CHAPTER 6

The cost efficiency of wild dog *Lycaon pictus* conservation in South Africa

6.1 Introduction

Cost efficiency in conservation can be gauged in terms of units of an environmental good conserved per unit money spent. Examples of units of 'environmental goods' in this context include, the recovery in numbers of a population of a species, or the land area in km^2 of forest conserved. Pressures on remaining natural habitats are increasing, and the number of threatened species is rising correspondingly (Guikema & Milke 1999). As a result, there is a worsening shortfall between the resources required for conservation, and what is available (Myers et al. 2000). For example, the costs of a globally effective reserve network encompassing terrestrial and marine habitats are estimated at $45 billion per year (Balmford et al. 2002), while current global spending on reserve networks is as little as $1 - 6 billion (James et al. 1999; Balmford et al. 2002). Expenditure on endangered species in the USA is estimated to be 20% of the amount required (Miller et al. 2002) and in developing countries the shortfall is likely to be substantially greater. The gulf between funding requirements and current global spending dictates that cost efficiency should be a primary consideration in conservation prioritisation (Balmford et al. 2003).

Conservation competes for donor funding with other human-centred issues and there has

been some political controversy surrounding the amount of money being spent on endangered species conservation (Baker 1999). Consequently, there is an ethical basis for the need for cost efficiency in conservation. In addition, there has been increasing debate surrounding the skewed distribution of donor funds (Czech et al. 1998; Baker 1999), with conservation efforts typically favouring a minority of charismatic species (Restani & Marzluff 2002). Prospects for recovery in populations of threatened species improve with increasing donor funding (Miller et al. 2002; Restani & Marzluff 2002), and cost efficient conservation programme design increases the chances of financial support (Moran et al. 1997). Cost efficiency is of particular importance in developing countries where the shortfall in funding for conservation is largest, and where the potential return from conservation spending is greatest (Balmford et al. 2003).

Cost efficiency has been the focus of a number of studies on conservation planning (Moran et al. 1997; Ando et al. 1998; Balmford et al. 2003), and several studies have reviewed spending in relation to the US Endangered Species Act (Baker 1999; Miller et al. 2002; Restani & Marzluff 2002). Research into the cost efficiency of conservation options involving single species, however, has been less common. Mech (1998) considered the costs associated with two wolf *Canis lupus* conservation options in Minnesota, while Main et al (1998) estimated the costs of two conservation plans for Florida panthers *Felis concolor coryi.* In many developing countries, cost efficiency in conservation planning has received little or no attention, despite a desperate shortage of funds.

In my study, the African wild dog is used as model species to investigate the role of donor funding in the conservation of an endangered carnivore in southern Africa, and to estimate the cost efficiency of current, and potential future conservation strategies.

6.1.1 Current conservation efforts involving wild dogs in South Africa

Despite an historic range comprising almost all of South Africa (Skinner & Smithers 1990), wild dogs are currently limited to a single viable population (177 – 434 individuals in 21 – 32 packs, Maddock & Mills 1994; Davies 2000), occurring in the Kruger National Park (henceforth referred to as "Kruger"). Most of South Africa (~ 70%) is comprised of private land, and state-owned protected areas comprise <5% of the national land area (Cumming 1991). Aside from Kruger, no other suitable reserves of sufficient size exist in South Africa to hold a second viable population of wild dogs. The current conservation focus is the creation of a meta-population, based on the reintroduction of packs into a number of geographically isolated reserves, with the aim of establishing a minimum of nine packs within 10 years (Mills et al. 1998). To date, wild dogs have been reintroduced into four state-owned protected areas: Hluhluwe-Umfolozi Park; Madikwe Game Reserve; Marakele National Park; Pilanesberg National Park, and two privately owned protected areas - Karongwe Game Reserve, and Venetia-Limpopo Nature Reserve. In future, expansion of the meta-population is likely to depend increasingly on privately owned reserves.

The 'meta-population management plan' (Mills et al. 1998) is a management intensive process requiring significant logistical investment, particularly during the initial

establishment phase of each sub-population (Chapter 5). Six years into the plan, there is a need to assess the efficacy and cost efficiency of this strategy, and to predict the cost efficiency of expanding the meta-population to incorporate private nature reserves.

In addition to the Kruger population and the meta-population, a third population of wild dogs occurs on ranchland, outside state and private nature reserves in South Africa, comprising ~ 76 individuals in ~ 17 packs and dispersing groups (Chapter 2). Focal areas of wild dog activity outside protected areas in South Africa include the ranching areas adjacent to the western border of Kruger, and the ranching areas along the Limpopo River (Chapter 2). Changing land use patterns and an increase in game ranching in South Africa has resulted in increasing potential for conserving wild dogs on ranchland. Given the shortage of large protected areas of suitable habitat type, ranchland is potentially important for the expansion of the South African wild dog population. This potential merits an assessment of the predicted cost efficiency of conserving wild dogs in this land tenure category.

The objectives of this study were twofold. 1) To determine the amount of money spent on wild dog conservation in South Africa over a period of five years (1997 - 2001, the first five years of the meta-population management plan), to determine the source of funding, and to document how it was spent. 2) To assess the cost efficiency of current conservation efforts involving wild dogs - within a large protected area (Kruger), and through the establishment of the meta-population, relative to two potential future conservation options. a) The expansion of the meta-population onto privately owned

nature reserves. Here, it was assumed that wild dogs are absent prior to reintroduction, and are prevented from leaving the reserve post release by the presence of perimeter fencing. b) Conserving naturally occurring wild dogs *in situ* on privately owned livestock / game ranchland. Although some of the ranches in such an area may in fact be private nature reserves, this scenario was distinguished from the reintroduction scenario by the fact that wild dogs occur naturally, without requiring reintroduction, and that wild dogs are able to pass between ranches, due to the absence of predator proof fencing between properties. The purpose of this assessment was to provide guidelines for the use of donor funding, and to focus conservation efforts.

6.2 Methods

6.2.1 Expenditure on wild dog conservation in South Africa (1997 – 2001)

Wild dog stakeholders in South Africa (Table 6.1) were asked to how much money was spent on activities related to wild dog conservation, when it was spent, on what it was spent and from whom was it received between 1997 and 2001. 'Stakeholders' included agencies involved in the conservation of wild dogs within Kruger and the meta-population reserves, provincial nature conservation representatives responsible for predators occurring outside of state and provincial parks, and researchers. Expenditures by captive breeders associated with the provision of wild dogs for reintroduction programmes were also documented. Budget records were obtained where possible, and alternatively the costs of activities conducted during the five-year period were estimated. The results presented should be considered minimum expenditure estimates.

Table 6.1 Stakeholders contacted for the collation of records of expenditure made on wild dog conservation during 1997 - 2001

Stakeholder	Involvement
De Wildt Cheetah Breeding Centre	Provision / transport of wild dogs for reintroduction
Hluhluwe-Umfolozi Park	Reintroduction site
Karongwe Game Reserve	Reintroduction site
Kwa-Zulu Natal Wildlife	Reintroduction at HUP [a]
Limpopo Nature Conservation	Capture and transport of wild dogs on ranchland
Madikwe Game Reserve	Reintroduction site
North West Parks Board	Reintroductions at Madikwe and Pilanesberg
Pilanesberg National Park	Reintroduction site
South African National Parks	Kruger population, professional assistance
University of Pretoria	Research
Venetia Limpopo Nature Reserve	Reintroduction site

[a] Hluhluwe-Umfolozi Park.

Expenditure records were converted into 2002 US$ figures, based on the Consumer Price Indices published by the South African Reserve Bank, and the mean US$ / South African Rand exchange rate for the first sixth months of 2002 ($1 = ZAR 10.99).

6.2.2 Cost efficiency indices

The following equation was derived to calculate the cost efficiency of the conservation of wild dogs under various scenarios:

$$CEI = \frac{100,000}{7}\left[\frac{Packs_1}{\left(\frac{C_1}{(1+r)}\right)} + \frac{Packs_2}{\left(\frac{C_2}{(1+r)^2}\right)} + \frac{Packs_3}{\left(\frac{C_3}{(1+r)^3}\right)} + \frac{Packs_4}{\left(\frac{C_4}{(1+r)^4}\right)} + \frac{Packs_5}{\left(\frac{C_5}{(1+r)^5}\right)} + \frac{Packs_5}{\left(\frac{\frac{C_5}{r}}{(1+r)^5}\right)} + \frac{Packs_5}{SSC}\right]$$

CEI represents the cost efficiency index, conceptually based on wild dogs conserved / $100,000 spent, adjusted for time through discounting. $Packs_1$ – $Packs_5$ represent the number of packs in the population resulting from a given strategy in years 1 - 5, while $Packs_5$ also represents the predicted population size in perpetuity, assuming that the number of packs will remain, or be managed to stay at this size. C_1 – C_5 are the costs over five years of a conservation option, while C_5 also represents continuing costs in perpetuity, assuming that the annual costs in perpetuity will be equal to the costs in year five. Costs of a conservation programme are likely to vary for the first few years, and it was felt that after five years, the costs of a conservation strategy would stabilise. *SSC* is the sum of the start up costs associated with a conservation programme, and r is the

discount rate, based on the average long-term South African Government Bond rates for the first six months of 2002.

This formula calculates a CEI for each of five years using packs and costs in each year, a CEI for the costs of maintaining a stable wild dog population with a known number of packs in perpetuity, and an index of the perpetual number of packs to the initial costs. Each individual CEI is then averaged into the overall CEI, which is multiplied by 100,000 to yield packs / $100,000.

The cost efficiency of conserving wild dogs within a large protected area (Kruger) was calculated slightly differently. Wild dogs have been present in Kruger since the inception of the park, and therefore 'start up costs' were not incurred, and thus excluded from the equation. In addition, significant costs are incurred every five years in Kruger as a result of the five yearly wild dog photographic census, and the equation was modified to account for this, assuming for tractability that one-fifth of the five-yearly cost occurs each year.

$$CEI = \frac{100,000}{6}\left[\frac{Packs_1}{\left(\frac{C_1}{(1+r)}\right)} + \frac{Packs_2}{\left(\frac{C_2}{(1+r)^2}\right)} + \frac{Packs_3}{\left(\frac{C_3}{(1+r)^3}\right)} + \frac{Packs_4}{\left(\frac{C_4}{(1+r)^4}\right)} + \frac{Packs_5}{\left(\frac{C_5}{(1+r)^5}\right)} + \frac{Packs_5}{\left(\frac{C_5 + \frac{\text{Five-year cost}}{5}}{(1+r)^5}\right)}\right]$$

6.2.3 Cost efficiency of conserving wild dogs within a large protected area (Kruger)

The cost efficiency of conserving wild dogs within a viable population was estimated, using the expenditure made on wild dogs in Kruger during 1997 – 2001, and the average number of packs counted in the last three photographic censuses in Kruger (28 packs, Maddock & Mills 1994; Wilkinson 1995; Davies 2000). The average number of packs was assumed to be a more accurate representation of the Kruger population than the latest estimate (21 packs), which is believed to constitute an unusually low population size resulting from poor hunting success, probably related to high rainfall (Davies 2000).

6.2.4 Cost efficiency of the establishment of the meta-population

Costs associated with the establishment and maintenance of sub-populations within the meta-population typically include: upgrading of perimeter fencing; upgrading of holding facilities; capture and transport of founders; veterinary costs; feeding the dogs in holding facilities; purchasing monitoring equipment; and monitoring. Wild dogs were reintroduced at Hluhluwe-Umfolozi Park and Madikwe Game Reserve in 1981 and 1994 respectively, and changing personnel prevented the collection of data on the initial reintroduction costs. Consequently, the costs of the initial reintroduction at these reserves were assumed to equal the average initial costs associated with reintroductions undertaken between 1997 and 2001 (Karongwe Game Reserve, Pilanesberg National Park and Venetia-Limpopo Nature Reserve). The costs of predation by wild dogs within the meta-population were not estimated because to date, no donor funding has been provided to compensate host reserves for these costs.

Records from the minutes of Wild Dog Advisory Group-South Africa (WAG-SA) meetings were used to document annual wild dog population sizes within each of the reserves in the meta-population. The total number of packs within the meta-population increased from 3 in 1997 and 1998, to 5 in 1999, 6 in 2000, 8 in 2001, and 10 in 2002. It was assumed that the 2002 population size (10 packs) within the meta-population represents the stable population size for the five reserves into which wild dogs had been reintroduced by that year.

6.2.5 Cost efficiency of the expansion of the meta-population through reintroduction into private nature reserves

In private nature reserves, predation is likely to result in real costs, as prey killed by wild dogs could otherwise be used for hunting or live capture and sale. In light of this, CEIs for the reintroduction of wild dogs onto private land were estimated, incorporating the costs associated with predation. It was assumed that the establishment costs and annual maintenance costs would equal the mean costs recorded at existing meta-population reserves.

Given a high (but within observed limits) annual probability of survivorship of: 0.8 for adult wild dogs; 0.7 for sub-adults; 0.7 for pups and a mean litter size of nine, it is estimated that an average Kruger pack size of five adults and two sub adults reintroduced into a meta-population reserve could potentially increase in size to 20 individuals within five years (Fuller at al 1992). This rate of increase has not been observed in the meta-population however, and for the purposes of this study, it was assumed that a

reintroduced pack of seven individuals would increase to the mean 2002 population size observed across reintroduced sub-populations (~ 13 adult and sub adult dogs) in two packs within the first year, and then remain at this level. Although the number of dogs is likely to fluctuate, 13 dogs was used as an average figure for the purposes of calculating costs. Three cost scenarios were presented to allow for variation in the extent to which predation by wild dogs would result in financial loss: a) where the value of all animals killed by wild dogs is fully compensated for; b) where half of prey killed is compensated for (given reduced intensity hunting), and; c) where predation results in no cost. In addition, cost estimates were made for two different prey-profiles, as observed in two parts of South Africa in which the reintroduction of wild dogs is likely to occur, northeastern South Africa and eastern South Africa, as recorded by Mills & Gorman (1997) and Kruger et al (1999) respectively. The costs of predation were estimated as in Chapter 5.

6.2.6 Cost efficiency of the conservation of wild dogs occurring on ranchland

If donor funding was utilised for the conservation of wild dogs on ranchland, it is assumed that the dogs would be monitored in order to help prevent persecution, and to assist with the allocation of funds for the compensation of land owners for losses due predation by wild dogs. Although ranchers attitudes towards wild dogs are variable, most negative attitudes are based on the perceived or real costs associated with their presence (Chapter 4). It is therefore assumed that the provision of compensation for losses due to predation by wild dogs would be sufficient incentive to encourage landowners to tolerate the species on their land. The costs of capturing wild dogs to attach telemetry equipment

were estimated as in Chapter 5. It was assumed that initially, three of the dogs would be radio-collared. Subsequent costs include those associated with intensive monitoring, re-capture to add collars and the cost of compensating for predation by wild dogs. It was assumed that three dogs would be immobilised annually to replace radio-collars and add collars to young individuals. With adequate habituation following release, wild dogs can be re-captured from the reintroduction site by darting from a vehicle and the costs will include vehicle usage, veterinary labour, and capture drugs. Kilometers driven was used as a index of monitoring effort - it was assumed that monitoring is conducted at a rate equal to that at Venetia-Limpopo Nature Reserve in the first year post-release (4,000 km monthly). The costs of re-capturing wild dogs following habituation, telemetry equipment, vehicle use and salaries associated with monitoring were estimated in the same way, and derived from the same sources as in Chapter 5.

Natural habitat is highly fragmented in South Africa (Chapter 2) and there is a limit to the number of wild dogs that could potentially be conserved in a given area on ranchland. The average number of resident packs occurring in each of the two areas in which wild dogs are most regularly sighted on private land in South Africa during 1996 and 2002 was 2.5 packs, and cost estimates were made for a stable sub-population size of three packs of the average size observed on ranchland (~ 7 dogs / pack, Chapter 2). Recently, wild dogs naturally re-colonised a game ranching area in Zimbabwe (where ranches have been consolidated into a collaborative nature reserve) and exhibited high rates of population increase (Pole 1999). It was assumed that an average newly formed pack (6 dogs) colonising an area of ranchland with adequate prey availability would exhibit a

rapid increase in numbers, from 6 in 1 pack, to 11 in two packs, 15 in two packs, 18 in three packs, to 21 in three packs in years 1 to 5, respectively, given published survivorship rates (Fuller et al. 1992). For the sake of cost, and cost efficiency calculations, it was assumed that the population size would remain at 21 individuals in 3 packs. The same predation cost scenarios were presented as for the private nature reserve reintroductions, with one difference. Wild dogs on private land are likely to come into contact with livestock and each prey-profile is assumed to include the same proportion of cattle (32.2%) observed in the sole published study of wild dogs in a ranching area (Rasmussen 1999).

6.3 Results

6.3.1 Expenditure on wild dog conservation (1997 - 2001)

An estimated $372,297 was spent on the conservation of wild dogs in South Africa between 1997 and 2001, at an average of $74,459 per annum. Of this $270,117 (72.6%) was spent specifically on the meta-population, $57,863 (15.5%) on wild dogs in Kruger and $33,942 (9.1%) on wild dogs on ranchland (Table 6.2). The remainder was spent on wild dog research not specifically related to any of the three populations (Frantzen et al. 2001; Knobel & du Toit 2003).

NGOs provided the most funding for wild dog conservation in South Africa during 1997 - 2001 (39.9%), followed by South African state agencies (36.8%), private donors

Table 6.2 Expenditure on the conservation of the three sub units of the South African wild dog population during 1997 – 2001, in 2002 US$ (ZAR in parentheses)

Sub unit	1997	1998	1999	2000	2001	Total
Kruger	7,505 (82,480)	7,305 (80,282)	24,820 (272,772)	9,829 (108,021)	8,404 (92,360)	57,863 (635,915)
Meta-population						
Hluhluwe	13,484 (148,189)	246 (2,704)	14,204 (156,102)	15,644 (171,928)	13,499 (148,354)	57,077 (627,276)
Karongwe	-	-	-	-	29,295 (321,952)	29,295 (321,952)
Madikwe	9,719 (106,812)	4,321 (47,488)	4,408 (48,444)	7,735 (85,008)	14,375 (157,981)	40,558 (445,733)
Pilanesberg	-	-	39,783 (437,215)	3,278 (36,025)	4,860 (53,411)	47,921 (526,651)
Venetia	-	-	-	-	79,750 (876,453)	79,750 (876,453)
[a] Miscellaneous	4,835 (53,137)	761 (8,364)	723 (7,946)	686 (7,539)	8,511 (93,536)	15,516 (170,522)
On ranchland	4,155 (45,663)	2,131 (23,420)	5,852 (64,312)	5,434 (59,720)	16,370 (179,906)	33,942 (373,021)
TOTAL	39,698 (436,281)	14,764 (162,258)	89,790 (986,791)	42,606 (468,241)	175,064 (1,923,953)	361,922 (3,977,524)

[a] Including the costs of a workshop at which the meta-population management plan was conceived (Mills et al. 1998), the costs of Wild dog Advisory Group-SA meetings, and the costs of purchasing of founder dogs for reintroductions.

(20.8%) and universities (2.5%). The majority of expenditure on the Kruger population (Figure 6.1) was provided by state agencies (65.8%), the remainder being provided by NGOs (34.2%). NGOs provided most of the money spent on the meta-population (44.5%), followed by private donors (27.9%), state agencies (26.8%), and universities (0.8%). The majority of the money spent on wild dogs on ranchland was provided by state agencies (71.9%), followed by NGOs (24.4%), and universities (3.7%).

In terms of money spent on the Kruger population, 64.0% of the money was spent on research, 34.1% on a photographic census of the population, 1.0% on attending meetings, and the remaining 0.9% on the capture and veterinary care of wild dogs, primarily for the removal of snares. For the meta-population (Figure 6.2), most was spent on monitoring and research (48.2%), feeding dogs in holding facilities (13.1%) and the upgrading of perimeter fencing (13.0%, more details in Appendix H). Of the money spent on wild dogs on ranchland, 39.7% was spent removing "problem animals", 29.0% was spent on research, 23.3% was spent on attending ranchers complaints, and 8.0% was spent by provincial nature conservation representatives attending wild dog-related meetings.

6.3.2 Cost efficiency of conserving wild dogs within a large protected area (Kruger)

The mean annual costs associated with conserving wild dogs in a large protected area are $11,573 (Table 6.3). Assuming that the mean population size of 28 packs of dogs within Kruger between 1988 – 2000 represents the stable long term population size, the cost efficiency of conserving wild dogs within Kruger is estimated to be 449 packs / $100,000 (Table 6.4). Conserving wild dogs within a large protected area is estimated to be more

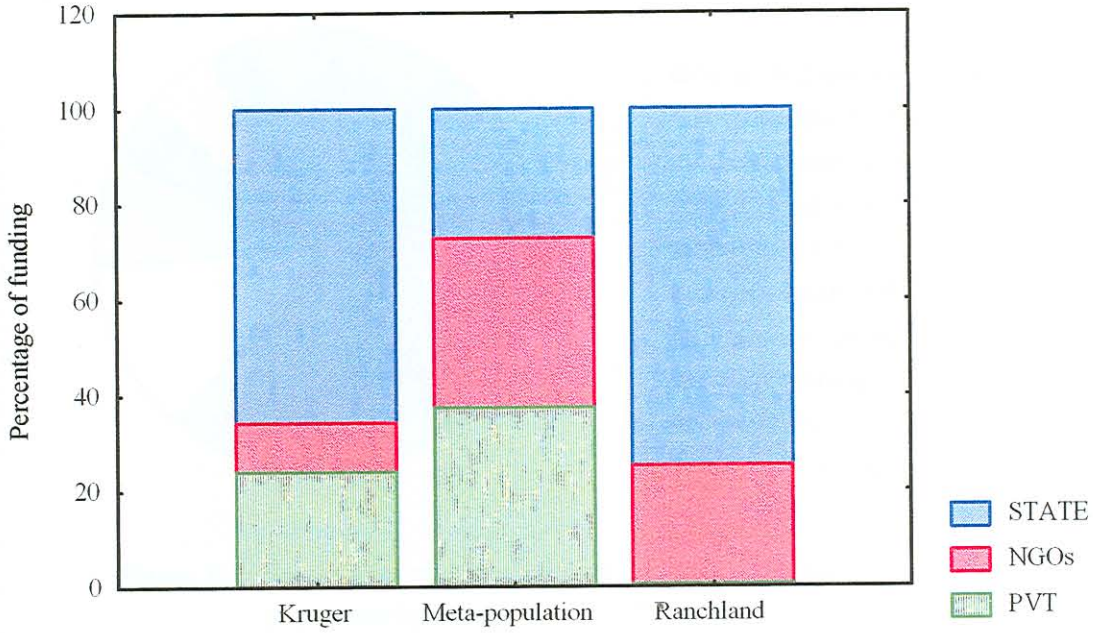

Figure 6.1 Source of expenditure (STATE - state agencies, NGOs and PVT - private companies) for each sub unit of the South African wild dog population during 1997 - 2001

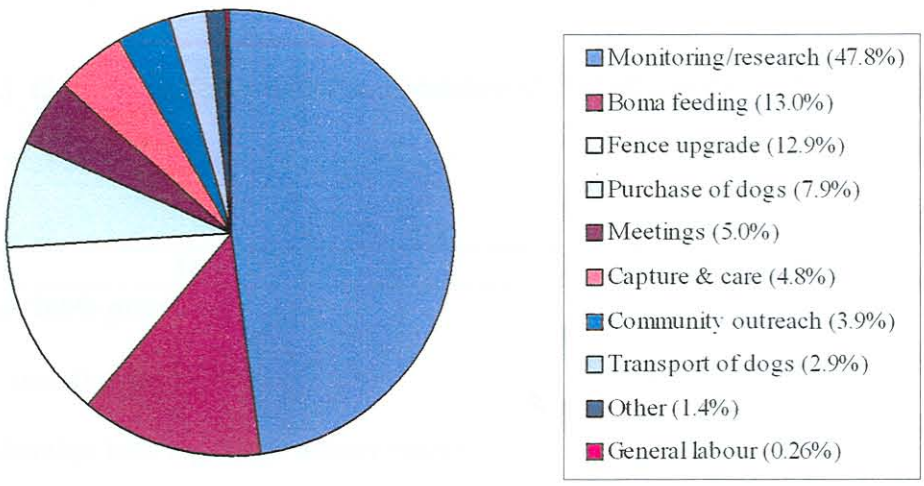

Figure 6.2 Breakdown of expenditure on the wild dog meta-population by activity (1997 - 2001)

Table 6.3 Cost estimates used for the calculation of cost efficiency indices, in 2002 US$ (ZAR in parentheses)

Item	Costs	
Within a viable population		
Average annual costs [a]	11,573	(127,187)
Reintroduction into a private nature reserve		
Initial costs [b]	36,880	(405,311)
Annual running costs [c]	10,554	(115,988)
Predation [d]		
ESA prey-profile [e], all prey compensated	101,762	(1,118,364)
ESA prey-profile, half prey compensated	50,881	(559,182)
NESA prey-profile [f], all prey compensated	17,761	(195,193)
NESA prey-profile, half prey compensated	9,563	(105,097)
Conservation of wild dogs on ranchland		
Initial costs		
First (helicopter-assisted) capture	1,980	(21,760)
Purchase of telemetry equipment	1,592	(17,496)
Average annual running costs		
Capture (darting from a vehicle)	1,012	(11,122)
Purchase of additional radio collars	721	(7,924)
Employee salary	4,648	(51,082)
Vehicle devaluation and maintenance	9,001	(98,921)
Predation costs		
ESA prey-profile [e], all prey compensated	115,761	(1,272,213)
ESA prey-profile, half prey compensated	57,881	(636,112)
NESA prey-profile [f], all prey compensated	22,883	(251,484)
NESA prey-profile, half prey compensated	11,942	(131,243)

[a] Equal to the average annual expenditure upon wild dogs in Kruger during 1997 – 2001.
[b, c] Equal to the average costs associated with the initial reintroduction and annual maintenance of wild dogs in the meta-population to date.
[d] Assuming the number of dogs is equal to that in year five.
[e] Eastern South Africa.
[f] Northeastern South Africa.

Table 6.4 Cost efficiency indices (dogs / $100,000) of conserving wild dogs under three conservation programmes in perpetuity

Scenario	CEI
Within a viable population	449
Establishment of the meta-population so far	23
Reintroduction into private reserves	
ESA prey-profile [a]	
All prey compensated	3
Half prey compensated	4
NESA prey-profile [b]	
All prey compensated	8
Half prey compensated	11
Zero predation costs	19
***In situ* on ranchland**	
ESA prey-profile [a]	
All prey compensated	14
Half prey compensated	16
NESA prey-profile [b]	
All prey compensated	19
Half prey compensated	22
Zero predation costs	27

[a] Eastern South Africa.
[b] Northeastern South Africa.

cost efficient than the meta population management plan by 20 times, than the reintroduction of dogs into a private nature reserve by 24 – 150 times, and than conserving wild dogs on ranchland by 17 – 32 times (Table 6.4).

6.3.3 Cost efficiency of the establishment of the meta-population

The meta-population increased from 19 individuals in three packs in 1997, to 54 sub adults and adults in 10 packs prior to the denning season in 2002, and the population target for the meta-population has been achieved in just over half of the time set aside for this purpose (Mills et al. 1998). The changes in dog and pack numbers by reserve during 1997 – 2001 were as follows: Hluhluwe-Umfolozi Park (13 adults and sub adults in two packs, down to seven sub adults and adults in two packs); Karongwe Game Reserve (zero up to four adults and sub adults in one pack); Madikwe Game Reserve (six adults and sub adults in two packs, up to 17 in three packs); Pilanesberg National Park (zero up to 13 adults and sub adults in two packs); Venetia Limpopo Nature reserve (9 adults and sub adults were released from holding facilities in January 2002, now two packs). An additional 16 wild dogs were released into Marakele National Park in May 2003. Assuming the number of wild dogs within the meta-population (excluding Marakele) stabilises at the 2002 population size of 54 sub adults and adults in 10 packs, this represents a cost efficiency of 23 packs / $100,000 (Table 6.4). The meta-population management plan so far is predicted to be more cost efficient than expanding the meta-population onto private nature reserves, within the predicted range of CEIs for the conservation of dogs on ranchland, and substantially less cost efficient than the conservation of dogs within a large protected area.

6.3.4 Cost efficiency of the expansion of the meta-population through reintroduction into private nature reserves

Mean expenditure on initial reintroductions of wild dogs into meta-population reserves over the last five years was $36,880 (range $5,372 - $79,750; n = 3 reintroductions), while the mean annual maintenance expenditure was $10,554 (range $4,948 - $56,862; n = 5 reintroductions, Table 6.2). Predicted annual costs of predation vary depending on the observed prey-profile and the proportion of prey killed that is compensated for (Table 6.3). The estimated CEI of reintroducing and conserving wild dogs within a private nature reserve is: 19 packs / $100,000 where predation results in no costs; 11 packs / $100,000 given a northeastern South African prey-profile, where half of prey killed is compensated for; 8 packs / $100,000 given a northeastern prey-profile where all prey is compensated for; 4 packs / $100,000 given an eastern South African prey-profile where half of prey killed is compensated for; and 3 packs / $100,000 given an eastern South African prey-profile where all prey are compensated for (Table 6.4). The expansion of the meta-population through reintroduction onto private nature reserves is predicted to be the least cost efficient strategy of those considered.

6.3.5 Cost efficiency of the conservation of wild dogs on ranchland

The costs of establishing a conservation initiative involving wild dogs on ranchland are <10% (9.7%) of those of reintroducing a pack of wild dogs into a reserve (Table 6.3). Average annual costs associated with predation by a sub-population of wild dogs are estimated to be 79.3% greater under an eastern South African prey-profile than under a northeastern South African prey-profile. The estimated CEI of reintroducing and

conserving wild dogs on ranchland is: 27 packs / $100,000 where predation results in no costs; 22 packs / $100,000 given a northeastern South African prey-profile where half of prey killed is compensated for; 19 packs / $100,000 given a northeastern prey-profile where all prey is compensated for; 16 packs / $100,000 given an eastern South African prey-profile where half of prey killed prey is compensated for; and 14 packs / $100,000 given an eastern South African prey-profile where all prey are compensated for (Table 6.4)

6.4 Discussion

6.4.1 Expenditure on wild dog conservation (1997 - 2001)

After many years of being overshadowed by Africa's better-known carnivores, wild dogs have received an increasing amount of attention from researchers and donors in recent years (Creel & Creel 2002). This interest was reflected in the amount spent on their conservation in South Africa between 1997 and 2001. Over $370,000 was spent, with donors including a variety of NGOs, private companies and state agencies. However, although substantial, this amount is dwarfed by expenditure estimates for other high profile carnivore species. An estimated $6 million is spent annually on tiger *Panthera tigris* conservation, and over $2 million spent annually within the Indian subcontinent alone (Christie 2001). In the USA, $350,000 was spent on wolf conservation in a single state (Minnesota) in 1998 (Mech 1998). Nonetheless, funding received for wild dog conservation in South Africa is increasing, and for this support to continue, the use of funds must be shown to be effective (Christie 2001).

Six years after the initiation of the meta-population management plan (Mills et al. 1998) the target population of nine packs was exceeded, and wild dogs have been successfully established and maintained in five reserves, with an additional reintroduction having been conducted in May 2003 at Marakele National Park. In addition, the Kruger wild dog population has been closely monitored. During 1988 and 2000, the Kruger population has fluctuated widely, increasing by 17.8% between 1988 - 1995, and then declining by 59.2% between 1995 - 2000 (Maddock & Mills 1994, Wilkinson 1995, Davies 2000). These population fluctuations stress the need for continued monitoring, and continued investment in the meta-population as an 'insurance policy'. It is reasonable to say that wild dog conservation in South Africa has been effective within the limits of set targets (Mills et al. 1998). Beyond these limits, however, little has been done to improve the conservation status of wild dogs, and very little funding was directed at the population occurring on ranchland. Money that was spent was directed primarily at the removal of 'problem' packs and consequently had a negative effect on the conservation of wild dogs on ranchland.

6.4.2 The cost efficiency of wild dog conservation

Maintaining large protected areas represents the single most important strategy for wild dog conservation (Woodroffe & Ginsberg 1997a), and is the most cost efficient way in which wild dogs can be conserved in South Africa. Most of the costs associated with conserving wild dogs under this scenario are indistinguishable from the costs of maintaining a large protected area in general, and very little specific expenditure is required. Furthermore, much of the expenditure on wild dogs within Kruger (for example

the photographic census) is not vital for the persistence of the population, and the cost efficiency of this strategy is potentially much greater. The expansion of several South African protected areas across national boundaries to create large transfrontier parks is proposed, and this creates potential for the expansion of the Kruger and Gona-re-zhou National Park (Zimbabwe) wild dog populations into Mozambique (Great Limpopo Transfrontier Park), and the establishment of viable populations in the proposed Limpopo / Shashi and Lubombo transfrontier conservation areas (www.peaceparks.org). Although the initial reintroduction of wild dogs into a large protected area would likely require more funds than necessary for the reintroduction of dogs into a meta-population reserve due to the necessity for a larger founder population for the creation of a population viable in the absence of artificial immigration, the ongoing costs would likely be negligible. Given the potential for establishing additional viable populations at a relatively low cost, it is suggested that donor funds be used to reintroduce wild dogs into the proposed Limpopo / Shashi and Lubombo transfrontier conservation areas as soon as they are established.

The meta-population management plan has been substantially less cost efficient than the conservation of wild dogs in large protected areas, due to the logistical difficulty associated with the reintroduction process. The expansion of the meta-population to include additional private nature reserves is likely to be less cost efficient still. So far, the reserves into which wild dogs have been reintroduced (largely state-owned) have absorbed the costs of predation by wild dogs post-release. The costs of predation by wild dogs are potentially very high (Chapter 5) and private nature reserves may not be willing

to accept these losses in the absence of compensation. Such compensation, in addition to the high start-up and maintenance costs would reduce the cost efficiency of wild dog reintroductions below that of competing conservation strategies. Furthermore, most of the reserves into which dogs have been reintroduced to date have had to invest relatively little in upgrading perimeter fencing or holding facilities due to existing high quality infrastructure. Upgrading standard game fencing to the specifications required for wild dogs is extremely costly (Chapter 5), and if the meta-population is expanded onto reserves without pre-existing predator proof fencing, the cost efficiency would decline further.

Under certain conditions, however, private nature reserve owners may be encouraged to reintroduce wild dogs at their own cost. Ecotourism is the most profitable land use on reserves of a size sufficient for wild dog reintroductions (Falkena 2000) and under these conditions the financial impact of predation by wild dogs is likely to be negligible. In addition, high quality fencing and boma facilities are likely to be already present, due to the importance of other carnivore species such as lions for attracting visitors to a reserve (Vorhies & Vorhies 1993). Furthermore, it is likely that as the methodology associated with reintroducing wild dogs and maintaining them post release improves, the process will become more efficient and costs will decline. Some of the costs incurred during reintroductions to date (such as holding dogs in captivity for lengthy periods, and extensive community outreach programmes) are not vital for the success of a reintroduction programme and could be excluded. Finally, the potential financial benefits associated with wild dog-based ecotourism are substantial ($11,000 - $64,000 / pack /

year), and sufficient to exceed the costs associated with reintroduction programmes under certain conditions (Chapter 5). In keeping with this, the agency responsible for the management of the meta-population (Wild Dog Advisory Group-SA) has received several applications for wild dog reintroductions from private nature reserve owners. Consequently, it is suggested that the expansion of the meta-population be limited to private nature reserves willing to carry the costs. Although some donor funding would still be required, for the provision of suitable founder animals and to provide technical assistance pre, and post release, donor funding requirements would be greatly reduced.

The conservation of wild dogs on ranchland has received very little attention, and yet is predicted to be of similar or greater cost efficiency than the current meta-population management plan under realistic scenarios, and substantially more cost efficient (by up to 5 times) than the expansion of the meta-population onto private nature reserves. The cost efficiency of conserving wild dogs on ranchland is likely to be closer to (or higher than) the higher estimates made in this chapter (22 – 27 packs / $100,000) for several reasons. First, impala *Aepyceros melampus* and kudu *Tragelaphus strepsiceros* are the most important components of the northeastern prey profile (Mills & Gorman 1997), and are the most common ungulates in most areas in which wild dogs occur on ranchland. Second, in some parts of South Africa, up to 33% of ranches are involved in ecotourism-based land uses (Chapter 4), and under these conditions, the costs of predation by wild dogs are likely to be much reduced or absent. Finally, there is scope for offsetting some or all of the costs of conserving wild dogs on ranchland with ecotourism-benefits, reducing dependency upon donor funding, and increasing cost efficiency further (Chapter

5). Indeed, a more sustainable and cost efficient strategy than compensating landowners for losses caused by predation would be to assist ranching communities to establish ecotourism schemes involving wild dogs, to enable wild dogs to effectively 'pay for their own conservation'. There are difficulties associated with using compensation as a conservation management tool on ranchland. Donor funding would be required indefinitely, and potentially to an increasing extent as populations of wild dogs on ranchland spread. The cessation of compensation at any point may result in a reversal of conservation achievements. Compensating ranchers for prey killed by wild dogs likely represents a worst case cost efficiency scenario for conserving wild dogs *in situ* on ranchland. Removing the costs of compensation, and replacing them with the costs of educational programmes and technical assistance for the establishment of wild dog-ecotourism operations would increase the cost efficiency of this conservation option markedly.

The best prospects for conserving wild dogs on ranchland occur where neighbouring ranchers have cooperated to remove fences and create large collaborative nature reserves. Under these circumstances, ranchers are typically more positive towards wild dogs, ecotourism based land uses are prevalent, predation by wild dogs is likely to result in little or no cost, and the scope for wild dog-based ecotourism is greatest (Chapter 4).

There is a ready supply of founder wild dogs on ranchland (Chapter 2), and large areas of suitable habitat as a result of the increasing prevalence of game ranching (Lambrechts 1996; van der Waal & Dekker 2000). Given adequate prey availability and sufficient

protection, wild dogs have the potential to increase in numbers rapidly following the re-colonisation of private land (Pole 1999) and there is reason to be optimistic that realistic conservation targets on ranchland in South Africa could be reached. Conserving wild dogs on ranchland has a potentially important role in increasing numbers and geographic distribution, and in providing buffers for populations occurring in adjacent protected areas (Woodroffe & Ginsberg 1998).

The cost efficiency approach adopted in the present study has wide application for other threatened species. There is increasing competition for funds between species, and between conservation projects within species, and funding agencies place increasing emphasis on 'value for money' in project choice (Restani & Marzluff 2001). Efforts to secure donor funding for endangered species are frequently hampered by a lack of good cost information (Wilcove & Chen 1998). Cost efficient conservation programme design is likely to improve the chances of financial support (Moran et al. 1997), maximise results of conservation efforts, and can benefit other species by increasing the availability of funds. This is well illustrated by the situation in North America, where improved cost efficiency in conservation programmes for a few species has the potential to benefit many. In 1995, of the $348 million spent on endangered species in the USA, >50% went to 10 species (Baker 1999). In sum, cost efficient conservation is vital to minimise the discrepancy between current global spending and the funding requirements of all threatened species (Balmford et al. 2003).

Wild dogs were an ideal species with which to investigate the role of donor funding in the conservation of an endangered species in Africa. They have been the focus of a large number of studies scattered across Africa (Creel & Creel 2002), and focused conservation efforts in South Africa. Donor support for wild dog conservation in South Africa has been reflected in the rapid attainment of conservation targets. Donor funding is most effective for species threatened by human activities (Miller et al. 2002). Human-related mortality is the primary cause of decline in wild dog numbers across Africa (Woodroffe & Ginsberg 1997b), and consequently, donor funding has the potential to improve the conservation status of species throughout it's range.

In South Africa, it is suggested that monitoring efforts be continued in Kruger, and that donor funding be used to establish wild dog populations in proposed transfrontier parks as soon as they are established. In addition, it is suggested that donor funding be directed towards the conservation of wild dogs on ranchland, and the maintenance of the meta-population. Expansion of the meta-population should be limited to reserves willing to carry the costs. Consideration of the cost efficiency of conservation options has an important role in guiding future conservation strategies involving wild dogs, and a wide variety of other threatened species in Africa, and elsewhere.

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