13.9 show the spread, of the same yields/requirements as Tables 13.6 and 13.7, across the various wildlife use/livestock production activities. Comparison between the two tables shows the changes to be expected if consumptive wildlife use is excluded from the suite of activities. Most notable is the reduction of 81 percent in the land required for community wildlife use. Generally, there is a small drop in the contribution of wildlife use to the economy (because of the overall dominance of wildlife viewing) but a large reduction in

Table 13.7: Total numbers of enterprise units, values generated and land required for optimal combinations of non-consumptive wildlife use and/or livestock production, maximising gross value added, on land allocated to wildlife in Botswana at different levels of availability of capital, labour and management (1991)

<table>
<thead>
<tr>
<th>Constraint or Category</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital (P'000,000)</td>
<td>50</td>
<td>100</td>
<td>150</td>
<td>200</td>
<td>250</td>
<td>300</td>
<td>350</td>
<td>400</td>
</tr>
<tr>
<td>Labour (number)</td>
<td>1,500</td>
<td>3,000</td>
<td>4,500</td>
<td>6,000</td>
<td>7,500</td>
<td>9,000</td>
<td>10,500</td>
<td>12,000</td>
</tr>
<tr>
<td>Managers (number)</td>
<td>100</td>
<td>200</td>
<td>300</td>
<td>400</td>
<td>500</td>
<td>600</td>
<td>700</td>
<td>800</td>
</tr>
</tbody>
</table>

| Number of enterprises       |        |        |        |        |        |        |        |        |
| Wildlife only               | 33     | 67     | 100    | 133    | 167    | 190    | 193    | 193    |
| Wildlife and livestock      | 231    | 262    | 262    |        |        |        |        |        |

| Gross value added (P'000,000)|        |        |        |        |        |        |        |        |
| Wildlife only               | 21.47   | 43.58  | 65.05  | 86.51  | 108.63 | 120.24 | 120.32 | 120.32 |
| Wildlife and livestock      | 123.21  | 125.32 | 125.32 |        |        |        |        |        |

| Net value added (P'000,000) |        |        |        |        |        |        |        |        |
| Wildlife only               | 16.79   | 34.10  | 50.89  | 67.68  | 84.99  | 94.08  | 94.14  | 94.14  |
| Wildlife and livestock      | 95.96   | 97.30  | 97.30  |        |        |        |        |        |

| Land required (hectares '000,000) |        |        |        |        |        |        |        |        |
| Wildlife only                 | 0.71    | 1.43   | 2.14   | 2.85   | 3.57   | 4.56   | 6.63   | 6.63   |
| Wildlife and livestock        | 4.97    | 7.32   | 7.32   |        |        |        |        |        |

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the amount of land required for wildlife uses. This is especially so in the land use zones towards the disturbed end of the spectrum which is illustrated in Figure 12.B in chapter 12. This means that the land which tends to have the lowest non-use values, also loses its use values which are, in any case, generally low.

Table 13.8: Optimal combinations of all wildlife use and/or livestock production, to maximise gross value added, on land allocated to wildlife in Botswana, with unlimited availability of capital, labour and management, expressed in terms of number of enterprise units, values generated and land requirements (1991)

<table>
<thead>
<tr>
<th>Wildlife/rangeland use</th>
<th>Number of enterprises</th>
<th>Gross value added* (pula'000,000)</th>
<th>Net value added* (pula'000,000)</th>
<th>Land required** (ha'000,000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wildlife viewing</td>
<td>182</td>
<td>118.27</td>
<td>92.52</td>
<td>3.891</td>
</tr>
<tr>
<td>Safari hunting</td>
<td>22</td>
<td>6.22</td>
<td>5.38</td>
<td>3.908</td>
</tr>
<tr>
<td>Community use, high***</td>
<td>4</td>
<td>1.44</td>
<td>1.33</td>
<td>1.200</td>
</tr>
<tr>
<td>Community use, low***</td>
<td>19</td>
<td>1.33</td>
<td>1.00</td>
<td>13.256</td>
</tr>
<tr>
<td>Game ranching</td>
<td>6</td>
<td>1.17</td>
<td>0.82</td>
<td>0.062</td>
</tr>
<tr>
<td>Cattle ranching</td>
<td>69</td>
<td>5.02</td>
<td>3.18</td>
<td>0.693</td>
</tr>
<tr>
<td>Ostrich farming</td>
<td>18</td>
<td>11.79</td>
<td>10.90</td>
<td>0.002</td>
</tr>
<tr>
<td>Crocodile farming</td>
<td>3</td>
<td>2.77</td>
<td>2.51</td>
<td>0.000</td>
</tr>
<tr>
<td>Elephant cropping</td>
<td>1</td>
<td>0.59</td>
<td>0.36</td>
<td>3.996</td>
</tr>
<tr>
<td>Product processing****</td>
<td>6</td>
<td>0.27</td>
<td>0.18</td>
<td>0.000</td>
</tr>
<tr>
<td>** Total wildlife only</td>
<td>261</td>
<td>143.85</td>
<td>115.02</td>
<td>26.314</td>
</tr>
<tr>
<td>** Total wildlife and livestock</td>
<td>330</td>
<td>148.87</td>
<td>118.20</td>
<td>27.008</td>
</tr>
</tbody>
</table>

* Gross value added to the national income per annum, net value added is gross value added less depreciation

** Includes 300 hectares for crocodile farming and 100 hectares for product processing

*** Community-based wildlife use projects in high-value area (Chobe enclave project, chapter 6) and low-value area (Ngwaketse project, chapter 6)

**** Medium-scale tanning enterprise (chapter 11)
In chapter 1 it was shown that the total amount of land designated for wildlife use in Botswana amounts to 22.7 million hectares, or 39 percent of the whole country. To this we can add some 4.3 million hectares, which is land outside that designated for wildlife but which is used predominantly for wildlife. It is of interest to note, from Table 13.8, that when all activities

| Table 13.9: Optimal combinations of non-consumptive wildlife use and/or livestock production, to maximise gross value added, on land allocated to wildlife in Botswana, with unlimited availability of capital, labour and management, expressed in terms of number of enterprise units, values generated and land requirements (1991) |

<table>
<thead>
<tr>
<th>Wildlife/rangeland use</th>
<th>Number of enterprises</th>
<th>Gross value added* (pula'000,000)</th>
<th>Net value added* (pula'000,000)</th>
<th>Land required (ha'000,000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wildlife viewing</td>
<td>182</td>
<td>118.27</td>
<td>92.52</td>
<td>3.891</td>
</tr>
<tr>
<td>Safari hunting</td>
<td>0</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Community use, high**</td>
<td>2</td>
<td>0.73</td>
<td>0.67</td>
<td>0.606</td>
</tr>
<tr>
<td>Community use, low**</td>
<td>3</td>
<td>0.21</td>
<td>0.16</td>
<td>2.075</td>
</tr>
<tr>
<td>Game ranching</td>
<td>6</td>
<td>1.12</td>
<td>0.78</td>
<td>0.059</td>
</tr>
<tr>
<td>Cattle ranching</td>
<td>69</td>
<td>5.00</td>
<td>3.17</td>
<td>0.690</td>
</tr>
<tr>
<td>Ostrich farming</td>
<td>0</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Crocodile farming</td>
<td>0</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Elephant cropping</td>
<td>0</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Product processing***</td>
<td>0</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td><strong>Total wildlife only</strong></td>
<td>193</td>
<td>120.32</td>
<td>94.14</td>
<td>6.632</td>
</tr>
<tr>
<td><strong>Total wildlife and livestock</strong></td>
<td>262</td>
<td>125.32</td>
<td>97.30</td>
<td>7.322</td>
</tr>
</tbody>
</table>

* Gross value added to the national income per annum, net value added is gross value added less depreciation

** Community-based wildlife use projects in high-value area (Chobe enclaves project, chapter 6) and low-value area (Ngwaketse project, chapter 6)

** Medium-scale tanning enterprise (chapter 11)
are fully expanded (after 15 years) all of this land will be used up. However, only 12 percent of this will generate more than P10 per hectare in gross value added. When the consumptive wildlife uses are excluded, the amount of land generating any use value at all is reduced to 7.3 million hectares, or only 27 percent of the total land available.

The results show that commercial livestock production has limited potential to compete economically with wildlife use on land allocated to wildlife. In Table 13.8 value added from livestock makes up only three percent of the total for the optimally allocated sector. It is noteworthy that the analysis included only commercial livestock production which is capital intensive and requires access to external markets. Traditional livestock keeping as a land use is not included, and the linear programming model is, in this sense, a partial analysis. The products of traditional livestock keeping are varied and include milk, meat, draft power and as a store of value. They are generally non-market or locally marketed products, and capital requirements are low. As is argued in chapter 10, expansion of traditional livestock-keeping is likely to be the main threat to wildlife in all the zones described in Figures 12.A and 12.B in chapter 12. Further work is required to determine the economic worth of traditional livestock-keeping and the degree to which it really does threaten to replace wildlife.

Government investment in wildlife

Table 13.10 shows the results of the economic cost-benefit analysis of public investment in the sector. The base case is the planned government expenditure and is the minimum considered necessary for the sector to be able to expand as anticipated. The other expenditure streams depict a slower growth rate and two faster growth rates, which might result if, for example, poaching pressures were to increase significantly. Table 10.5 in chapter 10 shows the results of a similar exercise for elephant. The effect that exclusion of consumptive wildlife uses would have on the results is also shown.

The base for the model is the gross value added for the sector recorded in Table 12.1 in chapter 12. After 15 years the sector would have expanded to produce gross value added as depicted in the second column in Table 13.8. This expansion, restricted to wildlife viewing, livestock production, ostrich production, crocodile production, results after 15 years in incremental gross value added amounting to P117 million. After 30 years, through market
development, intensification and expansion for most uses, the incremental gross value added
would increase to P200 million.

Table 13.10: Economic returns* to public expenditure in the wildlife sector showing the effect
of exclusion of consumptive wildlife uses and varying levels of expenditure
(Botswana, 1991)

<table>
<thead>
<tr>
<th>Measure of return to investment</th>
<th>Economic rate of return</th>
<th>Economic net present value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(percent)</td>
<td>(pula'000,000)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Case scenario</th>
<th>over 15 years</th>
<th>over 30 years</th>
<th>over 15 years</th>
<th>over 30 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>All wildlife uses included</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low cost**</td>
<td>6.37%</td>
<td>18.43%</td>
<td>3.1</td>
<td>434.3</td>
</tr>
<tr>
<td>Base case**</td>
<td>4.26%</td>
<td>16.97%</td>
<td>-13.8</td>
<td>348.6</td>
</tr>
<tr>
<td>High cost**</td>
<td>1.57%</td>
<td>14.80%</td>
<td>-32.5</td>
<td>234.9</td>
</tr>
<tr>
<td>Very high cost**</td>
<td>***</td>
<td>10.72%</td>
<td>-53.1</td>
<td>83.1</td>
</tr>
<tr>
<td>Non-consumptive wildlife uses only</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low cost**</td>
<td>-</td>
<td>12.2%</td>
<td>-68.2</td>
<td>205.0</td>
</tr>
<tr>
<td>Base case**</td>
<td>-</td>
<td>10.13%</td>
<td>-85.1</td>
<td>119.3</td>
</tr>
<tr>
<td>High cost**</td>
<td>-</td>
<td>6.27%</td>
<td>-103.8</td>
<td>5.6</td>
</tr>
<tr>
<td>Very high cost**</td>
<td>-</td>
<td>-</td>
<td>-124.4</td>
<td>-146.2</td>
</tr>
</tbody>
</table>

* Measured as first round, private sector, gross value added to national income
** Cost streams follow new capital and recurrent costs of NDP7 for first six years, thereafter
capital expenditures are constant and recurrent costs rise at differing rates: base case = four
percent, low-cost = two percent, high-cost = six percent, very high-cost = eight percent
*** Rate of return is negative

A worthwhile return is not possible after 15 years, except marginally with the low-cost
scenario, when all wildlife uses are included. After 30 years, acceptable returns are possible
with all cost scenarios, except the very high-cost one where consumptive wildlife use is excluded. The high-cost scenario with consumptive wildlife use excluded, results in an only marginally positive return.

The cost-benefit analysis can only give us an idea whether current and planned public expenditures on wildlife can result in economically profitable returns in terms of direct use values. The primary value of the analysis is for comparison with other sectors to which the public funds could be diverted. The inclusion of an income multiplier effect (in terms of carefully traced value added resulting from further rounds of spending) would be likely to result in higher measured returns, but unless we consider the effect to be different for other sectors, there is no point.

The analysis tells us that anticipated growth in direct use values from wildlife will be sufficient to justify current projections of public expenditures necessary to maintain the resource over the next 30 years. However, exclusion of consumptive uses and a high or very high costs scenario will preclude this. Since multiplier effects and other values (indirect use and non-use) are not yet taken into account it is clear that, in terms of total economic value, the sector is economically efficient. It behaves Botswana to find ways to capture non-use values, such as those identified in chapter 4, so as to enhance the total economic value of its wildlife resource. It also behaves Botswana to carefully plan its public expenditure in the sector to ensure that development of utilisation is optimal and that other values are not lost.

13.4 Chapter conclusion

In chapter 2 the motivation for this study was described, and this was to answer the question facing the government of Botswana at the start of NDP7: whether wildlife in Botswana can contribute positively and sustainably to national income without loss of biological diversity. More specifically, there were two questions:

- does the wildlife resource have the economic direct use values, which it is assumed to have in policy, and which justify the ongoing investments in it, and
- what allocation of land uses in the wildlife estate, as constrained by existing policy commitments, will maximise the contribution of the resource to national income without jeopardising the maintenance of the ecological balance?
The policy framework within which the study has been conducted includes commitment: to a land use plan, as well as maintenance or enhancement of the wildlife stocks. Fortuitously, the policy reflects a concept of sustainability resembling "strong" rather than "weak" sustainability, as described by Pearce et al. (1996).

The answer to the first question is in Part II of the thesis and the last part of this chapter: yes, the wildlife resource can contribute positively to national income, and this value can justify government's planned investments in the sector. The answer to the second question is also found in this chapter, and is as follows. In the early years of expansion of wildlife use, emphasis should be placed on wildlife viewing, and, to a lesser extent, ostrich production, crocodile production, and community wildlife use in high value areas. Later on, as capital, labour and management resources become more abundant, the sector should be diversified to ensure that all uses are fully developed. Thereafter, growth should be fostered where possible, through market development and intensification.

A ban on consumptive uses of wildlife would result in 16 percent less gross value added from wildlife in the sector, and would require 75 percent less land for wildlife use. The large reduction in the amount of land required for wildlife uses, if consumptive wildlife use is excluded, would have greatest impact in land use zones which tend to have the lowest non-use values. If all activities in the sector were fully expanded they would make use of 27 million hectares, of which only 12 percent would be generating more than P10 per hectare per annum in gross value added. When consumptive wildlife uses are excluded, the amount of land in use is reduced to 7.3 million hectares, and of this 44 percent would generate more than P10 per hectare per annum in gross value added.

The most striking finding, here, is that in a large proportion of the land allocated to wildlife, generation of only very low direct use values is possible because of constraints such as land/habitat, initial stock, stock levels, and off-take potential. This makes it likely that, without future relaxation of these constraints, the justification for maintaining these tracts as wildlife land will depend on their non-use values, or their indirect use values, if any.

We do not know what the non-use values (option and existence values) of wildlife in Botswana are, although the observed willingness to pay of tourists to conserve wildlife (chapter 4)
suggests that they are likely to exist. Intuitively, as shown in Figures 12.A and 12.B, it is logical to expect that these non-use values will be highest in the areas where biological diversity and wilderness quality are high. These are the areas where direct use values also tend to be high. Thus, it seems likely that the large proportion of wildlife land that has low direct use value also has low or non-existent option and existence values. Parts of the land in question have some indirect use value in that they constitute migration/reservoir areas for the wildlife on land with direct use value. However, this still leaves very large tracts of land allocated to wildlife with low likely economic value for wildlife.

The question arises as to what other land uses could substitute for wildlife on land which yield low direct use values from wildlife. Given the strong social and political pressure for development in Botswana, it is likely that demands for re-allocation of wildlife land for other uses will emerge. Technically, the only other land use option would be range use with livestock. Optimal allocation of resources on the wildlife estate would include some 700,000 hectares of commercial livestock production in wildlife management areas. This would enhance the total value added by only three percent. Commercial livestock production has limited potential to compete economically with wildlife use on the wildlife estate. On the other hand, although it was not modelled in this thesis, it is likely that traditional livestock-keeping could (because of its special characteristics, described above and in chapter 10) replace wildlife on much wildlife land. The need for specific research, in which the total economic value of the livestock sector and the non-use and indirect use values of the wildlife sector would be analysed, is indicated. Then, the spacial economic trade-off between wildlife and livestock needs specific analysis.

Some would recommend a policy for Botswana in which no killing of wildlife is permitted, i.e., where there is a ban on consumptive use of wildlife. While such a policy would not reduce the direct use value of the resource by much, it would greatly reduce the amount of wildlife land capable of generating direct use value. Thus, within the context of the wildlife sector, a ban on consumptive use of wildlife would be economically unsound. It remains to be seen if it would remain unsound in the context of a study incorporating the opportunity costs of traditional livestock-keeping.
Within the bounds of present policy commitments, the wildlife sector is economically efficient. The likely flow of positive use values from the sector justifies the anticipated public expenditures in it. However, Botswana should find ways to capture non-use values, and ensure that development of its wildlife use is optimal and that indirect use and non-use values are not lost.
Part IV

Conclusion
Chapter 14

General conclusion

14.1 Policy implications

In a developing country such as Botswana, pressures on land are such that its use for wildlife can only be justified if it contributes to national income. Lack of attention to wildlife economic values, and ways in which they can be captured, has meant that in many African countries, investment in wildlife has suffered relative to that in other land-use activities. A new approach to wildlife management, in which emphasis is placed on the supply and demand of wildlife values which can be captured, is emerging in Africa. However, the subject of African wildlife economics has as yet been little studied, and the backlog of fundamental research is immense.

The presently existing policy on wildlife-viewing tourism, which places emphasis on the development of high value, low impact activities is economically sound. Lodge development for wildlife viewing in prime wildlife areas is reasonably attractive as an investment for the private sector and is very desirable economically. Distortion between financial and economic profitability occurs in conditions of low profitability (such as when occupancy rates drop below 28 percent). In these conditions, there is a case for direct government support for enterprises, perhaps directed specifically at increasing occupancy rates.

Wildlife-viewing tourism is highly compatible with wildlife and habitat conservation, and is the most appropriate wildlife use in and around protected areas, where wildlife densities are high and the scenery is attractive. Analysis of the returns, in terms of national income, to
government investment in park plans and their implementation indicates that such expenditure is economically sound.

Analysis of the demand for wildlife-viewing tourism in Botswana indicates that fees for entry and use of parks should be differentiated between three categories: Botswana citizens, visitors from overseas and visitors from the southern African region. The levels of fees, which were markedly increased in 1989, are presently satisfactory, except that a lower fee for foreign tourists from the southern African region is needed. The average wildlife-viewing tourist in Botswana benefits from consumer surpluses amounting to between 17 and 20 percent of her/his trip expenditures made within Botswana. In 1989, the aggregate consumer surplus amounted to some P40 million. There is potential for Botswana to capture some of the consumer surplus of foreign tourists. A strategy needs to be devised for this.

In 1989, tourists were willing to pay some P8 million toward a wildlife conservation fund in Botswana. A trust fund could be developed to receive donations elicited from the tourist population. Price elasticity of demand for wildlife-viewing trips to Botswana was close to unity. This indicates that, in general, price levels for tourists are appropriate. Nevertheless, there is some indication that prices should be increased for tourists who use campsites and decreased for tourists who use lodges and other fixed facilities.

Safari hunting occupies an important complementary niche in the suite of wildlife uses which are possible in Botswana. The current policy, which is to intensify safari hunting as far as possible, particularly with the inclusion of elephant in safari hunting quotas, is economically sound. It is important that there be exclusivity of land use within concessions, but, because wildlife in Botswana is relatively mobile, there should be flexibility in the allocation of hunts between areas and concession holders. Wildlife viewing and safari hunting tend to be mutually exclusive but this exclusivity should be possible within concessions not between them. The zoning of land suitable for both wildlife viewing and safari hunting should allow for the practice of either or both of these two activities, at the discretion of the land user.

Wherever both wildlife and resident human communities are present together on public land, the development of community-controlled wildlife use is appropriate. This should take preference in terms of resource allocation over the centralised, licensed hunting system now in
place, which should be gradually phased out. Within community-based projects, capital-efficient, small-scale methods of wildlife use are most economically efficient, except where specialised skills are required, such as those associated with tourism activities. In the case of tourism, joint ventures between communities and private sector operators should be developed. There is strong economic justification for government support to community-based wildlife projects. Emphasis should be placed on facilitating efficient management by communities, as well as the development and maintenance of suitably high wildlife densities. The latter aspect is critical, for in most of the Kalahari region, game densities prevailing at the time of this study were found to be too low for financially viable community use. Moratoria on off-take lasting for several years are economically appropriate here. Where game densities are between about 100 and 25 hectares per large stock unit equivalent, off-take is economically viable but off-take moratoria of several years yield enhanced economic benefits. Whenever consumptive use is initiated, off-take at close to the maximum sustainable rate is important to avoid financial and economic losses. Selective protection of species which suffered catastrophic losses in the drought in the early 1980s is also economically sound.

Although community-based livestock-keeping, as distinct from livestock ranching, was not analysed, it is likely to be as important to the economic welfare of communities on public land as community-based wildlife use. However, livestock-keeping, as normally practised in Botswana, is much less compatible than ranching with the conservation of wildlife, habitats and biological diversity. It is important that the allocation of public land between these uses be such as to avoid losses in existing non-use and indirect use values.

Game ranching is an economically efficient activity on private and leasehold land, but, because of the very high capital requirements for stocking and developing ranches, it does not offer high financial returns to investors. However, analysis suggests that, at least in the Kalahari region, and probably in most of Botswana, it is more economically sound than commercial cattle ranching. As an activity which promotes wildlife and habitat conservation on land which would otherwise be used for commercial livestock production, it deserves to be promoted by government. Here, attention should be given to removing veterinary and bureaucratic obstacles to ranch and market development.
It is important, particularly in areas of low production potential, that game ranching is developed in a way that minimises capital investment. This means minimising costs of enclosure and restocking as well as making as much use as possible of existing ranch infrastructure and naturally occurring game populations. Land-use zoning should not preclude use of game on livestock ranches, or use of livestock on game ranches, as it is often a combination of activities that is most efficient economically. Because of its relatively low economic efficiency, game ranching is not recommended for unfenced public lands. Here, use of free-ranging wildlife through community projects, or, in the absence of resident communities, concessions, are economically more appropriate.

*Ostrich farming* (breeding and rearing) was found to be an attractive proposition for investors and it has the potential to contribute significantly to economic growth. Botswana’s large wild population (some 50,000) gives the country a slight comparative advantage in acquisition of stock. However, breeding is intensive and reliant on feed from arable agriculture. The availability of feed will be the main constraint to expansion. Policy should promote expansion, but only as long as an economically efficient supply of feed is possible. While extensive ostrich breeding can be promoted on any land with access to reasonably good roads and markets, intensive breeding and rearing is best suited to sites close to main centres and feed sources.

Whether or not live exports of ostrich bred and reared on farms is economically efficient depends on one or more of the following considerations: the export to domestic price ratios, the degree to which the domestic industry is able to absorb retained birds, and the age classes of birds being exported. These conditions are subject to change in the short- and medium-term, so that regulation allowing exports or not is likely to result in inefficiencies. Producers should be free to market live or for slaughter, wherever they can find markets. Government intervention should be restricted to *promotion* of the most economically desirable option at the time. Although the benefits of live bird exports should be captured opportunistically, promotion of ostrich production in the long term should aim at financial viability in slaughter bird production. This is because the current, high, live-bird prices are likely to drop drastically in the future.
Crocodile ranching (intensive rearing of wild-bred stock) has an advantage over crocodile farming (intensive breeding and rearing) only if the commercial harvest of wild eggs, associated with ranching, provides benefits for resident human communities and thus provides incentives for communities to protect wild populations. Both farming and ranching are equally attractive financially, but they need to be organised so as to withstand periodic temporary collapse in product prices. The most significant limiting factor to crocodile production is the supply of cheap, high-quality feed. For flexibility and resilience, production units need to combine both farming and ranching, as well as other sources of income such as tourism. Expansion along these lines should only be promoted where economically efficient feed and water supplies are possible.

Where crocodile eggs are harvested from the wild, five percent of the harvested egg number can be returned to the wild (as animals reared to slaughter age) without jeopardising economic efficiency. This, however, should only be done if resident human communities in egg harvesting areas desire it.

The factors affecting whether the export of live crocodile is economically efficient or not are the same as those described for ostrich. Here, as is the case with ostrich, producers should be free to market animals alive or for slaughter, to domestic or foreign markets, whichever option is most advantageous at the time. Government intervention should be restricted to promotion of the most economically desirable option at any time. Under most conditions, however, export of live juveniles or, to a lesser extent, hatchlings, is much more economically viable than the export of live adults.

The present policy on elephant management in Botswana, which is aimed at maximising all possible use values, through consumptive cropping, hunting and non-consumptive tourism is sound. It is likely that for the continued survival of the elephant population, it will be necessary for all possible use values to be captured within Botswana's society. However policy should aim to maximise all realisable economic values, including non-use values. Ways and means of capturing any non-use values for Botswana's elephant should be developed and implemented, with emphasis on ensuring sustainability.

The promotion of wildlife-viewing tourism involving elephant should continue. Analysis
suggests that there is no financial and little economic incentive for an elephant cropping programme. This will only change if markets for elephant products can be fully redeveloped. Botswana should certainly continue efforts to regain markets for non-ivory elephant products, and should make the most of newly opened, ivory-marketing opportunities, while supporting research into the viability of this reopening. The inclusion of elephant on safari-hunting quotas will significantly increase the economic value of the elephant resource, and enhance the value of community wildlife use and safari hunting itself.

Among all the possibilities for processing of wildlife products which were analysed, the processing of some elephant products, specifically ivory carving and elephant hide processing, (at pre-CITES ban prices) were shown to have high financial and economic potential for expansion. Other wildlife-product processing activities, such as small- and medium-scale tanning or meat processing, also have potential for expansion, but will likely be constrained by shortages of raw material. The potential for significant increases in value added through the processing of wildlife products in Botswana has thus diminished with the international ban on trade in elephant products. Wherever it is found to be economically efficient, wildlife product processing is worthy of promotion, because of its key role in job creation, particularly in rural areas.

Several policy implications relating to the allocation of resources in the wildlife sector as a whole have been identified. While regulation by government of wildlife use activities in the country should be minimal, there is one area where it is essential. This is in the zoning of land for uses and combinations of uses. The most important function of land-use zones is to place limits on land uses, to ensure that preservation values (non-use and indirect use values) are not lost. The principle of safe minimum standards should guide land-use zoning. Areas with highest preservation values should be zoned for use only as wilderness. Areas with progressively lower preservation value should be zoned to allow progressively more uses, as appropriate for each zone. Areas with lowest preservation value can be zoned to allow for all uses. The result will tend to be a suite of resource uses along the zoning spectrum, ranging from wilderness in the most remote, least disturbed areas, though tourism uses in less disturbed areas, to capital-extensive but people-intensive land uses in moderately disturbed areas, and further to capital-intensive ranching and farming systems in the most disturbed areas close to urban centres.
In the early years of expansion of wildlife use, emphasis should be placed on wildlife viewing, and, to a lesser extent, ostrich production, crocodile production, and community wildlife use (the latter in high potential areas). Later on, as capital, labour and management become more abundant, the sector should be diversified to ensure that all uses are fully developed. Thereafter, growth should be fostered where possible, through market development and intensification.

Within the framework of public policy, the optimal allocation of resources in the sector would include some 700,000 hectares of commercial livestock production within wildlife management areas. As stated above, commercial livestock production has limited potential to compete economically with wildlife use and does not have a severe impact on wildlife and habitat conservation. On the other hand, *traditional livestock-keeping* (not modelled in this thesis), has a relatively severe impact on conservation. As rural human populations increase, traditional livestock-keeping will likely be the main threat to wildlife land, as well as wildlife and habitat conservation. While commercial livestock could be permitted near the periphery of land designated for wildlife, traditional livestock-keeping would best be prohibited on all wildlife land, to ensure no net losses of non-use and indirect use values.

A ban on consumptive uses of wildlife would result in 16 percent less gross value added from wildlife in the sector, and would require 75 percent less land for wildlife use. The large reduction in the amount of land required for wildlife uses, if consumptive wildlife use is excluded, would have greatest impact in land-use zones which are likely to have low non-use values. If *all* activities in the wildlife sector were fully expanded, in an optimal manner over 15 years, they would make use of 27 million hectares, but only 12 percent of this will generate *high* direct use value. These findings have some interesting implications.

A large proportion of land allocated to wildlife thus has low direct use value. The survival of this proportion as wildlife land will tend to depend on its current non-use and indirect use values, if any, or whether traditional livestock-keeping, as an alternative activity, can generate use values in it. In the longer term, use of this land may be split between community-based wildlife use and traditional livestock-keeping. Zoning it for community-based wildlife use is

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^1 Optimality is applied in this thesis within a framework of public policy constraints
helping, and will help, retain preservation values. A specific research project, complementary to this one, is recommended, to investigate the total economic value of the trade-off between wildlife and traditional livestock-keeping in the wildlife estate.

If the wildlife sector were to be fully expanded in an optimal manner over 15 years, but consumptive wildlife uses were excluded, the amount of land under wildlife use would be reduced to 7.3 million hectares, or 3.2 percent of the total land available. Thus, a ban on consumptive wildlife use would result in a large proportion of wildlife land being unable to generate direct use value. A ban on consumptive wildlife use would jeopardise the future of much wildlife land, the preservation of which might otherwise be assured. Within the context of the wildlife estate and its current land allocation and stock commitments, such a ban would be economically unsound. It remains to be seen if it would remain economically unsound in the context of a policy framework permitting traditional livestock-keeping in the wildlife estate. If livestock-keeping has very high economic value it could replace consumptive wildlife use over much of the wildlife estate, resulting in higher economic benefits overall.

14.2 Concluding remarks

The wildlife resource in Botswana is able to contribute positively to the national income. However, its contribution is unlikely to ever exceed more than four or five percent of the total gross domestic product. The wildlife sector is economically efficient. The likely flow of positive use values from it over the next thirty years justifies anticipated public expenditures in it. However, care should be taken in making sure that expenditures are aimed directly at attainment of the policy goals described above.

The findings in this thesis thus generally confirm the hypothesis, presented in chapter 1, that wildlife in Botswana can contribute positively and sustainably to national income, and that this can happen without loss in biological diversity. It is concluded that the survival of wildlife on the 39 percent of Botswana’s land, currently allocated to it, depends largely on the ability of the resource to generate economic value to the highest possible degree over the widest possible area. As described above, the way in which this might be achieved is through an array of uses, yielding direct use values, within a framework of land use zoning which precludes any
loss of indirect use, and non-use values. The economic efficiency of the sector could likely be enhanced if any non-use values could be captured for the national benefit.
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Appendix 1.1

Abbreviations and acronyms used
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<thead>
<tr>
<th>Abbreviation</th>
<th>Definition</th>
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<td>%</td>
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<td>@</td>
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<td>thousands of</td>
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<td>millions of</td>
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<td>AE</td>
<td>absolute error</td>
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<td>ACP</td>
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<td>ANOVA</td>
<td>analysis of variance</td>
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<td>BDC</td>
<td>Botswana Development Corporation</td>
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<td>BMC</td>
<td>Botswana Meat Commission</td>
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<td>BNRMP</td>
<td>Botswana Natural Resources Management Project</td>
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<td>CAMPFIRE</td>
<td>Communal Areas Management Programme for Indigenous Resources</td>
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<td>CEAS</td>
<td>Central Economic Advisory Service</td>
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<td>CHA</td>
<td>controlled hunting area</td>
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<tr>
<td>CITES</td>
<td>Convention for International Trade in Endangered Species of Fauna and Flora</td>
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<td>CSERGE</td>
<td>Centre for Social and Economic Research on the Global Environment</td>
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<td>DWNP</td>
<td>Department of Wildlife and National Parks</td>
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<td>ENPV</td>
<td>economic net present value</td>
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<td>ERR</td>
<td>economic rate of return</td>
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<tr>
<td>et al.</td>
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<td>etc.</td>
<td>etcetera</td>
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<td>EU</td>
<td>European Union</td>
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Appendix 1.1 (continued)

exp  exponential
exp.  expenditure
expend.  expenditure
FAO  Food and Agriculture Organisation
FAP  Financial Assistance Policy
FNPV  financial net present value
FRR  financial rate of return
F-ratio  value of F determined using F-test
GATT  General Agreement on Tariffs and Trade
GDP  gross domestic product
GmbH  Gesellschaft mit beschränkter Haftung (limited liability company)
GTZ  Deutsche Gesellschaft für Technische Zusammenarbeit
GVA  gross value added (to national income)
ha  hectare
HATAB  Hotel and Trade Association of Botswana
IACTS  International Alligator/Crocodile Trade Study
IIED  International Institute for Environment and Development
in litt.  by letter
IRR  internal rate of return
ITC  International Trade Centre
KCS  Kalahari Conservation Society
KD  Kgalagadi District
km²  square kilometres (1 km² = 100 ha)
LEEC  London Environmental Economics Centre
LIFE  Living in a Finite Environment
LSU  large stock unit equivalent
Ltd.  Limited
mat.  material(s)
Mgmt  management
N  number (as variable in equations)
NDB  National Development Bank
Appendix 1.1 (continued)

NDP7 Botswana's seventh national development plan
no. number
NPV net present value
P price (as variable in equations)
P probability (in statistical validation)
P Botswana pula (P1.00 = US$0.47 = £0.28)
PL probability level
pers. comm. personal communication
Pty. Proprietary
PWV Gauteng province, South Africa
Q quantity (as variable in equations)
r² coefficient of determination
r_m intrinsic or instantaneous rate of increase of population
SACIM Southern African Centre for Ivory Marketing
SACU Southern African Customs Union
SADC Southern African Development Community
SADCC Southern African Development Coordination Conference
SARCCUS Southern African Regional Commission for the Conservation
and Utilisation of the Soil
SDR Special Drawing Right
SE standard error
Sp.A. Società per Azioni (joint-stock company)
spp. species (plural)
T time (as variable in equations)
t-test statistical test using t-distribution
t-value value of t determined using t-test
UCL University College London
UK United Kingdom
UNDP United Nations Development Programme
US United States
US$ United States dollar
USA United States of America
Appendix 1.1 (continued)

USAID
viz.
W. to donate
WMA(s)
WWF
yrs
Z$  

United States Agency for International Development
namely
Willingness to donate
wildlife management area(s)
World Wildlife Fund (US) or World Wide Fund for Nature
years
Zimbabwe dollar
Appendix 2.1

Examples of two financial and economic enterprise models
Appendix 2.1

Safari hunting enterprise - Okavango/Chobe region - base case
## Appendix 2.1 (continued)

### TABLE A.1: CAPITAL REQUIREMENTS

<table>
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<th>ITEM</th>
<th>STATUS</th>
<th>UNIT QUANT.</th>
<th>PRICE (Pula)</th>
<th>COST (Pula)</th>
<th>LIFE YEARS</th>
<th>AMORTISATION AND INTEREST (%)</th>
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<td>40</td>
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<td>: Other Animals</td>
<td>NT</td>
<td>0</td>
<td>300</td>
<td>0</td>
<td>40</td>
<td>0</td>
<td>0</td>
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<tr>
<td><strong>Horses and Donkeys</strong></td>
<td>NT</td>
<td>0</td>
<td>300</td>
<td>0</td>
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<td>0</td>
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<td>.05</td>
<td>T</td>
<td>146580</td>
<td>14658</td>
<td>15</td>
<td>1927</td>
<td>977</td>
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<td><strong>SUBTOTAL - MOVABLE CAPITAL</strong></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td>161238</td>
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<td><strong>WORKING CAPITAL</strong></td>
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<tr>
<td><strong>VARIABLE</strong></td>
<td>.30</td>
<td>T</td>
<td>203005</td>
<td>60902</td>
<td>9335</td>
<td>70377</td>
<td>36927</td>
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<td><strong>OVERHEAD</strong></td>
<td>.30</td>
<td>T</td>
<td>201988</td>
<td>60596</td>
<td>9089</td>
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<td><strong>SUBTOTAL - WORKING CAPITAL</strong></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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### Table A2: Stock Composition by Species at Full Production

<table>
<thead>
<tr>
<th>Item</th>
<th>Head</th>
<th>Factor</th>
<th>Large Stock Units (LSU)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Big Cats</td>
<td>238</td>
<td>0.00</td>
<td>0</td>
</tr>
<tr>
<td>Eland</td>
<td>119</td>
<td>1.00</td>
<td>119</td>
</tr>
<tr>
<td>Gemsbok</td>
<td>3007</td>
<td>0.40</td>
<td>1288</td>
</tr>
<tr>
<td>Hartebeest</td>
<td>7376</td>
<td>0.25</td>
<td>1844</td>
</tr>
<tr>
<td>Kudu</td>
<td>119</td>
<td>0.40</td>
<td>48</td>
</tr>
<tr>
<td>Ostrich</td>
<td>714</td>
<td>0.26</td>
<td>186</td>
</tr>
<tr>
<td>Small Animals</td>
<td>4505</td>
<td>0.00</td>
<td>0</td>
</tr>
<tr>
<td>Springbok</td>
<td>14395</td>
<td>0.08</td>
<td>1152</td>
</tr>
<tr>
<td>Steenbok/Duiker</td>
<td>1902</td>
<td>0.07</td>
<td>124</td>
</tr>
<tr>
<td>Wildebeest</td>
<td>1665</td>
<td>0.40</td>
<td>666</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>34640</td>
<td></td>
<td><strong>5660</strong></td>
</tr>
</tbody>
</table>

**Game Density on Land:** 22 hectares/LSU; **Concession Size:** 181119 hectares

### Table A3: Sales at Full Production

<table>
<thead>
<tr>
<th>Item</th>
<th>Offtake</th>
<th>Number</th>
<th>Value (Pula)</th>
<th>Income (Pula)</th>
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<tr>
<td><strong>SAFARI HUNTING</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All Species</td>
<td>-</td>
<td>90</td>
<td>1294</td>
<td>116716</td>
</tr>
<tr>
<td>Eland</td>
<td>1.00%</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Gemsbok</td>
<td>0.65%</td>
<td>25</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Hartebeest</td>
<td>0.16%</td>
<td>12</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Kudu</td>
<td>0.00%</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Ostrich</td>
<td>0.30%</td>
<td>24</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Small Animals</td>
<td>0.00%</td>
<td>12</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Springbok</td>
<td>0.19%</td>
<td>12</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Steenbok/Duiker</td>
<td>0.65%</td>
<td>12</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Wildebeest</td>
<td>0.70%</td>
<td>12</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Safari Fees:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adults</td>
<td>197</td>
<td>-Days/Year @</td>
<td>2599 Pula/Day = 512975</td>
<td></td>
</tr>
<tr>
<td>: Adults</td>
<td>102</td>
<td>-Days/Year @</td>
<td>543 Pula/Day = 55524</td>
<td></td>
</tr>
<tr>
<td>: Game Viewing</td>
<td>66</td>
<td>-Days/Year @</td>
<td>442 Pula/Day = 29200</td>
<td></td>
</tr>
<tr>
<td><strong>SUBTOTAL - SAFARI HUNTING</strong></td>
<td>366</td>
<td>191</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| **LIVE SALES**     |         |        |              |               |
| Big Cats           | 0.00%   | 0      | 250          | 0             |
| Eland              | 0.00%   | 0      | 250          | 0             |
| Gemsbok            | 0.00%   | 0      | 250          | 0             |
| Hartebeest         | 0.00%   | 0      | 250          | 0             |
| Kudu               | 0.00%   | 0      | 250          | 0             |
| Ostrich            | 0.00%   | 0      | 250          | 0             |
| Small Animals      | 0.00%   | 0      | 250          | 0             |
| Springbok          | 0.30%   | 0      | 250          | 0             |
| Steenbok/Duiker    | 0.00%   | 0      | 250          | 0             |
| Wildebeest         | 0.00%   | 0      | 250          | 0             |
| **SUBTOTAL - LIVE SALES** |   |        |              |               |
### Appendix 2.1 (continued)

### TABLE Aa3: SALES AT FULL PRODUCTION (CONTINUED)

<table>
<thead>
<tr>
<th>MEAT (CROP. &amp; SAF. HUNT.)</th>
<th>CITESIEN PROJECT</th>
<th>COLD DRESSED MASS</th>
<th>BILTONG</th>
<th>VALUE</th>
<th>INCOME</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>QUOTA NUMBER</td>
<td>Kgs/Cse.</td>
<td>Tot.Ags</td>
<td>Pula</td>
<td>Pula</td>
</tr>
<tr>
<td>Big Cats</td>
<td>0</td>
<td>0</td>
<td>.00</td>
<td>.00</td>
<td>.00</td>
</tr>
<tr>
<td>Eland</td>
<td>5.00%</td>
<td>0</td>
<td>5</td>
<td>311.00</td>
<td>332.40</td>
</tr>
<tr>
<td>Gemsbok</td>
<td>5.10%</td>
<td>10</td>
<td>184</td>
<td>105.00</td>
<td>4351.05</td>
</tr>
<tr>
<td>Harlebeest</td>
<td>6.00%</td>
<td>20</td>
<td>423</td>
<td>92.00</td>
<td>8746.83</td>
</tr>
<tr>
<td>Kudu</td>
<td>5.70%</td>
<td>0</td>
<td>7</td>
<td>115.00</td>
<td>375.15</td>
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<tr>
<td>Ostrich</td>
<td>6.30%</td>
<td>5</td>
<td>40</td>
<td>30.00</td>
<td>269.76</td>
</tr>
<tr>
<td>Small Animals</td>
<td>0.00%</td>
<td>0</td>
<td>0</td>
<td>.00</td>
<td>.00</td>
</tr>
<tr>
<td>Springbok</td>
<td>9.40%</td>
<td>100</td>
<td>1253</td>
<td>12.00</td>
<td>3665.54</td>
</tr>
<tr>
<td>Steenbok/Buiker</td>
<td>14.40%</td>
<td>0</td>
<td>274</td>
<td>7.50</td>
<td>462.30</td>
</tr>
<tr>
<td>Wildebeest</td>
<td>5.10%</td>
<td>10</td>
<td>75</td>
<td>122.00</td>
<td>2056.34</td>
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<td>Hides and Eggs</td>
<td>5.20%</td>
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<td><strong>SUBTOTAL-MEAT</strong></td>
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<tr>
<td>Hiking Trail Fees</td>
<td>0</td>
<td>4</td>
<td>50 Pula/Day</td>
<td>7140</td>
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</tr>
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<td><strong>GROSS INCOME</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>714015</td>
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</table>

### TABLE Aa4: VARIABLE EXPENDITURE AT FULL PRODUCTION

<table>
<thead>
<tr>
<th>ITEM</th>
<th>STATUS</th>
<th>PULA/LSU</th>
<th>PULA/HECTARE</th>
<th>PULA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fodder and Supplements</td>
<td>T</td>
<td>.00</td>
<td>.00</td>
<td>0</td>
</tr>
<tr>
<td>Veterinary and Medicine Costs</td>
<td>NT</td>
<td>.00</td>
<td>.00</td>
<td>0</td>
</tr>
<tr>
<td>Marketing Costs: Advertising</td>
<td></td>
<td>1.26</td>
<td>.04</td>
<td>7140</td>
</tr>
<tr>
<td>: Agents Fees</td>
<td>T</td>
<td>18.92</td>
<td>.59</td>
<td>107102</td>
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<tr>
<td>: Live Game Distribution</td>
<td>T</td>
<td>.00</td>
<td>.00</td>
<td>0</td>
</tr>
<tr>
<td>: Biltong Distribution</td>
<td>T</td>
<td>.00</td>
<td>.00</td>
<td>0</td>
</tr>
<tr>
<td>Safari Costs: Accommodation</td>
<td>T</td>
<td>4.01</td>
<td>.13</td>
<td>22669</td>
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<td>: Transport</td>
<td>T</td>
<td>6.89</td>
<td>.22</td>
<td>39000</td>
</tr>
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<td>: CHA Entrance Fees</td>
<td>NT</td>
<td>1.08</td>
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<td>6094</td>
</tr>
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<td>Live Sales Costs: Aerial Support</td>
<td>T</td>
<td>.00</td>
<td>.00</td>
<td>0</td>
</tr>
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<td>: Field Ops</td>
<td>T</td>
<td>.00</td>
<td>.00</td>
<td>0</td>
</tr>
<tr>
<td>: Transport</td>
<td>T</td>
<td>.00</td>
<td>.00</td>
<td>0</td>
</tr>
<tr>
<td>: Licence Fees</td>
<td>NT</td>
<td>.00</td>
<td>.00</td>
<td>0</td>
</tr>
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<td>Cropping Costs: Ammunition</td>
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<td>.00</td>
<td>0</td>
</tr>
<tr>
<td>: Supplies and Packaging</td>
<td>T</td>
<td>.00</td>
<td>.00</td>
<td>0</td>
</tr>
<tr>
<td>: Transport</td>
<td>T</td>
<td>.00</td>
<td>.00</td>
<td>0</td>
</tr>
<tr>
<td>: Licence Fees</td>
<td>NT</td>
<td>.00</td>
<td>.00</td>
<td>0</td>
</tr>
<tr>
<td>Fuels, Oils and Miscellaneous Costs</td>
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<td><strong>TOTAL VARIABLE EXPENDITURE</strong></td>
<td>35.87</td>
<td>1.12</td>
<td>203905</td>
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</table>
### Appendix 2.1 (continued)

**FINANCIAL/ECONOMIC MODEL Aa - SAFARI HUNTING ENTERPRISE - NGAMILAND - BASE CASE**

**TABLE Aa5: OPERATING OVERHEAD EXPENDITURE AT FULL PRODUCTION**

<table>
<thead>
<tr>
<th>ITEM</th>
<th>STATUS</th>
<th>PULA/LSU</th>
<th>PULA/HECTARE</th>
<th>PULA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salaries and Wages: Labour</td>
<td>NT</td>
<td>6.70</td>
<td>.21</td>
<td>37950</td>
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<td>: Manager</td>
<td>NT</td>
<td>20.09</td>
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<td>113687</td>
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<td>Administration</td>
<td>NT</td>
<td>3.84</td>
<td>.12</td>
<td>21710</td>
</tr>
<tr>
<td>Maintenance and Repairs</td>
<td>NT</td>
<td>2.00</td>
<td>.06</td>
<td>11312</td>
</tr>
<tr>
<td>Insurance</td>
<td>NT</td>
<td>1.29</td>
<td>.04</td>
<td>7539</td>
</tr>
<tr>
<td>Travelling</td>
<td>NT</td>
<td>1.77</td>
<td>.06</td>
<td>10090</td>
</tr>
<tr>
<td><strong>TOTAL OPERATING OVERHEAD EXPENDITURE</strong></td>
<td></td>
<td>35.69</td>
<td>1.12</td>
<td>201988</td>
</tr>
</tbody>
</table>

**TABLE Aa6: STATIC FINANCIAL MODEL (AT FULL PRODUCTION)**

<table>
<thead>
<tr>
<th>ITEM</th>
<th>UNITS</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concession Extent</td>
<td>Hectares</td>
<td>181119</td>
</tr>
<tr>
<td>Concession Stock</td>
<td>Large Stock Units (LSU)</td>
<td>5660</td>
</tr>
<tr>
<td>Total Capital Requirement</td>
<td>Pula</td>
<td>534447</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>GROSS INCOME</th>
<th>PULA/LSU</th>
<th>PULA/HECTARE</th>
<th>PULA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>126.15</td>
<td>5.94</td>
<td>714015</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>VARIABLE COSTS</th>
<th>PULA/LSU</th>
<th>PULA/HECTARE</th>
<th>PULA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>35.87</td>
<td>1.12</td>
<td>203005</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>GROSS MARGIN</th>
<th>PULA/LSU</th>
<th>PULA/HECTARE</th>
<th>PULA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>90.28</td>
<td>2.82</td>
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</table>

<table>
<thead>
<tr>
<th>OVERHEAD COSTS</th>
<th>PULA/LSU</th>
<th>PULA/HECTARE</th>
<th>PULA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overhead Operating Costs</td>
<td>35.69</td>
<td>1.12</td>
<td>201988</td>
</tr>
<tr>
<td>Loan Amortisation and Interest</td>
<td>3.11</td>
<td>.10</td>
<td>17594</td>
</tr>
<tr>
<td>Provisions for Capital Replacement</td>
<td>4.89</td>
<td>.15</td>
<td>27695</td>
</tr>
<tr>
<td>Interest on Variable Working Capital</td>
<td>1.61</td>
<td>.05</td>
<td>9135</td>
</tr>
<tr>
<td>Interest on Overhead Working Capital</td>
<td>1.61</td>
<td>.05</td>
<td>9135</td>
</tr>
<tr>
<td>Rental</td>
<td>19.20</td>
<td>.60</td>
<td>108672</td>
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<tr>
<td>Management Fee</td>
<td>.00</td>
<td>.00</td>
<td>0</td>
</tr>
<tr>
<td><strong>TOTAL OVERHEAD COSTS</strong></td>
<td>66.11</td>
<td>2.07</td>
<td>374173</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>NET CASH INCOME</th>
<th>PULA/LSU</th>
<th>PULA/HECTARE</th>
<th>PULA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>24.18</td>
<td>.76</td>
<td>136856</td>
</tr>
</tbody>
</table>

\[
\text{NET CASH INCOME/PI100 TOTAL CAPITAL INVESTMENT (TCI) = 25.60} \\
\text{TOTAL BENEFITS*/PI100 TOTAL CAPITAL INVESTMENT = 54.18} \\
\text{TOTAL BENEFITS*/HECTARE = 1.60}
\]

* "Total Benefits" = all of Net Cash Income, Salaries and Wages, Licences and Duties and Rental.
### Appendix 2.1 (continued)

**FINANCIAL/ECONOMIC MODEL Aa - SAFARI HUNTING ENTERPRISE - NGAMILAND - BASE CASE**

#### TABLE A1: STATIC ECONOMIC MODEL (AT FULL PRODUCTION)

<table>
<thead>
<tr>
<th>ITEM</th>
<th>UNITS</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concession Extent</td>
<td>Hectares</td>
<td>181119</td>
</tr>
<tr>
<td>Concession Stock</td>
<td>Large Stock Units (LSU)</td>
<td>5660</td>
</tr>
<tr>
<td><strong>CAPITAL REQUIREMENTS</strong></td>
<td><strong>PULA/LSU</strong></td>
<td><strong>PULA</strong></td>
</tr>
<tr>
<td>Domestic Component</td>
<td>43.51</td>
<td>246271</td>
</tr>
<tr>
<td>Tradable Component &amp; Import Parity</td>
<td>56.01</td>
<td>316994</td>
</tr>
<tr>
<td>Total Economic Value</td>
<td>99.52</td>
<td>563265</td>
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<tr>
<td><strong>FINANCING</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Domestic Interest Cost</td>
<td>2.35</td>
<td>13294</td>
</tr>
<tr>
<td>Foreign Interest Cost &amp; Import Parity</td>
<td>2.50</td>
<td>14623</td>
</tr>
<tr>
<td><strong>ECONOMIC BENEFITS</strong></td>
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</tr>
<tr>
<td>Gross Income &amp; Import Parity</td>
<td>138.77</td>
<td>785416</td>
</tr>
<tr>
<td><strong>ECONOMIC COSTS</strong></td>
<td></td>
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</tr>
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<td><strong>DOMESTIC COMPONENT</strong></td>
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**NET ECONOMIC BENEFIT/P100 TOTAL CAPITAL COST:** 51.19

**CAPITAL COST/EMPLOYMENT OPPORTUNITY CREATED:** 40233

**NUMBER OF EMPLOYMENT OPPORTUNITIES/1000 HECTARES:** 0.08

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**341**
### Appendix 2.1 (continued)

**FINANCIAL/ECONOMIC MODEL Aa - SAFARI HUNTING ENTERPRISE - NGANILAND - BASE CASE**

**TABLE A99: CAPITAL PHASING, DEPRECIATION SCHEDULE AND CALCULATION OF RESIDUAL VALUE**

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**NON DEPRECIABLE ASSETS**

- Stock
- Phased Expenditure
- Residual value
- Working Capital
- Phased Expenditure

**TOTAL PHASED CAPITAL EXPENDITURE**

- Domestic Component 147763
- Tradable Component 254165
- Total Financial Value 401925
- Total Economic Value 427342

**TOTAL ASSET RESIDUAL VALUE**

- Financial Value 280427
- Economic Value 293694

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### Appendix 2.1 (continued)

**FINANCIAL/ECONOMIC MODEL As - SAFARI HUNTING ENTERPRISE - NGAMALAND - BASE CASE**

**TABLE Aa10: LOAN FINANCING SCHEDULE**

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Appendix 2.1 (continued)

FINANCIAL/ECONOMIC MODEL Aa - SAFARI HUNTING ENTERPRISE - NGAMILAND - BASE CASE

**TABLE Aa1: FINANCIAL ANALYSIS - 5 YEARS (PULA, 1989)**

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Appendix 2.1 (continued)

**FINANCIAL/ECONOMIC MODEL AA - SAFARI HUNTING ENTERPRISE - NGAMILAND - BASE CASE**

**TABLE A14: ECONOMIC ANALYSIS - 5 YEARS (PULA, 1989)**

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**TABLE A15: ECONOMIC ANALYSIS - 10 YEARS (PULA, 1989)**

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345
Ostrich farming enterprise - Limpopo region - base case
Appendix 2.1 (continued)

**FINANCIAL/ECONOMIC MODEL MA - INTENSIVE OSTRICH PRODUCTION (FARMING) - BASE CASE**

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INTEREST AT 15%
Appendix 2.1 (continued)

**FINANCIAL/ECONOMIC MODEL No - INTENSIVE OSTRICH PRODUCTION (FARMING) - BASE CASE**

**TABLE H.2: STOCK COMPOSITION BY SPECIES AT FULL PRODUCTION**

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**LAND REQUIREMENTS**
FARM SIZE & AVERAGE OF 0.3 HA./BIRD: 115 HECTARES

**TABLE H.3: SALES AT FULL PRODUCTION**

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**LIVE SALES (EXPORTS)**

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<tbody>
<tr>
<td>REARING STOCK</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eggs/Chicks (&lt;1 Year)</td>
<td>.00%</td>
<td>0</td>
<td>159</td>
<td>0</td>
</tr>
<tr>
<td>Juveniles (1-2 Years)</td>
<td>.00%</td>
<td>0</td>
<td>747</td>
<td>0</td>
</tr>
<tr>
<td>Juveniles (2-3 Years)</td>
<td>.00%</td>
<td>0</td>
<td>747</td>
<td>0</td>
</tr>
<tr>
<td>BREEDING STOCK</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adults (3-4 Years)</td>
<td>.00%</td>
<td>0</td>
<td>747</td>
<td>0</td>
</tr>
<tr>
<td>Adults (4-5 Years)</td>
<td>.00%</td>
<td>0</td>
<td>747</td>
<td>0</td>
</tr>
<tr>
<td>Adults (5-6 Years)</td>
<td>.00%</td>
<td>0</td>
<td>747</td>
<td>0</td>
</tr>
<tr>
<td>Adults (6-7 Years)</td>
<td>.00%</td>
<td>0</td>
<td>747</td>
<td>0</td>
</tr>
<tr>
<td>SUBTOTAL- LIVE SALES</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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348
### Table A.2: Sales at Full Production (Continued)

<table>
<thead>
<tr>
<th>Other Sales</th>
<th>Offtake</th>
<th>Cold Dressed Mass</th>
<th>Biltong</th>
<th>Value</th>
<th>Income</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Rearing Stock</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eggs/Chicks (&lt; 1 Year)</td>
<td>.00%</td>
<td>0</td>
<td>.00</td>
<td>.00</td>
<td>0</td>
</tr>
<tr>
<td>Juveniles (1-2 Years)</td>
<td>.00%</td>
<td>0</td>
<td>.00</td>
<td>.00</td>
<td>0</td>
</tr>
<tr>
<td>Juveniles (2-3 Years)</td>
<td>.00%</td>
<td>0</td>
<td>.00</td>
<td>.00</td>
<td>0</td>
</tr>
<tr>
<td><strong>Breeding Stock</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adults (3-4 Years)</td>
<td>.00%</td>
<td>0</td>
<td>.60</td>
<td>.00</td>
<td>0</td>
</tr>
<tr>
<td>Adults (4-5 Years)</td>
<td>.00%</td>
<td>0</td>
<td>.60</td>
<td>.00</td>
<td>0</td>
</tr>
<tr>
<td>Adults (5-6 Years)</td>
<td>.00%</td>
<td>0</td>
<td>.60</td>
<td>.00</td>
<td>0</td>
</tr>
<tr>
<td>Adults (6-7 Years)</td>
<td>.00%</td>
<td>0</td>
<td>.60</td>
<td>.00</td>
<td>0</td>
</tr>
<tr>
<td>Other Items</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Subtotal: Other Sales</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td><strong>TOURISM</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Entrance Fees/Curios</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td># Tourists/Year</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Pula/Tourist</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td><strong>Gross Income</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1046359</td>
</tr>
</tbody>
</table>

### Table A.4: Variable Expenditure at Full Production

<table>
<thead>
<tr>
<th>Item</th>
<th>Status</th>
<th>Pula/LBU</th>
<th>Pula/Hectare</th>
<th>Pula</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lucerne (P0.35/kg)/Supplements (P0.58/kg)</td>
<td>T</td>
<td>.00</td>
<td>.00</td>
<td>582454</td>
</tr>
<tr>
<td>Veterinary and Medicine Costs</td>
<td>NT</td>
<td>.00</td>
<td>.00</td>
<td>15071</td>
</tr>
<tr>
<td>Marketing Costs: General (P3.5% of Income)</td>
<td>T</td>
<td>.00</td>
<td>.00</td>
<td>36523</td>
</tr>
<tr>
<td>: Agents Fees</td>
<td>T</td>
<td>.00</td>
<td>.00</td>
<td>0</td>
</tr>
<tr>
<td>: Live Game Distribution</td>
<td>T</td>
<td>.00</td>
<td>.00</td>
<td>0</td>
</tr>
<tr>
<td>: Biltong Distribution</td>
<td>T</td>
<td>.00</td>
<td>.00</td>
<td>0</td>
</tr>
<tr>
<td>Safari Hunting Costs: Accommodation</td>
<td>T</td>
<td>.00</td>
<td>.00</td>
<td>0</td>
</tr>
<tr>
<td>: Transport</td>
<td>T</td>
<td>.00</td>
<td>.00</td>
<td>0</td>
</tr>
<tr>
<td>: Licence Fees</td>
<td>NT</td>
<td>.00</td>
<td>.00</td>
<td>0</td>
</tr>
<tr>
<td>Production Costs: Stock Replacement</td>
<td>T</td>
<td>.00</td>
<td>.00</td>
<td>3108</td>
</tr>
<tr>
<td>: Packaging (P2.2/kg)</td>
<td>T</td>
<td>.00</td>
<td>.00</td>
<td>37604</td>
</tr>
<tr>
<td>: Transport (49000 km)</td>
<td>T</td>
<td>.00</td>
<td>.00</td>
<td>5456</td>
</tr>
<tr>
<td>: Electricity (P455/month)</td>
<td>NT</td>
<td>.00</td>
<td>.00</td>
<td>750</td>
</tr>
<tr>
<td>: Iags (P0.21/bird)</td>
<td>T</td>
<td>.00</td>
<td>.00</td>
<td>6718</td>
</tr>
<tr>
<td>: Supplies (P1.90/bird)</td>
<td>T</td>
<td>.00</td>
<td>.00</td>
<td>0</td>
</tr>
<tr>
<td>: Transport (Freight)</td>
<td>T</td>
<td>.00</td>
<td>.00</td>
<td>8400</td>
</tr>
<tr>
<td>: Export Duty</td>
<td>NT</td>
<td>.00</td>
<td>.00</td>
<td>0</td>
</tr>
<tr>
<td>Fuels, Oils and Miscellaneous Costs</td>
<td>T</td>
<td>.00</td>
<td>.00</td>
<td>696164</td>
</tr>
<tr>
<td><strong>Total Variable Expenditure</strong></td>
<td></td>
<td>.00</td>
<td>.00</td>
<td>0</td>
</tr>
</tbody>
</table>
Appendix 2.1 (continued)

FINANCIAL/ECONOMIC MODEL Na - INTENSIVE OSTRICH PRODUCTION (FARMING) - BASE CASE

TABLE Na5: OPERATING OVERHEAD EXPENDITURE AT FULL PRODUCTION

<table>
<thead>
<tr>
<th>ITEM</th>
<th>STATUS</th>
<th>PULA/LSU</th>
<th>PULA/HECTARE</th>
<th>PULA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salaries and Wages: Labour</td>
<td>M1</td>
<td>.00</td>
<td>.00</td>
<td>32000</td>
</tr>
<tr>
<td>: Manager</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Administration</td>
<td>M1</td>
<td>.00</td>
<td>.00</td>
<td>2250</td>
</tr>
<tr>
<td>Maintenance and Repairs (FC - 14,3% - 6%)</td>
<td>M1</td>
<td>.00</td>
<td>.00</td>
<td>10718</td>
</tr>
<tr>
<td>Insurance (Assets x 1%)</td>
<td>M1</td>
<td>.00</td>
<td>.00</td>
<td>3386</td>
</tr>
<tr>
<td>Travelling</td>
<td>M1</td>
<td>.00</td>
<td>.00</td>
<td>13875</td>
</tr>
<tr>
<td><strong>TOTAL OPERATING OVERHEAD EXPENDITURE</strong></td>
<td></td>
<td>.00</td>
<td>.00</td>
<td>96503</td>
</tr>
</tbody>
</table>

TABLE Na6: STATIC FINANCIAL MODEL (AT FULL PRODUCTION)

<table>
<thead>
<tr>
<th>ITEM</th>
<th>UNITS</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production Scale</td>
<td>Skins/Annua</td>
<td>1400</td>
</tr>
<tr>
<td>Total Feed Cost (FC)</td>
<td>Pula</td>
<td>582484</td>
</tr>
<tr>
<td>Total Investment (ICL)</td>
<td>Pula</td>
<td>519724</td>
</tr>
<tr>
<td><strong>GROSS INCOME</strong></td>
<td></td>
<td>114.51</td>
</tr>
<tr>
<td><strong>VARIABLE COSTS</strong></td>
<td></td>
<td>36.18</td>
</tr>
<tr>
<td><strong>GROSS MARGIN</strong></td>
<td></td>
<td>38.32</td>
</tr>
<tr>
<td><strong>OVERHEAD COSTS</strong></td>
<td></td>
<td>38.32</td>
</tr>
<tr>
<td>Overhead Operating Costs</td>
<td></td>
<td>10.54</td>
</tr>
<tr>
<td>Loan Amortisation and Interest</td>
<td></td>
<td>2.77</td>
</tr>
<tr>
<td>Provisions for Capital Replacement</td>
<td></td>
<td>3.19</td>
</tr>
<tr>
<td>Interest on Variable Working Capital</td>
<td></td>
<td>3.43</td>
</tr>
<tr>
<td>Interest on Overhead Working Capital</td>
<td></td>
<td>.47</td>
</tr>
<tr>
<td>Rental</td>
<td></td>
<td>.00</td>
</tr>
<tr>
<td>Management Fee</td>
<td></td>
<td>.00</td>
</tr>
<tr>
<td><strong>TOTAL OVERHEAD COSTS</strong></td>
<td></td>
<td>20.41</td>
</tr>
<tr>
<td><strong>NET CASH INCOME</strong></td>
<td></td>
<td>17.91</td>
</tr>
</tbody>
</table>

**NET CASH INCOME/P100 TOTAL CAPITAL INVESTMENT (ICL):** 17.91

**TOTAL BENEFITS*/P100 TOTAL CAPITAL INVESTMENT:** 22.93

**TOTAL BENEFITS*/P100 TOTAL FEED COST (FC):** 35.97

* "Total Benefits" = all of Net Cash Income, Salaries and Wages, Licences and Duties and Rental.
Appendix 2.1 (continued)

**FINANCIAL/ECONOMIC MODEL 1a - INTENSIVE OSTRICH PRODUCTION (FARMING) - BASE CASE**

**TABLE 2.17: STATIC ECONOMIC MODEL (AT FULL PRODUCTION)**

<table>
<thead>
<tr>
<th>ITEM</th>
<th>UNITS</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production Scale</td>
<td>Skins/Annual</td>
<td>1400</td>
</tr>
<tr>
<td>Total Economic Feed Cost (EFC)</td>
<td>Pula</td>
<td>649700</td>
</tr>
</tbody>
</table>

**CAPITAL REQUIREMENTS**

<table>
<thead>
<tr>
<th>ITEM</th>
<th>UNITS</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic Component</td>
<td>Pula</td>
<td>462088</td>
</tr>
<tr>
<td>Traceable Component &amp; Import Parity</td>
<td>Pula</td>
<td>498866</td>
</tr>
<tr>
<td>Total Economic Value (TECV)</td>
<td>Pula</td>
<td>960954</td>
</tr>
</tbody>
</table>

**FINANCING**

<table>
<thead>
<tr>
<th>ITEM</th>
<th>UNITS</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic Interest Cost</td>
<td>Pula</td>
<td>51289</td>
</tr>
<tr>
<td>Foreign Interest Cost &amp; Import Parity</td>
<td>Pula</td>
<td>0</td>
</tr>
</tbody>
</table>

**ECONOMIC BENEFITS**

<table>
<thead>
<tr>
<th>ITEM</th>
<th>PULA/P100 TECI</th>
<th>PULA/P100 EFC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gross Income &amp; Import Parity</td>
<td>120.03</td>
<td>179.65</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1150995</td>
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</table>

**ECONOMIC COSTS**

**DOMESTIC COMPONENT**

<table>
<thead>
<tr>
<th>ITEM</th>
<th>UNITS</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shadow Unskilled Citizen Wages</td>
<td>1.47</td>
<td>2.50</td>
</tr>
<tr>
<td>Other Citizen Wages</td>
<td>2.58</td>
<td>3.86</td>
</tr>
<tr>
<td>Citizen Services</td>
<td>2.27</td>
<td>3.40</td>
</tr>
<tr>
<td>Electricity</td>
<td>.57</td>
<td>.85</td>
</tr>
<tr>
<td>Maintenance and Repairs</td>
<td>1.12</td>
<td>1.67</td>
</tr>
<tr>
<td>Other Domestic Economic Costs</td>
<td>1.45</td>
<td>2.17</td>
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<tr>
<td><strong>SUBTOTAL DOMESTIC COMPONENT</strong></td>
<td>9.65</td>
<td>14.45</td>
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**TRADEABLE COMPONENT (INTERNATIONAL PARITY)**

<table>
<thead>
<tr>
<th>ITEM</th>
<th>UNITS</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feed and Raw Material Costs</td>
<td>66.81</td>
<td>100.00</td>
</tr>
<tr>
<td>Foreign Reproduction</td>
<td>.00</td>
<td>.00</td>
</tr>
<tr>
<td>Foreign Services</td>
<td>4.20</td>
<td>6.29</td>
</tr>
<tr>
<td>Fuels and Oils</td>
<td>4.31</td>
<td>6.46</td>
</tr>
<tr>
<td>Foreign Interest</td>
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<td>.00</td>
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<tr>
<td>Foreign Lease Payments</td>
<td>.00</td>
<td>.00</td>
</tr>
<tr>
<td>Foreign Rentals</td>
<td>.00</td>
<td>.00</td>
</tr>
<tr>
<td>Foreign Net Income</td>
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<td>.00</td>
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<tr>
<td>Other Tradeable Economic Costs</td>
<td>5.41</td>
<td>8.10</td>
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<tr>
<td><strong>SUBTOTAL TRADEABLE COMPONENT</strong></td>
<td>80.74</td>
<td>120.85</td>
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</table>

**TOTAL ECONOMIC COSTS**

<table>
<thead>
<tr>
<th>ITEM</th>
<th>UNITS</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>90.39</td>
<td>135.29</td>
</tr>
<tr>
<td></td>
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<td>856827</td>
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**NET ECONOMIC BENEFIT (INCREMENTAL NET BENEFIT)**

<table>
<thead>
<tr>
<th>ITEM</th>
<th>UNITS</th>
<th>TOTAL</th>
</tr>
</thead>
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<tr>
<td></td>
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**DOMESTIC RESOURCE COST RATIO:**

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**NET ECONOMIC BENEFIT/P100 TOTAL CAPITAL COST:**

<table>
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<th>UNITS</th>
<th>TOTAL</th>
</tr>
</thead>
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<tr>
<td></td>
<td>29.63</td>
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**CAPITAL COST/EMPLOYMENT OPPORTUNITY CREATION:**

<table>
<thead>
<tr>
<th>ITEM</th>
<th>UNITS</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>56409</td>
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</tbody>
</table>
Appendix 2.1 (continued)

FINANCIAL/ECONOMIC MODEL N2 - INTENSIVE OSTRICH PRODUCTION (FARMING) - BASE CASE

TABLE N26: STOCK PROJECTION

<table>
<thead>
<tr>
<th>YEAR</th>
<th>0</th>
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<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9/10</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**STOCK PURCHASES (NUMBERS CAPTURED)**

**REARING BIRDS**
Eggs/Chicks 2000 0 0 0 0 0 0 0 0 0
1 Year Old Birds 34 0 0 0 0 0 0 0 0 0
2 Year Old Birds 35 0 0 0 0 0 0 0 0 0

**BREEDING BIRDS**
3 Year Old Birds 36 0 0 0 0 0 0 0 0 0
4 Year Old Birds 35 0 0 0 0 0 0 0 0 0
5 Year Old Birds 35 0 0 0 0 0 0 0 0 0
6 Year Old Birds 34 0 0 0 0 0 0 0 0 0

**TOTALS** 2210 0 0 0 0 0 0 0 0 0

**STOCK ON HAND (NUMBERS)**

**REARING BIRDS**
1 Year Old Birds 27 1400 1400 1376 1332 1327 1341 1365 1405 1405
2 Year Old Birds 28 26 30 30 30 30 30 30 30 30

**BREEDING BIRDS**
3 Year Old Birds 29 27 26 29 29 29 29 29 29 29
4 Year Old Birds 28 28 28 28 28 28 28 28 28 28
5 Year Old Birds 27 27 27 26 24 27 27 27 27 27
6 Year Old Birds 27 27 26 26 25 27 27 27 27 27

**TOTALS** 2166 3536 3501 3415 3378 3391 3432 3514 3554 3554

% of Full Production 60.95% 99.48% 98.51% 96.00% 95.00% 95.41% 96.57% 99.86% 100.50% 100.00%

**STOCK SALES (NUMBERS)**

**REARING BIRDS**
Eggs/Chicks 0 0 0 0 0 0 0 0 0 0
1 Year Old Birds 0 1369 1369 1345 1301 1306 1310 1354 1374 1374
2 Year Old Birds 0 0 0 0 0 0 0 0 0 0

**BREEDING BIRDS**
3 Year Old Birds 0 0 0 0 0 0 0 0 0 0
4 Year Old Birds 0 0 0 0 0 0 0 0 0 0
5 Year Old Birds 0 0 0 0 0 0 0 0 0 0
6 Year Old Birds 0 26 26 26 26 24 25 26 26 26

**TOTALS** 0 1395 1395 1370 1327 1330 1333 1359 1400 1400
Appendix 2.1 (continued)

FINANCIAL/ECONOMIC MODEL N°2 - INTENSIVE OSTRICH PRODUCTION (FARMING) - BASE CASE

TABLE N°5: VALUE OF STOCK

<table>
<thead>
<tr>
<th>YEAR</th>
<th>VALUE/UNIT</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9/10</th>
</tr>
</thead>
</table>

### VALUE OF STOCK PURCHASES (CAPTURE, PULA, 1991)

**REARING BIRDS**

<table>
<thead>
<tr>
<th>Eggs/Chicks</th>
<th>151450</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Year Old Birds</td>
<td>14107</td>
</tr>
<tr>
<td>2 Year Old Birds</td>
<td>14543</td>
</tr>
</tbody>
</table>

**BREEDING BIRDS**

| 3 Year Old Birds | 14993 |
| 4 Year Old Birds | 14522 |
| 5 Year Old Birds | 14216 |
| 6 Year Old Birds | 13790 |

**TOTALS**

259630

### VALUE OF STOCK ON HAND (PULA, 1991)

**REARING BIRDS**

<table>
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<tr>
<th>Eggs/Chicks</th>
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</tr>
<tr>
<td>2 Year Old Birds</td>
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</table>

**BREEDING BIRDS**

| 3 Year Old Birds | 21442 |
| 4 Year Old Birds | 20977 |
| 5 Year Old Birds | 20520 |
| 6 Year Old Birds | 19906 |

**TOTALS**

403373

### VALUE OF STOCK SALES (PULA, 1991)

**REARING BIRDS**

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**BREEDING BIRDS**

| 3 Year Old Birds | 19270 |
| 4 Year Old Birds | 19415 |
| 5 Year Old Birds | 19058 |
| 6 Year Old Birds | 19058 |

**TOTALS**

0

**% of Full Production**

.00% 99.63% 99.63% 97.89% 92.76% 94.54% 92.76% 92.76% 92.76%
# Appendix 2.1 (continued)

**FINANCIAL/ECONOMIC MODEL Ra - INTENSIVE OSTRICH PRODUCTION (FARMING) - BASE CASE**

**TABLE NAJO: CAPITAL PHASING, DEPRECIATION SCHEDULE AND CALCULATION OF RESIDUAL VALUE**

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<tr>
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<td>67959</td>
<td>50996</td>
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</tbody>
</table>

**NON DEPRECIABLE ASSETS**

| Stock | | | | | | | | | | | | |
| Phased Expenditure | 298630 | | | | | | | | | | | |
| Residual value | 405373 | 384204 | 379502 | 371226 | 372426 | 375821 | 383950 | 389708 | 389708 | 389708 | 389708 |

| Working Capital | | | | | | | | | | | | |
| Phased Expenditure | 237740 | | | | | | | | | | | |

**TOTAL PHASED CAPITAL EXPENDITURE**

| Domestic Component | | | | | | | | | | | | |
| Tradable Component | 372105 | 88983 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Financial Value | 714397 | 139387 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

**TOTAL ASSET RESIDUAL VALUE**

| Financial Value | 700400 | 389297 | 74586 | 698500 | 728750 | 695213 | 699212 | 696103 | 721525 | 686742 | 647123 |
| Economic Value | 716735 | 801894 | 166949 | 310428 | 744138 | 705289 | 722618 | 708167 | 746077 | 698434 | 651685 |
Appendix 2.1 (continued)

**FINANCIAL/ECONOMIC MODEL Case - INTENSIVE OSTRICH PRODUCTION (FARMING) - BASE CASE**

**TABLE A18: LOAN FINANCING SCHEDULE**

| ITEM                          | PERIOD (Yrs) | 0   | 1   | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 9   | 10  |
|-------------------------------|--------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| LONG TERM LOANS              |              |     |     |     |     |     |     |     |     |     |     |     |
| TWENTY YEAR LOANS            |              |     |     |     |     |     |     |     |     |     |     |     |
| Total Expenditure            | 65376        |     |     |     |     |     |     |     |     |     |     |     |
| Loan Disbursements           | 65096        | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 |
| Loan Payments                | 65096        | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 |
| Amortisation                 | 65096        | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 |
| Interest Payments            | 65096        | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 |
| Loans Outstanding            | 65096        | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 |
| FIFTEEN YEAR LOANS           |              |     |     |     |     |     |     |     |     |     |     |     |
| Total Expenditure            | 75910        |     |     |     |     |     |     |     |     |     |     |     |
| Loan Disbursements           | 75910        | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 |
| Loan Payments                | 75910        | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 |
| Amortisation                 | 75910        | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 |
| Interest Payments            | 75910        | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 |
| Loans Outstanding            | 75910        | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 |
| SIX YEAR LOANS               |              |     |     |     |     |     |     |     |     |     |     |     |
| Total Expenditure            | 66682        |     |     |     |     |     |     |     |     |     |     |     |
| Loan Disbursements           | 66682        | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 |
| Loan Payments                | 66682        | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 |
| Amortisation                 | 66682        | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 |
| Interest Payments            | 66682        | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 |
| Loans Outstanding            | 66682        | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 |
| FOUR YEAR LOANS              |              |     |     |     |     |     |     |     |     |     |     |     |
| Total Expenditure            | 67959        |     |     |     |     |     |     |     |     |     |     |     |
| Loan Disbursements           | 67959        | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 |
| Loan Payments                | 67959        | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 |
| Amortisation                 | 67959        | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 |
| Interest Payments            | 67959        | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 |
| Loans Outstanding            | 67959        | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 | 4606 |
| SHORT TERM LOANS             |              |     |     |     |     |     |     |     |     |     |     |     |
| Working Capital              |              |     |     |     |     |     |     |     |     |     |     |     |
| Overdraft                    | 237740       | 237740 | 237740 | 237740 | 237740 | 237740 | 237740 | 237740 | 237740 | 237740 | 237740 | 237740 |
| Interest Payments            | 35661        | 35661 | 35661 | 35661 | 35661 | 35661 | 35661 | 35661 | 35661 | 35661 | 35661 | 35661 |
| TOTAL LONG TERM LOAN DISBURSEMENTS |       |     |     |     |     |     |     |     |     |     |     |     |
| Domestic Component           | 112739       | 36292 | 0     | 0     | 0     | 16990 | 0     | 11690 | 5010 | 16990 | 0   | 0   |
| Foreign Component            |              |     |     |     |     |     |     |     |     |     |     |     |
| TOTAL LONG TERM LOAN AMORTISATION |       |     |     |     |     |     |     |     |     |     |     |     |
| Domestic Component           | 105681       | 14111 | 14111 | 14111 | 14111 | 14111 | 14111 | 14111 | 14111 | 14111 | 14111 | 14111 |
| Foreign Component            |              |     |     |     |     |     |     |     |     |     |     |     |
| TOTAL INTEREST PAYMENTS      |              |     |     |     |     |     |     |     |     |     |     |     |
| Domestic Component           | 42141        | 46993 | 46993 | 46993 | 46993 | 46993 | 46993 | 46993 | 46993 | 46993 | 46993 | 46993 |
| Foreign Component            |              |     |     |     |     |     |     |     |     |     |     |     |
| TOTAL LOANS OUTSTANDING     |              |     |     |     |     |     |     |     |     |     |     |     |
| Domestic Component           | 112719       | 158776 | 144262 | 130150 | 133926 | 118913 | 116490 | 107387 | 110264 | 96151 | 82037 |
| Foreign Component            |              |     |     |     |     |     |     |     |     |     |     |     |

* Economic Values (# Import Parity)
Appendix 2.1 (continued)

**TABLE A12: FINANCIAL ANALYSIS - 5 YEARS (PULA, 1989)**

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<th>Year 2</th>
<th>Year 3</th>
<th>Year 4</th>
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**TABLE A13: FINANCIAL ANALYSIS - 7 YEARS (PULA, 1989)**

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**TABLE A14: FINANCIAL ANALYSIS - 10 YEARS (PULA, 1989)**

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### Table 2A6: Economic Analysis - 10 Years (Pula,1989)

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Appendix 2.2

List of animal and plant names used in the text
Appendix 2.2
List of animal and plant names used in the text

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<td>Canis mesomelas</td>
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<td>(eastern)</td>
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Species, as named in text, are listed alphabetically under mammals, birds, reptiles, trees and shrubs, and grasses. Where it is of economic interest, subspecies are given.
Appendix 2.2 (continued)

Mountain reedbuck -
Nyala -
Oribi -
Puku -
Reedbuck -
Roan -
Sable -
Sharpe’s steenbok -
Side-striped jackal -
Silver fox -
Sitatunga -
Spotted hyaena -
Springbok -
Springhare -
Steenbok -
Tsessebe -
Warthog -
Waterbuck -
White rhino -
White-tailed deer -
Wild cat -
Wild dog -
Wildebeest -
Yellow mongoose -
Yellow-spotted dassie -
Zebra -

**Redunca fulvorufula**
Tragelaphus angasii
Ourebia ourebi
Kobus vardontii
Redunca arundinum
Hippotragus equinus
Hippotragus niger
Raphicerus sharpei
Canis adustus
Vulpes chama
Tragelaphus spekei
Crocuta crocuta
Antidorcas marsupialis
Pedetes capensis
Raphicerus campestris
Damaliscus lunatus
Phacochoerus aethiopicus
Kobus ellipsiprymnus ellipsiprymnus
Ceratotherium simum
Odocoileus virginianus
Felis lybica
Lycaon pictus
Connochaetes taurinus
Cynictis penicillata
Heterohyrax brucei
Equus burchelli

**Birds** (Class Aves)

**Common name**
Black korhaan -
Burchell’s sandgrouse -
Ducks -

**Scientific name**
Eupodotis afra
Pterocles burchelli
Family Anatidae
Appendix 2.2 (continued)

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Trees and shrubs (Woody species of Class Magnoliatae)

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<td>Camel thorn</td>
</tr>
<tr>
<td>Acacia fleckii</td>
<td>Blade thorn</td>
</tr>
<tr>
<td>Acacia lutetii</td>
<td>Kalahari sand acacia</td>
</tr>
<tr>
<td>Acacia mellifera</td>
<td>Black thorn</td>
</tr>
<tr>
<td>Acacia nigrescens</td>
<td>Knob-thorn</td>
</tr>
<tr>
<td>Acacia tortilis</td>
<td>Umbrella thorn</td>
</tr>
<tr>
<td>Baikiea plurijuga</td>
<td>Rhodesian teak</td>
</tr>
<tr>
<td>Boscia albitrunca</td>
<td>Shepherd’s tree</td>
</tr>
<tr>
<td>Burkea africana</td>
<td>Red syringa</td>
</tr>
<tr>
<td>Colophospermum mopane</td>
<td>Mopane</td>
</tr>
<tr>
<td>Combretum apiculatum</td>
<td>Red bushwillow</td>
</tr>
<tr>
<td>Combretum collinum</td>
<td>Bushwillow</td>
</tr>
<tr>
<td>Combretum hereroense</td>
<td>Russet bushwillow</td>
</tr>
<tr>
<td>Conniphora species</td>
<td>Myrrh family (Burseraceae)</td>
</tr>
<tr>
<td>Croton gratissimus</td>
<td>Lavender croton</td>
</tr>
<tr>
<td>Dichrostachys cinerea</td>
<td>Sickle bush</td>
</tr>
<tr>
<td>Elephantorrhiza elephanta</td>
<td>Mosiatsane</td>
</tr>
</tbody>
</table>
Appendix 2.2 (continued)

<table>
<thead>
<tr>
<th>Scientific name</th>
<th>Common name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grewia flava</td>
<td>Brandy bush</td>
</tr>
<tr>
<td>Lonchocarpus nelsii</td>
<td>Kalahari apple-leaf</td>
</tr>
<tr>
<td>Pterocarpus angolensis</td>
<td>Mukwa</td>
</tr>
<tr>
<td>Terminalia sericea</td>
<td>Silver terminalia</td>
</tr>
</tbody>
</table>

Sedges (Family Cyperaceae)

<table>
<thead>
<tr>
<th>Scientific name</th>
<th>Common name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cyperus papyrus</td>
<td>Papyrus</td>
</tr>
</tbody>
</table>

Grasses (Family Poaceae)

<table>
<thead>
<tr>
<th>Scientific name</th>
<th>Common name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aristida stipitata</td>
<td>Long needle prick grass</td>
</tr>
<tr>
<td>Eragrostis lemanniana</td>
<td>Lehmann's love grass</td>
</tr>
<tr>
<td>Eragrostis pennis</td>
<td>Broom grass</td>
</tr>
<tr>
<td>Schmidia pappophoroides</td>
<td>Kalahari sand couch</td>
</tr>
<tr>
<td>Stipagrostis uniplumis</td>
<td>Silky bushman grass</td>
</tr>
</tbody>
</table>
Appendix 4.1

Questionnaire used in the contingent valuation study
DEPARTMENT OF WILDLIFE AND NATIONAL PARKS. ECONOMICS SECTION,
QUESTIONNAIRE FOR INDIVIDUAL TOURISTS

The Department of Wildlife and National Parks (DWNP) has the task of administering the wildlife sector in Botswana. It needs to ensure that conservation of the wildlife heritage and biodiversity are not jeopardised by the utilisation of wildlife, and that the latter contributes optimally to the economy. Careful planning, based on sound information, is required. The aim of this questionnaire is to determine the characteristics of demand for wildlife-based tourism in Botswana.

We would be grateful if you could help by answering the following questions. You need not give your name and, in any case, all responses will be completely confidential. Please answer by placing ticks in the boxes that apply, or by filling in the blanks as appropriate.

1. BACKGROUND

1.1. Name of respondent (optional):________________________

1.2. Nationality:________________________

1.3. Where are you currently resident?
   Place:________________________Country:________________________

1.4. What is your residential status in Botswana?
   Citizen/__/ Resident/__/ Non-Resident/__/______

1.5. From what place did you depart for this trip
   Place:________________________Country:________________________

1.6. What other countries are you visiting on this trip
   __________________________

1.7. How long will you be away from home?
   ________________Days

1.8. How much of your visit to Botswana will involve wildlife-related activities?
   ________________Days
1.9. If you are participating in wildlife-related activities, what is your main purpose?
Wildlife Viewing/✓  Photography/✓  Hunting/✓
Other: ____________________________

1.10. How will you be travelling to destinations in Botswana?
With a Tour/✓  Self Driven/✓  Other: ____________________________

1.11. Which wildlife-related destinations in Botswana (e.g. parks, reserves, hunting areas) are you visiting on this trip?

1.12. In what type of accommodation are you staying?
Hotels/✓  Game Lodges/✓  Hunting Camps/✓
Campsites/✓  Other: ____________________________

1.13. Please indicate your approximate annual income.
Amount: _______________ Currency: _______________

2. EXPENDITURE ESTIMATES

In order that the supply of tourism products can be tailored to fit demand, we need to characterise the diversity of demand. The following questions relate mainly to expenditures. Note that whatever your answers are, they cannot affect actual prices.

2.1. Please estimate the total cost of your holiday.
Amount: _______________ Currency: _______________

2.2. How much of this (if any) are you, personally, spending within Botswana?
Amount: _______________ Currency: _______________

2.3. Given the overall degree of enjoyment/satisfaction you are experiencing on this trip in Botswana, do you consider it to be value for money?
Yes/✓  No/✓

2.4. Would you return on a visit of a similar nature?
Yes/✓  No/✓
2.5. If not (you answered "No" to question 2.4.), which, if any, of the following cost levels (for your visit) is low enough to induce you to return?

- Three quarters (.75) of present cost
- Half (.5) of present cost
- One quarter (.25) of present cost
- Not Applicable

2.6. If so (you answered "Yes" to question 2.4.), which of the following cost levels (for your visit) is high enough to prevent you returning?

- One and a quarter (1.25) times present cost
- One and a half (1.5) times present cost
- One and three quarter (1.75) times present cost
- Two (2) times present cost
- Two and a half (2.5) times present cost
- Three (3) times present cost
- Not Applicable

2.7. Botswana's wildlife is under threat from competing land uses and from poachers. Would you be prepared to pay toward a special fund which would be used directly in protecting wildlife in Botswana? (Assume that the funds would be applied in the best way you can think of)

- Yes, but once only
- Yes, each time I come on a trip such as this one
- Yes, once per year, as a membership subscription
- No

2.8. If yes (you answered "Yes" to Question 2.7.), approximately how much would you be willing to contribute?

Amount: __________________________ Currency: __________________________

- Not Applicable

2.9. If yes (you answered "Yes" to Question 2.7.), what type of organisation should any such funds be channelled through?

- Not Applicable

2.10. Currently the fee paid to Government for a non-resident, non-citizen to enter a National Park in Botswana is fifty Pula (or $US25) per day. Do you consider this fee appropriate?

- Yes
- No
2.11. If not (you answered "No" to question 2.10), what do you think would be a fair amount to pay, for this category?
Amount (per day): ____________________ Currency: ____________________
Not Applicable /___/

3. ENJOYMENT AND SATISFACTION

Planning for development in wildlife areas while minimising environmental damage and ensuring satisfactory service requires an idea of tourist preferences. Your ratings, below, can help us build up a picture of these.

3.1. How do you rate the quality of service from the following officials, or the quality of the following park infrastructure and amenities in Botswana?

<table>
<thead>
<tr>
<th>Quality of Service/Amenity</th>
<th>High</th>
<th>Moderate</th>
<th>Low</th>
<th>Very Low</th>
<th>Don't Know</th>
</tr>
</thead>
<tbody>
<tr>
<td>Immigration Officials</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Customs Officials</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wildlife/Park Officials</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Park Roads</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Park Campsites</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

3.2. Please rate each of the following items according to their likely contribution to your enjoyment/satisfaction (please try to place one tick for each item).

<table>
<thead>
<tr>
<th>Enjoyment/Satisfaction Rating</th>
<th>Very high</th>
<th>High</th>
<th>Moderate</th>
<th>Low</th>
<th>Don't know</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Items</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wildlife</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attractive Scenery</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Undisturbed Wilderness</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Adventure</td>
<td></td>
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<tr>
<td>Indigenous Culture</td>
<td></td>
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<tr>
<td>Restfulness</td>
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<td>Entertainment</td>
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<tr>
<td>Education</td>
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<td></td>
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<tr>
<td>Other:</td>
<td></td>
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</table>

(Continued)
3.2 (Continued)

<table>
<thead>
<tr>
<th>Wildlife &quot;Species&quot;</th>
<th>Enjoyment/Satisfaction Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buffalo</td>
<td></td>
</tr>
<tr>
<td>Bushbuck</td>
<td></td>
</tr>
<tr>
<td>Cheetah</td>
<td></td>
</tr>
<tr>
<td>Crocodile</td>
<td></td>
</tr>
<tr>
<td>Eland</td>
<td></td>
</tr>
<tr>
<td>Elephant</td>
<td></td>
</tr>
<tr>
<td>Gemsbok</td>
<td></td>
</tr>
<tr>
<td>Giraffe</td>
<td></td>
</tr>
<tr>
<td>Hartebeest</td>
<td></td>
</tr>
<tr>
<td>Hippo</td>
<td></td>
</tr>
<tr>
<td>&quot;Hyenas&quot;</td>
<td></td>
</tr>
<tr>
<td>Kudu</td>
<td></td>
</tr>
<tr>
<td>Ostrich</td>
<td></td>
</tr>
<tr>
<td>&quot;Large Birds&quot;</td>
<td></td>
</tr>
<tr>
<td>Leopard</td>
<td></td>
</tr>
<tr>
<td>Lion</td>
<td></td>
</tr>
<tr>
<td>Reedbuck</td>
<td></td>
</tr>
<tr>
<td>Sitatunga</td>
<td></td>
</tr>
<tr>
<td>&quot;Snakes&quot;</td>
<td></td>
</tr>
<tr>
<td>&quot;Small Antelope&quot;</td>
<td></td>
</tr>
<tr>
<td>&quot;Small Birds&quot;</td>
<td></td>
</tr>
<tr>
<td>&quot;Small Mammals&quot;</td>
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<tr>
<td>Springbok</td>
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<tr>
<td>Waterbuck</td>
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<td>Wild Dog</td>
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<td>Wildebeest</td>
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<tr>
<td>Zebra</td>
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<tr>
<td>Other:</td>
<td></td>
</tr>
<tr>
<td>Other:</td>
<td></td>
</tr>
<tr>
<td>Other:</td>
<td></td>
</tr>
</tbody>
</table>

3.3. Finally, If there are any specific comments you would like to make, please do so (continue overleaf if you want):


Thank you very much for your assistance. We would be grateful if you could return the questionnaire - to the person who gave it to you - or to a member of the Department of Wildlife and National Parks in Botswana - or send it by mail to:

Economics Section,
Department of Wildlife and National Parks,
P.O. Box 131, GABORONE. BOTSWANA

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