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The potential contribution of ecotourism to African wild dog *Lycaon pictus* conservation in South Africa

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Abstract

African wild dogs are endangered, and in South Africa as elsewhere, they inhabit a fraction of their former range. In this study, we assessed the potential for economic benefits derived from ecotourism to offset the costs of three wild dog conservation options using a contingent valuation study of the willingness of visitors to four protected areas to pay to see wild dogs at the den – within a viable population in a large protected area (Kruger National Park), through reintroduction into nature reserves, and through the conservation of wild dogs occurring on ranchland in situ. Results indicated that tourism revenue from wild dogs in large protected areas is more than sufficient to offset the costs and could potentially be used to subsidise wild dog reintroductions or the conservation of wild dogs in situ on ranchland. On ranchland and for reintroductions, tourism revenue was generally predicted to offset most of the costs of conserving wild dogs where predation costs are low, and to exceed the costs where willingness to pay is high, and/or where the costs of predation by wild dogs are zero. Conservation efforts should facilitate the derivation of eco-tourism-related benefits from wild dogs on ranchland and in private reserves to create incentives for wild dog conservation. Ecotourism should be part of a multifaceted approach to wild dog conservation which also includes education and awareness campaigns, and efforts to encourage landowners to cooperate to form conservancies.

Keywords: Contingent valuation; Game ranching; Meta-population; Reintroduction; Use-values

1. Introduction

A catastrophic human-induced extinction event is currently underway, with species going extinct at a thousand times the background rate (Pimm et al., 1995). Species extinctions, coupled with large-scale deterioration of wilderness habitat are predominantly the product of three principal economic causes: lack of information on the value of ecosystems; failure of markets to capture benefits provided by nature; and promotion of environmentally harmful agricultural activities through perverse state subsidies (Constanza et al., 1998; Balmford et al., 2002). Unprofitable sheep farming in the Swiss Alps, for example, is subsidized, creating conditions conducive to conflict with large carnivores (Breitenmoser, 1998). Large carnivores frequently conflict with humans by killing livestock or game animals and are among the most challenging species to conserve (Linnell et al., 2001).

The economic impact (real or perceived) of wildlife has a strong influence upon people's attitudes towards conservation (Infield, 1988). Protection of economic interests has been the basis for state-sponsored carnivore persecution programs worldwide, and for ongoing

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persecution by individuals (Fanshawe et al., 1991). A major challenge lies in providing benefits to the people bearing both direct costs and opportunity costs (foregoing benefits from the harvest of wildlife populations or the conversion of habitats) resulting from wildlife conservation (Moran, 1994). In many cases landowners are forced to bear the costs resulting from the presence of large carnivores, while society at large benefits from their 'existence value' (Rasker and Hackman, 1995). Conservation strategies that reduce costs incurred by local people, and promote exploitation of the use values of large carnivores are needed to create financial incentives for conservation. In addition, efforts are needed to raise awareness of the ecological benefits associated with large carnivores, such as control of prey populations (Mills, 1991).

In Africa there has been increasing interest in the potential for ecotourism to offset costs associated with conservation (Norton-Griffiths, 1995). Ecotourism is a rapidly growing industry, and developing nations are increasingly popular destinations (Gössling, 1999). Furthermore, there are significant consumer surpluses among visitors to African protected areas (i.e. a willingness among visitors to pay more for a wildlife experience than they currently do, Moran, 1994; Barnes and de Jager, 1996), the capture and appropriate distribution of which has the potential to improve attitudes of local people towards conservation (Infield, 1988). Large carnivores represent ideal targets for conservation strategies based upon financial incentives from ecotourism, by virtue of their popularity with tourists. In this study, we investigate the potential for ecotourism benefits to offset the costs of conserving the endangered African wild dog (*Lycaon pictus*).

In South Africa, wild dogs occur in three distributions, a single viable population in Kruger National Park (Kruger) of 177–434 individuals (Maddock and Mills, 1994; Davies, 2000), a meta-population of around 110 dogs in six reserves (pre-denning season 2003, based on information obtained from Wild Dog Advisory Group-South Africa meetings minutes), and a population of about 76 dogs on private ranchland (Lindsey et al., in press-a). The focus of recent conservation efforts has been establishing the meta-population by reintroducing wild dogs into a series of isolated reserves linked by management (Lindsey et al., in press-b). This process is costly and future reintroductions may depend upon ecotourism benefits being able to offset some or all of the costs. Wild dogs on ranchland are persecuted in response to perceived costs associated with their presence and are limited in distribution as a result (Lindsey et al., in press-a), similar to a situation faced by cheetahs (*Acononyx jubatus*) on ranchland in Namibia (Marker et al., 2003a). Improvement in the conservation status of these dogs is unlikely to occur in the absence of improved economic incentives for landowners.

We estimate the costs and potential tourism benefits for combined wild dog conservation/ecotourism operations in three scenarios, using a pack as the functionally minimum demographic unit. (1) A viable population in Kruger. (2) Reintroduction into a nature reserve with perimeter fencing of sufficient standard to prevent the dogs from leaving the reserve post-release. Within this scenario there is a gradation from 'ecotourism reserves' in which predation by wild dogs is perceived to result in no cost, to reserves in which land use involves the consumptive utilization of wildlife, and predation is perceived to result in direct cost to the reserve owner. (3) Conservation of naturally occurring wild dogs in situ on livestock/game ranchland.

The potential benefits of wild dog tourism are discussed in Section 2. Section 3 examines costs associated with tourism operations as well as costs incurred as a result of the presence of wild dogs under various land tenure arrangements. Section 4 summarizes the values defined in the previous two sections and determines the net present value of the wild dog tourism proposal. Finally, Section 5 discusses the results of the study and implications for wild dog conservation.

2. Potential benefits of wild dog tourism

2.1. Contingent valuation survey

A series of contingent valuation surveys were conducted to estimate the potential market value for wild dog tourism. Contingent valuation methods involve the construction of a contingent market in which survey respondents express their willingness to pay (WTP) for changes in the quantity or quality of a good (Mitchell and Carson, 1989). Many criticisms of the contingent valuation method revolve around its efficacy in extracting less tangible non-use values such as option, existence and bequest values (Loomis and White, 1996; White et al., 2001). In this study, we used contingent valuation to measure the value of a potential market good – opportunities to view wild dog adults and puppies at a den site. The value of this good is comprised only of direct use value and this eliminates many of the problems associated with the conventional application of contingent valuation (Mitchell and Carson, 1989). Target respondents are easily identified, removing the risk of population choice bias, the goods in question are easily explained, and respondents are experienced in making similar transactions, removing the risk of scenario misspecification bias (Mitchell and Carson, 1989). Finally, the risk of embedding, whereby WTP bids are influenced by the moral satisfaction of paying for an environmental good, with little sensitivity to the scope of the good (Carson, 2000) is lower in studies of direct use value (Navrud and Mungatana, 1994), and minimal in this

study because respondents were offered no more than a simple tourist experience.

We used an open-ended question designed to determine the willingness of visitors to protected areas to pay for wild dog-viewing opportunities. Open-ended questions tend to yield conservative WTP estimates, and remove the potential for starting-point bias associated with close-ended formats (Navrud and Mungatana, 1994). The mean WTP of tourists interested in seeing wild dogs was calculated by removing zero bids. We then estimated annual income from occupancy rates calculated by multiplying the percentage of visitors willing to pay to see wild dogs at each reserve, by the average number of tourists visiting each reserve per three month period, up to a maximum of 12 visitors to the den per day – one trip with six visitors in the morning and one in the evening. Estimated costs associated with running an ecotourism operation of this nature, obtained from a tour operator (ccAfrica), were subtracted from revenue estimates, including; a guides' salary, vehicle-running and depreciation costs, and monthly advertising in a national wildlife magazine.

Sampling was done at two public reserves, Pilanesberg National Park (PNP) and Kruger, to obtain WTP estimates from low to medium budget tourists, and at two private nature reserves, Djuma Game Reserve (DGR) and Ngala Game Reserve (NGR), to obtain WTP bids from "up market" tourists. Pre-testing was done at PNP to highlight problems with draft questionnaires. The following question was used to determine tourists' WTP to see wild dogs:

Although wild dogs are present at Pilanesberg/Kruger/Ngala/Djuma, you have a less than 5%/10%/20%/20% chance of seeing them during your stay. For three months in winter, wild dogs remain in the vicinity of the den in which they have pups. During this time, the location of wild dogs is very predictable and guided trips to see them would be almost guaranteed sightings. How much would you pay per person, to go on an optional, small (six persons, max) guided tour to a den, to improve your chances of seeing wild dogs to more than 90%?

Direct interview surveys were conducted at PNP and Kruger. Refusal rate at both parks was less than 5%. Interviewing was not permitted at DGR and NGR, and questionnaires were distributed to guests on arrival to complete during their stay. A total of 605 completed questionnaires were obtained from the four sample sites.

2.2. Results of survey

Mean WTP was highest at NGR ($59/person/trip, $n = 87$), followed by DGR ($53, $n = 77$), PNP ($12, $n = 238$) and Kruger ($12, $n = 203$). Almost 80% of visitors at PNP were willing to pay to see wild dogs (78.9% of 90,000 visitors/3 months), compared to 73.4% (of 260,000 visitors) at KNP, 65.0% (of 2400 visitors) at NGR, and 52.3% (of 955 visitors) at DGR. Average annual estimates of gross income were $13,838 (Kruger and PNP WTP), $24,274 (DGR WTP), and $65,844 (NGR WTP). The costs of running an ecotourism operation on wild dogs were estimated to be $4793 (advertising – $590; guide's salary $927; vehicle use and depreciation – $3278).

3. Costs of wild dog conservation

For each scenario, cost estimates for required goods and services were obtained from recognized state agencies or from three private companies (where possible) and the intermediate quote used, unless otherwise stated. Sources of cost estimates are available from the authors on request.

3.1. Kruger national park

The costs of conserving a viable population of wild dogs in Kruger were impossible to distinguish from the general costs of conserving a large protected area, so only costs related directly to wild dog conservation were considered. Expenditure records were derived from Kruger staff during direct interviews. The costs of capturing, collaring and monitoring a pack to locate dens for ecotourism were also estimated. It was assumed that one person would be employed for six months during the first year, and for three months during subsequent years. Wild dogs in Kruger are habituated to vehicles, and it was expected that dogs could be darted from a vehicle. Cost estimates were based upon the attachment of three collars initially, and recapture of three dogs every second year to replace collars. Cost estimates were based upon monitoring at a rate equal to that done at Venetia-Limpopo Nature Reserve in their wild dog monitoring programme for three months in the first year (4000 km monthly), half this in the second three months of the first year, and at a 1000 km per month thereafter for three months during subsequent years. Kruger is large ($\sim$20,000 km^2) and predation by wild dogs was assumed to cause no economic cost. Additional costs included veterinary input for the removal of snares and a five-yearly photographic population census. From these data, an estimate of expenditure per pack was derived, given the average number of packs in Kruger (28 packs: Davies, 2000).

3.2. Private nature reserve

Cost estimates were made for the reintroduction of a pack into a reserve of 360 km^2, equal to the smallest home range size observed in Kruger (Mills and Gorman, 1997), and their post-release maintenance. Cost

estimates were based upon the reintroduction of an average sized newly formed pack (~6 dogs, McNutt, 1996), assuming that the pack increases to the average pack size in Kruger (10 dogs; Mills and Gorman, 1997) and is managed to keep numbers at this level on average.

Reintroduction sites require adequate perimeter fencing and pre-release holding (boma) facilities, and cost estimates were based on two scenarios – where adequate fencing and boma facilities already exist, and where existing fencing and boma facilities require upgrading to 'wild dog specifications' (Hofmeyr, 2000). It is assumed that the shape of the theoretical 360 km^2 reserve approximates a square. Costs were based on a captive (boma) period of six weeks, with a feeding regime of two impala (*Aepyceros melampus*) carcasses per week.

Suitable captive (Frantzen et al., 2001) and free ranging wild dogs are readily available and it was assumed that founders could be acquired without charge. The costs of capturing free ranging wild dogs for reintroduction are difficult to evaluate, and for the purpose of this study they were based upon 3 h of helicopter flying time (assuming a den location is known), two days labor from one wildlife veterinarian, one skilled foreman, 20 laborers, the transport of capture equipment, and the transport of the dogs following capture.

Wild dogs should be vaccinated for rabies and several other diseases (Hofmeyr et al., 2000). This would be administered through intra-muscular injection during the initial capture, and a booster rabies vaccine provided following immobilisation in the boma. Premiums for indemnity cover of ZAR 5 million (~$450,000) for protection against liability claims resulting from the reintroduction were included in cost estimates. Monitoring costs included labor, vehicle use, the radio collaring of three founder dogs. Cost estimates were based on a monitoring intensity of 4000 km monthly for the first six months, 2000 km/month for the second six months, and 1000 km/month thereafter. For the first year post-release, it was assumed that 100% of an employees' time would be spent on monitoring, decreasing to 25% thereafter. The costs of replacing collars were estimated as for the Kruger scenario. Additional cost estimates were made for adding and removing six individuals every five years, to permit gene flow between wild dogs in isolated reserves.

Predation by wild dogs post-release represents a potential additional cost, the extent depending upon the land use of the reserve. Three cost scenarios were considered: (1) all prey killed results in costs; (2) half of prey killed results in costs; and (3) predation causes no costs. Cost estimates were made for 10 wild dogs, based upon prey profiles (Table 1) observed in southern Kruger (Mills and Gorman, 1997) and Hluhluwe-Umfolozi Park (Kruger et al., 1999), which represent likely prey-profiles for two areas in which reintroductions are likely northeastern and eastern South Africa. Cost estimates were calculated following Lindsey et al. (in press-b).

3.3. Private ranchland

The costs of conserving wild dogs on ranchland were estimated for a pack of 10 dogs. In this scenario, costs included initial helicopter assisted capture of a pack to attach three radio collars, monitoring at the same intensity as for the Kruger scenario to habituate dogs and locate dens, and re-capture every second year to replace

Table 1
Percent biomass made up by each prey species, sex and age class in two wild dog prey-profiles

Area	Total (%)	Adult male (%)	Adult female (%)	Sub adult (%)	Juvenile (%)
Eastern South Africa[a]					
Grey duiker *Sylvicapra grimmia*	0.1	0.1	0.05	0	0
Impala *Aepyceros melampus*	16.2	4.2	5.6	1.2	5.2
Kudu *Tragelaphus strepsiceros*	0.7	0.1	0.1	0.3	0.3
Nyala *Tragelaphus angasi*	76.1	31.8	29.8	7.8	6.7
Red duiker *Cephalophus natalensis*	0.3	0.2	0.15	0	0
Reedbuck *Redunca arundinum*	0.9	0.3	0.3	0.2	0.1
Waterbuck *Kobus ellipsiprymnus*	2.2	0.2	0.3	0.9	0.8
Wildebeest *Connochaetes taurinus*	3.5	0.3	0.5	1.4	1.3
Total	100				
Northeast South Africa[b]					
Bushbuck *Tragelaphus scriptus*	2.0	0.5	0.6	0.3	0.2
Grey duiker *Sylvicapra grimmia*	4.4	2.2	2.2	0	0
Impala *Aepyceros melampus*	81.0	18.6	25.7	13.0	8.6
Kudu *Tragelaphus strepsiceros*	8.1	0.3	0.6	2.2	4.1
Reedbuck *Redunca arundinum*	2.0	0.5	0.6	0.3	0.2
Steenbok *Raphicerus campestris*	2.5	1.3	1.3	0	0
Total	100				

[a] Kruger et al. (1999).
[b] Mills and Gorman (1997), Pole (1999).

Table 2
Cost estimates used for the calculation of PVs in 2002 US$(ZAR in parentheses)

Item[a]	Costs and benefits
Within a viable population	
Initial costs	2176 (23,911)
Average annual costs	4692 (51,564)
Additional five-yearly costs	8180 (89,900)
Reintroduction into a nature reserve	
Initial costs	
With fencing and boma upgrades	131,099 (1,440,776)
Without fencing and boma upgrades	6440 (70,776)
Average annual running costs	8501 (93,428)
Additional five-yearly costs	3297 (36,238)
Predation costs	
ESA prey-profile, all prey compensated	78,278 (860,279)
ESA prey-profile, half prey compensated	39,139 (430,139)
NESA prey-profile, all prey compensated	13,662 (150,144)
NESA prey-profile, half prey compensated	6831 (75,072)
Conservation of wild dogs on ranchland	
Initial costs	1979 (21,755)
Average annual running costs	4616 (50,735)
Predation costs	
ESA prey-profile, all prey compensated	55,124 (605,816)
ESA prey-profile, half prey compensated	27,562 (302,908)
NESA prey-profile, all prey compensated	11,373 (124,989)
NESA prey-profile, half prey compensated	5686 (62,494)

[a] ESA, eastern South Africa; NESA, northeastern South Africa.

collars on three dogs. Additional costs include those resulting from predation. Wild dogs on private land are likely to come into contact with livestock and to be conservative, one third of the biomass of each prey-profile is assumed to comprise cattle, as suggested from a study in Zimbabwe during a period of high losses (Rasmussen, 1999). Cattle prices were obtained from the First National Bank Department of Agricultural Information.

3.4. Cost estimates

Estimated logistical costs associated with conserving wild dogs are lowest within a viable population ($10/dog/year), and highest for wild dog reintroductions (up to $8678/dog/year, Table 2). The annual net costs of conserving wild dogs following reintroductions and on ranchland are strongly dictated by the extent to which predation results in costs (Table 3).

4. Net present value of wild dog conservation with tourism

4.1. Present value of costs and benefits

All cost and benefit estimates were converted into US$,using the mean US$/ZAR exchange rate for the first six months of 2002 ($1 = R10.99). Future costs and benefits were discounted, using average long-term South African Government Bond rates for the first six months of 2002, to yield present values (PVs). In reality, due to a variety of potentially unforeseen factors, it may take some time for costs and benefits to stabilize. Consequently, the calculation of PVs is expressed in a general form, assuming that it would take five years for costs or benefits to stabilize. Benefit estimates were converted to PVs as follows:

$$\mathrm{TB} = \frac{B_1}{(1+r)} + \frac{B_2}{(1+r)^2} + \frac{B_3}{(1+r)^3} + \frac{B_4}{(1+r)^4} + \frac{B_5(1+\frac{1}{r})}{(1+r)^5}$$

TB represented the ecotourism benefits of conserving a pack of wild dogs in perpetuity and B_1–B_5 represented the annual benefits under each scenario over five years. The term where B_5 was located accounted for the continuing benefits in perpetuity, assuming that benefits in perpetuity would be equal to B_5.

Cost estimates were converted to PVs as follows:

$$\mathrm{TC} = \mathrm{SSC} + \frac{C_1}{(1+r)} + \frac{C_2}{(1+r)^2} + \frac{C_3}{(1+r)^3} + \frac{C_4}{(1+r)^4} + \frac{C_5}{(1+r)^5} + \frac{\frac{C_5 + \frac{\text{Five-year cost}}{5}}{r}}{(1+r)^5}$$

Table 3
Ongoing annual costs, benefits and net costs/benefits of conserving wild dogs under three scenarios in 2002 US$

	Ongoing annual costs[a]	Low benefits[b]	High benefits[b]	Net costs/benefits with low benefits	Net costs/benefits with high benefits
Viable population	4139	9045	61,051	+4906	+56,912
Reintroduction[c]					
Eastern prey-profile					
All prey compensated	85,151	9045	61,051	−76,106	−24,100
Half prey compensated	46,012	9045	61,051	−36,967	+15,039
Northeast prey-profile[c]					
All prey compensated	20,535	9045	61,051	−11,490	+40,516
Half prey compensated	13,704	9045	61,051	−4659	+47,347
Zero predation costs	6873	9045	61,051	+2172	+54,178
Ranchland					
Eastern prey-profile					
All prey compensated	59,188	9045	61,051	−50,143	+1862
Half prey compensated	31,626	9045	61,051	−22,581	+29,425
Northeast prey-profile[d]					
All prey compensated	15,437	9045	61,051	−6392	+45,614
Half prey compensated	9750	9045	61,051	−705	+51,301
Zero predation costs	4064	9045	61,051	+4981	+56,987

[a] Ongoing costs, from the second year and onwards following the higher first year costs.
[b] Assuming six people visit the den twice per day during the denning season, using the Kruger and Ngala willingness to pay estimates for the low and high benefit scenarios, respectively, minus the costs of the ecotourism operation.
[c] Most likely cost scenarios for wild dog reintroductions.
[d] Most likely scenario for wild dogs on ranchland.

Total costs (TC) represented the PV of the costs of conserving a pack in perpetuity. SSC was the sum of the start up costs of a conservation program, and r was the discount rate. C_1–C_5 represented the annual maintenance costs under each scenario over five years, and the penultimate term, where C_5 was located accounts for the continuing costs in perpetuity, assuming that annual costs in perpetuity would be equal to C_5. The last term in the equation accounted for costs occurring on a five-yearly basis (such as the photographic census in Kruger), assuming for tractability that one-fifth of the five-yearly cost occurred each year.

4.2. Estimated net present values

The net present value (NPV) of each conservation option was then calculated by subtracting TB from TC: NPV = TB − TC (Table 4). NPVs presented are the present value of all present and future costs, and not an amount that a reserve owner or ranching community would pay or receive at any given time. For example, given the mean ranch size in the areas where wild dogs occur on private land in South Africa (3047 ha ± 236 S.E.), and an average home range size (55,300 ha, Fuller et al., 1992), a pack would traverse ~18 ranches, and costs would be spread accordingly. Under these conditions, predation by a single dog would cost between \$32–\$306/rancher/year, or \$569–\$5512/dog/year (see Table 2).

5. Discussion

During the denning season, when the den site is known the location of wild dogs is predictable (Fuller et al., 1992), and they are easily habituated, avoiding the need for contentious supplementary feeding programmes necessary for tourism programmes involving some species (Walpole, 2001). Wild dogs are charismatic and their conservation plight is well publicized, both factors that increase WTP bids in contingent valuation studies (White et al., 2001), and there is potential to generate substantial revenue from wild dog-based ecotourism. This potential may be greater still if ecotourism is conducted outside the denning season.

The degree to which ecotourism benefits can offset costs depends greatly upon the WTP estimates used to calculate benefits, which varied from \$12 to \$59 dollars per person among guests at KNP and PNP, and those at NGR. Daily rates at the two national parks (\$10–\$100 per person) are much lower than those for the private reserves (\$300–\$400) and much of the variation in WTP is likely to be due to variation in tourist budgets. The success of wild dog ecotourism operations may be somewhat dependent on the extent to which high-budget guests can be attracted.

There is also significant variation in the costs associated with conserving wild dogs. Conserving dogs in a viable population involves the lowest costs per pack, and eco-tourism benefits from one pack (\$9045/year) are predicted to exceed average annual costs of conserv-

Table 4
Predicted NPVs in 2002 US$ of conserving a wild dog pack in perpetuity, within a viable population (Kruger), through reintroduction into a nature reserve, and in situ on ranchland, under various scenarios of costs and benefits (ZAR in parentheses)

Scenario	Low benefits[a]		High benefits[a]	
Viable population	+74,008 (813,349)			
Reintroduction	Fence upgrade	No fence upgrade	Fence upgrade	No fence upgrade
Eastern prey-profile				
All prey compensated	−773,782 (8,503,867)	−649,124 (7,133,867)	−339,679 (3,733,069)	−215,020 (2,363,069)
Half prey compensated	−447,078 (4,913,388)	−322,419 (3,543,388)	−12,975 (142,590)	+111,684 (1,227,410)
Northeast prey-profile[b]				
All prey compensated	−234,414 (2,576,204)	−109,755 (1,206,204)	+199,690 (2,194,594)	+324,348 (3,564,594)
Half prey compensated	−177,394 (1,949,556)	−52,735 (579,556)	+256,710 (2,821,241)	+381,364 (4,191,241)
Zero predation costs	−120,374 (1,322,909)	+4285 (47,091)	+313,730 (3,447,889)	+438,388 (4,817,889)
Ranchland				
Eastern prey-profile				
All prey compensated	−421,607 (4,633,464)		+12,496 (137,334)	
Half prey compensated	−191,539 (2,105,018)		+242,564 (2,665,780)	
Northeast prey-profile[c]				
All prey compensated	−57,329 (630,048)		+377,829 (4,152,336)	
Half prey compensated	−8938 (98,232)		+425,165 (4,672,566)	
Zero predation costs	+38,529 (423,428)		+472,632 (5,194,225)	

[a] Assuming six people visit the den twice per day during the denning season, using the Kruger and Ngala willingness to pay estimates for the low and high benefits scenarios, respectively, minus the costs of the ecotourism operation.
[b] Most likely cost scenarios for wild dog reintroductions.
[c] Most likely scenario for wild dogs on ranchland.

ing the entire Kruger population ($4692). Tourist volumes in Kruger are high (Engelbrecht and van der Walt, 1993) and almost 75% of guests are willing to pay to see wild dogs. These factors, coupled with large consumer surpluses among visitors to African protected areas suggest that the tourist market in Kruger may be sufficient to support ecotourism on multiple packs, at rates above the mean WTP. These revenues would potentially be sufficient to fund conservation initiatives elsewhere in the country.

The NPV of wild dog reintroductions varies from positive to prohibitively negative and careful site selection for wild dog reintroduction is vital. At the most costly, the conservation of a single wild dog reintroduced into a nature reserve is estimated to cost $8678/year.Wildlife is the property of landowners in southern Africa (Cumming, 1991) and predation on wild ungulates may cause substantial costs if full values are assumed to apply.

There are, however, several reasons to believe that many nature reserves provide conditions conducive to positive NPVs for wild dog reintroductions. First, there are many suitable reserves with existing predator proof fencing and suitable boma facilities in South Africa. Second, relatively low value impala and kudu *Tragelaphgus strepsiceros* constitute the primary prey species of wild dogs in most parts of southern Africa (Fuller et al., 1992). Third, ecotourism is the most profitable land use in reserves of a size sufficient for the reintroduction of wild dogs (Barnes and de Jager, 1996) and under these conditions, the realized costs of predation by wild dogs are likely to be low or zero. Fourth, wild dogs select for individuals in poor condition and a portion of prey killed is likely to remove individuals that would have died anyway (Pole et al., 2004). Fifth, the intensive post-release monitoring that is typically done is not vital and lower intensity monitoring would decrease costs. Finally, many nature reserves have existing ecotourism operations with a ready source of high-paying visitors. Under these conditions, nature reserve owners may be willing to reintroduce dogs at their own cost.

The logistics involved in conserving wild dogs in situ on ranchland are less costly than reintroduction programs, and ecotourism revenues are predicted to offset most of the costs given low predation costs, and all of the costs given zero predation costs or high benefits. Where wild dogs occur on ranchland, most ranchers (82.7%) derive part or all of their income from hunting or livestock, and ranches are typically small and game-fenced (Lindsey, 2003). Under these conditions, predation by a single dog may cost as much as $569–$5512/dog/year,compared to $3.40–$389/wilddog/year incurred by ranchers in Kenya where wildlife is not owned by the landowner (Woodroffe et al., in press). Thus negative attitudes among ranchers towards wild dogs may be based to some extent on legitimate economic costs, instead of or in addition to 'prejudice' or 'ignorance' (Fanshawe et al., 1991; Rasmussen, 1999). Although research into the actual economic impact of

wild dogs on wild prey and livestock under South African conditions is urgently required, ecotourism benefits have significant potential to improve landowner attitudes by offsetting some or all of the potential predation costs. Conservation efforts on ranchland should focus on helping ranchers to establish ecotourism operations.

There are, however, several limitations for the potential role of ecotourism in wild dog conservation, and conservation efforts should not rely solely on ecotourism benefits. (1) Ecotourism-related benefits do not always cover the costs of conserving wild dogs, as has been found for protected area management (Walpole et al., 2001). This is particularly likely in areas away from the typical tourist routes where ranches or reserves may not be able to attract significant numbers of visitors, although this could possibly be overcome through advertising. (2) In areas with low numbers of wild dogs, ecotourism maybe precluded if the den is positioned in an area inaccessible to vehicles. (3) Ecotourism fails to capture non-use values associated with wild dogs. (4) Ecotourism on wild dogs may limit other conservation ventures if the time and money spent by tourists results in lower spending on other ecotourism opportunities. (5) Tourism is extremely sensitive to political instability, which can result in large reductions in international arrivals and a corresponding decrease in revenues (Sillero-Zubiri and Laurenson, 2001). (6) Tourism results in direct environmental problems, through the usage of fossil fuels and conversion of habitat associated with transporting and housing visitors (Gössling, 1999), and in this case potentially through the disturbance of wild dogs.

Although remarkably tolerant, wild dogs may be sensitive to disturbance at the den. If disturbed, wild dogs tend to move their puppies to a new den site which results in mortality risks due to potential exposure to predators such as lions (*Panthera leo*), spotted hyaenas (*Crocuta crocuta*), and to people. It is thus of vital importance that ecotourism involving denning wild dogs is conducted in a responsible manner. A major effort should be made to habituate wild dogs to the presence of a vehicle prior to the denning season. In addition, we recommend that ecotourism operations are carefully monitored, and in the event of there being negative effects on the wild dogs, these operations should be adjusted accordingly, by immediately pulling back, or if this does not have the desired effect, even halted.

In addition to ecotourism, conservation programmes for wild dogs should include other strategies, such as educational and awareness programs aimed at instilling a conservation ethic, and ensuring that ranchers consider the ecological benefits associated with wild dogs. Education programmes have successfully reduced persecution of cheetahs by landowners in Namibia (Marker et al., 2003b), and have the potential to achieve similar results with wild dogs on ranchland in South Africa. Landowners should also be encouraged to cooperate to form conservancies (through the removal of boundary fencing between neighbouring properties), to create conditions more conducive to predator conservation (Lindsey, 2003). Finally, conservation efforts should aim to appropriate non-use values associated with wild dogs, despite the difficulty associated with capturing these values with conventional markets. Non-use values for biological resources are high (Turpie et al., 2003) and this is likely to be particularly true for charismatic species such as wild dogs. Urban residents in Sri Lanka are willing to pay sufficiently towards Asian elephant (*Elaphus maximus*) conservation to compensate farmers for the costs these animals impose (Bandara and Tisdell, 2004) and a similar scheme might work for wild dog conservation in South Africa.

The methods in this study are applicable to a wide variety of other species. For example, expanding populations of large carnivores in Europe and North America are increasingly conflicting with landowners due to increasing livestock depredation (Breitenmoser, 1998; Mech, 1998). Our study indicates that tourists are willing to pay substantial amounts to view large carnivores in their natural habitats and given the popularity of large carnivores among urban residents in the developed world (Ericsson and Heberlein, 2003), the establishment of ecotourism operations on private land has the potential to offset costs and create incentives for their conservation.

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