

11 Combining TCM and CVM of endangered species conservation programme: estimation of the marginal value of vultures (*Gyps fulvus*) in the presence of species–visitors interaction¹

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1 Introduction

Using different valuation techniques in order to estimate the value of endangered species is well documented in the literature. Those benefits can be contrasted against the protection cost or against alternative uses of the habitat that might risk their existence. However, performing a cost-benefit analysis (CBA) should take into account issues such as the value of the marginal individual, tradeoff analysis among competing goals and a feedback interaction between the size of a species' population versus number of visitors allowed in a particular wildlife park.

The central aim of this chapter is to examine how employing the travel cost method (TCM) in conjunction with the contingent valuation method (CVM) can provide insights as to whether the protecting measures and associated allocated budget for the conservation of a particular wildlife species are in accordance with public priorities. This question is examined in a case study assessing the values associated with the protection of the Griffon vulture (*Gyps fulvus*) via the development of one particular protection method, namely feeding stations. We also performed a simple CBA of the total conservation efforts at the national level and compared it with the total benefit derived from the increased number of vultures over a given period of a national protecting plan. Our second aim is to show how valuation techniques can be used for wildlife policy analysis in

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two other respects: entrance-fee policy and allocation of efforts to protect species among competing sites.

We see two contributions in the study discussed in this chapter. First, it measures the value of the marginal individual of an endangered species in order to conduct a cost-benefit analysis. Since policy should be judged at the margin, calculating the average values of extinction species provides the wrong signal for benefit estimation (Bulte and Van Kooten 1999; Kontoleon and Swanson 2003). We used a multiple-scenario questionnaire format which enabled us to trace a demand function for the species and by that receive the value of the marginal individual. The second contribution lies in the policy implications of using TCM and CVM beyond determining the cost-benefit question of 'should we conserve or not?'

The study addressed two policy issues: the debate between revenue vs. efficiency and the issue of site interaction. In times of budget constraints, it is a necessity to consider other options for financing nature conservation beyond the general budget (Van Sickle and Eagles 1998). Hence alternative sources of revenues (such as from recreation) should also be considered even though they may entail loss in welfare. Using the demand functions derived from the TCM analysis we can reveal the impact of the tradeoff between revenue increases and welfare decreases.

With respect to the issue of site interaction, there is a need to combine in the analysis the number of individual vultures and number of visitors. There is a positive feedback between these two parameters which policy makers should take into account as a higher number of vultures bring more visitors. We estimate the value visitors place on the marginal vulture through the CV study while the TC analysis allows us to assess the number of additional visitors. Combining results from both methods could reveal the optimal number of vultures that should be targeted at each site as well as how many more visitors they would attract (González-Cabán *et al.* 2003).

The Israeli Red List of Threatened Animals classifies the Eurasian Griffon vulture, *Gyps fulvus*, as Vulnerable (Dolev and Perevolotsky 2002). The population of the Griffon vulture, once numerous and abundant throughout its breeding range, has suffered from a severe decline during the last century. In Israel, although protected by law, the population has declined from over 1,000 breeding pairs in the second half of the nineteenth century (Mendelssohn and Leshem 1983; Tristram 1885) to a present number of about 140 breeding pairs (Bahat, personal communication). This worrisome decline is a result of hunting, excessive

usage of pesticides (Mendelsohn 1972; Shlosberg 2001), electrocutions (Lehman *et al.* 1999) and improved pastoral hygiene which has resulted in a reduction in the available food for vultures (Cramp and Simmons 1980; Wilbur 1983).

The Griffon vulture is an obligatory carrion feeder which forages over extensive areas (Cramp and Simmons 1980; Mundy *et al.* 1992). In Israel, its main food source is cattle (Bahat 1995). Since this food source is not always available, and since natural food sources have become scarce due to changes in land use in recent years, there is a need for supplementary feeding in the form of a feeding station. Such feeding stations have proven to be successful in sustaining stable vulture populations in Israel and elsewhere (Bahat *et al.* 2002; Mundy *et al.* 1992).

Since 1996, the Israel Electric Company has joined forces with the Israel Nature and National Parks Authority and the Society for the Protection of Nature in Israel in a mutual effort to protect the Griffon vulture and other endangered raptors. The budget for this project is allocated to various protecting measures, including the operation of feeding stations (Bahat *et al.* 2002).

The benefit of protecting vultures is both ecological and social: as scavengers, vultures are crucial to the well-being of the environment, by releasing it from dead animals that could otherwise be hazardous both to wildlife and to humans. Yet vultures also have significant recreational interest. While vultures are not a common sight in other parts of the country, the Gamla Nature Reserve in Northern Israel attracts significant crowds who are able to observe the soaring flight patterns and breeding efforts of the vultures.

In the next section we will review the operation of feeding stations as a management tool in an overall scheme of protecting vultures. We will also present studies valuing use and non-use values of endangered species and the methods used for such valuation. This review will include also CVM-TCM interaction, entrance-fee analysis and estimation of the value of the marginal individual. Section 3 will describe the study sites. Section 4 presents the TCM and CVM results from samples derived from the Gamla and Hai-Bar Nature Reserves, as well as from the general population. Section 5 will provide a break-even point analysis for feeding stations as a means of preserving the population of vultures at the two specific sites as well as a cost-benefit analysis of the total investment in vulture conservation in Israel. Furthermore, we will examine two additional policy issues: entrance-fee analysis under different policy goals, as well as an analysis of the optimal allocating of conservation efforts between two competing sites. The last section concludes.

2 Literature review

2.1 Feeding stations

One of the conservation efforts of protecting vultures and preventing their decline is the operating of feeding stations where food quality can be assured and the availability of food can attract vultures to areas where they once were abundant (Mundy *et al.* 1992).

A well-operated feeding station can also serve as a source of bone fragments to the breeding parents, to compensate for the absence of the main bone-crushers in their foraging areas (Richardson *et al.* 1986). In the absence of bone fragments, the parents search for various substitutes which are equally hard, such as pieces of metal, swallow them after filling their crop and regurgitate them at the nest (Mundy *et al.* 1992). These pieces are useless as a supply of calcium for the nestling's skeleton and can also be harmful, even lethal. As a result, the nestling suffers from rickets and may not reach the fledgling stage (Houston 1978).

This management tool was first used in South Africa in 1966, where a feeding scheme for the Bearded vulture, *Gypaetus barbatus*, was conducted (Butchart 1988). In France, the use of feeding stations started in the Pyrenees in 1969 (Terrasse 1985). Right after that, feeding stations were established in other places in Europe and in the USA, as part of the reintroduction programme of the endangered California condor, *Gymnogyps californianus* (Wilbur *et al.* 1974). The population of the Black vulture, *Aegypius monachus*, in Greece is also recovering as the result of operating feeding stations (Vlachos *et al.* 1999).

In order to deal with rickets, the South African Vulture Study Group has begun to provide bone fragments in feeding stations. Rickets declined from 16.9 per cent in 1976 to 3.7 per cent in 1983 (Richardson *et al.* 1986).

In Israel, the Nature Reserves and Parks Authority started the operating of feeding stations in 1972. A network of sixteen feeding stations was spread all over the country. These feeding stations were placed in vultures' foraging zones and are located in areas where carcasses can be provided on a regular basis (Bahat *et al.* 2002).

A routine supplement of bone fragments at the local feeding station at Gamla Nature Reserve began in 1998. As a result, the number of bone fragments found in the nests increased and the number of nests containing artifacts decreased. Furthermore, the number of nestlings suffering from rickets dropped (Ben-noon *et al.* 2003).

2.2 *The value of wildlife viewing and protecting*

Two of the most commonly used economic valuation methods are the travel cost and contingent valuation methods.

One of the major difficulties in determining the optimal amount of wildlife protection is that the economic benefits associated with species conservation are often non-marketed. The 'extra' value gained over costs is an estimate of the net economic benefits, or consumer surplus derived from wildlife viewing. Brown (1993) estimated the value of viewing elephants in Kenya through the application of both TCM and CVM. The total net economic value per foreign visitor on a wildlife-viewing safari was calculated. A portion of that total value, 12.6 per cent, was allocated to viewing elephants specifically, a value which was translated to \$23–27 million. As a result of such studies, the Kenya Nature Protecting Authority has realised the economic implications of declining elephant populations due to poaching.

Similarly, using TCM and CVM techniques the annual recreational value of wildlife viewing in Lake Nakuru National Park in Kenya was found to be \$7.5–15 million (Navrud and Mungatana 1994). The flamingos, *Phoenicopterus minor*, in the lake accounted for more than one third of this value. Considering that Lake Nakuru is just one of several parks in Kenya, and that wildlife viewing is becoming an important part of the global trend of increasing ecotourism, the results of this study suggest that sustainable management of wildlife resources could provide a significant and much-needed revenue source for the country in the future. This economic potential can also secure the preservation of wildlife and hence provide the possibility for a 'win-win' outcome.

Another application of the CVM to the conservation of endangered species was undertaken in the State of Victoria, Australia (Jakobsson and Dragun 2001). Two CVM questionnaires were used. The results show a higher value for protecting the Leadbeaters' possum (A\$40–84 million) than for competing activities in the area (such as timber cut from the region). Furthermore, the value people place on conservation of all endangered species (A\$160–340 million) was larger in at least one order of magnitude than the direct expenditure on conserving flora and fauna in the area (about A\$10 million per year).

Most of the wildlife valuation studies deal with the value of its entire habitat (or nature reserve) or the value of a representative individual of a given population of an endangered species. However, policy decisions are often made on the margin. Bulte and Van-Kooten (1999, 2000) argue that for species such as the ancient temperate rainforests and minke

whales (*Balaenoptera acutorostrata*), the likelihood of going below the critical species threshold level should dictate whether policy decisions should be led by teleological (utilitarian) or deontological (Kantian) reasoning. Their conclusion is that in many cases it is necessary to depart from the utilitarian approach. Yet their argument can be reversed in our case. As long as the species has gone beyond the critical level and as long as there is an increasing marginal cost of protecting the species, a marginal analysis should be applied.

Other researchers who dealt with the value of the marginal species include Kontoleon and Swanson (2003), González-Cabán *et al.* (2003) and Paulrod (2004). Paulrod estimated the value of the marginal benefit of angling in Sweden for sport fishing. He found that the marginal value of catch can vary from a few Swedish Krone to a few hundred Swedish Krone depending on site location and type of fish. Therefore, it is important to take marginal valuation into account when undertaking resource allocation decisions.

Kontoleon and Swanson (2003) and González-Cabán *et al.* (2003) dealt with land-based species. Both tried to use marginal valuation in order to estimate the value of habitat, though Kontoleon and Swanson (2003) dealt with an endangered species (the panda, *Ailuropoda melanoleuca*) while González-Cabán (2003) dealt with deer hunting. The benefits assessed in the first study are derived from preservation of the species itself (non-use values), while in the latter study benefits are derived from hunting (use values). Kontoleon and Swanson used a CV study in which respondents were asked to relate to three panda conservation scenarios – cages, pens and free in the wild – with each scenario entailing a different amount of land allocation. They found strong evidence for decreasing marginal values per hectare which ranges from \$0.72/hectare to \$0.000054/hectare depending on the scenario. González-Cabán *et al.* (2003) assessed the added recreational benefits from increasing deer population by a programme of prescribed burning. The study was undertaken in the San Bernardino National Forest in Southern California. Prescribed burning improves deer habitat and as such attracts more hunters. The value of the marginal hunting trip was translated to the value of a marginal deer and from there on to the marginal value of land. It was found that the value of land decreases from more than US\$7920/acre down to US\$1200/acre as one goes from the first to the 8,500th acre. Again, contrasting this finding with the cost of prescribing fire can be of great assistance to decision makers as to how many acres to devote to that activity. In our study, we estimated the value of the marginal species, the Griffon vulture, but did not translate it into hectares but into conservation efforts, namely number of feeding stations. As in Kontoleon and

Swanson (2003), respondents were presented with three scenarios which differed in the number of soaring vultures in the sky that a respondent sees.

One way of dealing with obtaining marginal values is to combine CVM and TCM studies. González-Cabán *et al.* (2003) used TCM results of additional trips as a response to added population in order to achieve the marginal value of a deer. Yet there are other reasons for combining TCM–CVM studies such as calibrating CVM hypothetical responses. If one can decompose the CVM results to its use and non-use values and if one can compare the use value derived from CVM to the use value derived from TCM, it might be of interest to include the non-use value also as a reliable estimate. Carson *et al.* (1996) provides a comprehensive literature review of such studies. It is interesting to note that while one would expect CVM estimates to be larger (as they include both use and non-use values), most studies found evidence of the opposite. The CVM/TCM value ranges from 0.3 to 0.5. Carson *et al.* (1996) provides some reasons for this finding while we will also refer to this issue further on in the chapter. In our case study we combine CVM and TCM in order to decide about the optimal effort allocation between two competing sites. Once an additional vulture is added to the site, there is an added value to existing visitors. However, in a dynamic setting, their numbers would increase and would boost the added value to the site even further. The added benefit depends on the elasticity of the demand function derived from the TCM.

2.3 *Entrance fee analysis*

Entrance fees for natural sites or parks can be an important contribution to preserving the site and raising revenues for managing it through the best available means. Fees can also be a rationing tool to prevent peak-season congestion of visitors which, in return, has an adverse affect on the site. In times of increasing budget limits, natural sites which raise their own sources of funds can partly alleviate the lack of resources usually provided by central government.

However, entrance fees are controversial on two grounds. First, they have negative distributional implications. Some argue that nature-based recreation is a community necessity and should be provided to its inhabitants. The other argument relates to the efficiency provision of a public good. Once a site such as a museum or nature reserve is built and established, there is no extra cost from an additional visitor (at least for low levels of congestion). Thus, there is no justification for charging an entrance fee, at least from a marginal cost perspective. This argument assumes that the museum or the nature reserve is a pure public good.

Charging a positive price for such goods may deter some users which will lead to a social deadweight loss. This reasoning holds as long as parks are considered to be pure public goods. However, in most cases there are marginal costs associated with added visitors, for example extra roads, more parking spaces, more hiking trails, etc. Hence, the need for optimal park pricing emerges.

The problem with pricing natural resources is that it tries to achieve too many goals with only one tool, namely the entrance fee. Without having a clear definition of society's welfare function and the tradeoffs between various policy objectives, all that remains to be done is to compare different prices and see how they achieve these different goals.

Optimal pricing of public goods is a persistent and common problem observed in both developed (Van Sickle and Eagles 1998; Mendes 2000; Herath and Kennedy 2004) and developing nations (Mercer *et al.* 1995). Not only natural parks face this dilemma. Willis (2003) analysed and compared three pricing options for the public park of Bosco di Capodimonte in Naples, Italy: efficient pricing which means zero entrance fees, maximising revenue and covering operation costs. Each pricing mechanism dictates revenues, cost recovery as well as the magnitude of any welfare losses. In our study we employ the same criteria, namely cost recovery and maximum revenue, but also trace the revenue function in order to identify the relevant location on the curve in which tradeoffs exist between revenue increases and welfare decreases.²

3 The study sites

Gamla Nature Reserve is located at the centre of the Golan Heights in Northern Israel. The reserve contains the highest waterfall in Israel, archaeological sites and the largest Griffon vulture nesting colony in the country. An average of around 100,000 tourists visit the area each year.

Hai-Bar Nature Reserve is located on the Southeastern outskirts of Haifa, in the heart of Mount Carmel, and aims to provide the means for the breeding and rehabilitation of animals that were once common in the Mediterranean area, in order to eventually release them into the wild. An average of about 45,000 people per year visit this reserve.

² One way of dealing with the undesired distributional implications of a uniform price was suggested by Mendes (2000), where differential price is assessed based on willingness to pay. In this study we did not employ this option as to make it applicable, a mechanism for differentiating people at the gate is required. Beyond its potentially politically incorrect nature, this pricing approach also entails some degree of paternalism since the government decides what low-income people can do with 'vouchers' distributed to them. Another suggested pricing mechanism is to decrease congestion. We have excluded this pricing option as well because of lack of data. This remains, however, an issue for future research.

Table 11.1 *Travel cost – regression Hai-Bar*

Parameter (variable)	Coefficient	t-stat
Constant	0.0359	5.454
No. of children	-0.0008	-2.513
Green organisation membership	-0.0035	-1.476
Education	0.0025	1.515
Income	3.6038E-07	2.047
Travel cost	-0.0001	-12.639
		R ² = 0.41
		F = 36.34

Dependent variable: travel frequency

4 The valuation process

TCM and CVM questionnaires were distributed among visitors at Gamla and Hai-Bar Nature Reserves. CVM questionnaires were also distributed within a representative sample of the general population.

4.1 TCM

TCM was conducted in order to estimate the use values of the sites, reflected in the travel costs incurred by the visitors. The TC function would capture the negative relationship between demand for visits and travel costs. In addition, we controlled for membership in a green organisation, education and income levels by adding them as additional explanatory variables.

In total, 170 questionnaires were distributed at Gamla Nature Reserve (NR) from January to June 2002; 143 were usable (85 per cent). At Hai-Bar NR, 270 out of the 296 questionnaires were usable (91 per cent). The questionnaires were distributed from November 2002 to April 2003.

4.1.1 Calculating TCM

Travel cost was calculated based on the abovementioned socio-economic variables as well as the cost of travel, the opportunity cost of time and the entrance fee to the site. The regression results are given in Tables 11.1 and 11.2 for Hai-Bar and Gamla respectively.

As can be seen from the tables, at Hai-Bar, the coefficients on travel cost, number of children and income are significant at the 99 per cent level. At Gamla, only the travel cost coefficient is significant. This is theoretically consistent as people would purchase fewer trips if they live

Table 11.2 *Travel cost – regression Gamla*

Parameter (variable)	Coefficient	t-stat
Constant	0.155	1.115
Travel cost	-0.0002	-4.63
Income	-1.35578E-06	-0.090
Length of trip	-0.002	-0.520
No. of children	5.36222E-05	0.083
Education	-0.0186	-0.420
		R ² = 0.40
		F = 35.45

Dependent variable: travel frequency

further from the site. The result of the income coefficient at Hai-Bar is also expected, while the sign for ‘number of children’ is somewhat surprising as it would be expected to be positive on account of the significant educational role of the Hai-Bar reserve. A possible explanation might be that families with children are attracted to other types of recreational sites.

We used a zonal TCM approach which results in the following demand functions for Gamla and Hai-Bar NRs as given in equations (1) and (2) respectively.³ These demand functions are estimated after holding all significant variables at their mean level.

$$P = TC_G = 293 - 0.0037(VI_G) \quad (1)$$

$$R^2 = 0.913$$

$$P = TC_H = 506 - 0.0133(VI_H) \quad (2)$$

$$R^2 = 0.823$$

where: TC_G = visiting price for Gamla NR
 TC_H = visiting price for Hai-Bar NR
 VI_G = number of visitors to Gamla NR
 VI_H = number of visitors to Hai-Bar NR

4.1.2 *Calculating the value of viewing vultures*

The value of viewing vultures was calculated according to the relative importance visitors attributed to this experience and was found to be between 85 per cent and 92 per cent for Gamla and Hai-Bar NRs. Based

³ Other functional forms were tested as well: log-linear, linear-log (exponential), log-log and reciprocal. Because we use linear approximation in section 5, we keep error consistency by reporting only the linear case.

on that, we can extract the total value of viewing vultures at both sites, as given in equations (3) and (4) for Gamla and Hai-Bar respectively.

$$TBenefit_G = \sum TC_G = 293 (VI_G) - 0.00185 (VI_G)^2 \quad (3)$$

$$TBenefit_H = \sum TC_H = 506 (VI_H) - 0.00665 (VI_H)^2 \quad (4)$$

The values of the sites as related to viewing vultures are 11.76 M. NIS and 9.84 M. NIS for Gamla and Hai-Bar NRs respectively.^{4,5}

4.2 CVM

We used CVM questionnaires to estimate the total value of viewing and protecting vultures. We undertook in person interviews as recommended by the NOAA panel (Arrow *et al.* 1993). CVM questionnaires were distributed to a sample of 150 and 151 visitors at Gamla and Hai-Bar NRs respectively, with the assumption that they too attribute non-use values to viewing and protecting vultures, even if they were users while completing the questionnaire (Shechter *et al.* 1998). Furthermore, this is indeed the relevant population which is able to value the site because of their affinity and familiarity with it (Carson 2000). The questionnaire was also distributed among a sample of 150 individuals from the general population. It was assumed that the willingness to pay (WTP) of this sample would be lower than the WTP of the other two, but greater than zero.

Prior to the final form of the questionnaire, it was handed to four focus groups, which gave their feedback on the clarity and length of the questionnaire. Their distribution of WTP bids was used to formulate the payment card used in the final questionnaire (Arrow *et al.* 1993).⁶ A general description of the samples is given in Table 11.3.

The WTP question was presented in three scenarios, adopting the method used by Loomis (1987) at Mono Lake and by Kontoleon and Swanson (2003) on the giant panda. In these studies respondents were presented with three levels of the environmental attribute they were asked to value. We showed people three levels of vulture population density (Figure 11.1). Since at the Gamla NR seeing vultures in the sky is a common sight, respondents were asked about their WTP to prevent their decline, whereas at Hai-Bar NR and the sample of the general population,

⁴ 1\$ = 4.4 NIS.

⁵ In order to keep the consistency with the calculation process, this number of visitors for the value of the sites was derived from the functional form of the demand curve and not from actual data. However, there is a difference of about 15 per cent which is in the acceptable range (Bateman *et al.* 2002).

⁶ A full version of the questionnaire can be obtained from the authors upon request.

Table 11.3 *CVM questionnaire – socio-economic characteristics of the three samples*

	Gamla	Hai-Bar	General pop.
Gender	Men	Men	Men
Age	26–35	36–45	46–55
Origin	Israeli	Israeli	Israeli
Marital status	Married	Married	Married
No. of children	2–3	2–3	2–3
Residence	Urbanites	Urbanites	Urbanites
Green organisation membership	Non-members	Non-members	Non-members
Source of knowledge			from the media
Education	Academic	Academic	Academic
Income	Average	Average	Average

Note: the table provides a description of the most frequent characteristics of the respondents in the sample

Gamla questionnaire:



Stage 1



Stage 2



Stage 3

Hai-Bar questionnaire:



Stage 1



Stage 2



Stage 3

Figure 11.1. Three-stage scenarios

where vultures are not a common sight, respondents were asked about their WTP to increase their number in the sky.

Population density was demonstrated by presenting the respondents with different numbers of soaring vultures. At the Gamla NR, the two scenarios were as follows:

Scenario 1: How much are you willing to pay to prevent a move from picture 1 to picture 2 (WTP 1)?

Scenario 2: How much are you willing to pay to prevent a move from picture 2 to picture 3 (WTP 2)?

The scenarios presented at Hai-Bar NR were:

Scenario 1: How much are you willing to pay to enable a move from picture 1 to picture 2 (WTP 1)?

Scenario 2: How much are you willing to pay to enable a move from picture 2 to picture 3 (WTP 2)?

The number of soaring vultures represents the actual population density at the site. At Gamla NR, five soaring vultures in the picture represent ninety-five vultures on site (the current situation), two depicted vultures represent thirty-eight actual vultures. At Hai-Bar NR, two soaring vultures in the picture represent five vultures on site (the current situation), while seven vultures in the picture represent eighteen vultures on site.

The purpose of using this method is twofold. First, it allows us to check whether reported values are consistent with declining marginal benefits. Second, it enables us to derive a demand function of marginal WTP with respect to number of vultures.

In addition, a regression was fitted to the WTP where the explanatory variables were income, education, age, gender, marital status and membership of a 'green' organisation. The details results are not presented here for reasons of brevity, but all coefficients had the expected sign which provides an indication of the internal consistency of our results.

4.2.1 CVM results

Summary statistics of the distribution of the reported WTP amounts for each scenario at each site are presented in Table 11.4.

As the table shows, there is a large difference between the mean and the median WTP figures. This is probably due to the non-normal distribution of the reported birds and the large number of relatively extreme results on the right-hand side of the distribution tail. The issue of mean versus median is important to public decision making, especially in democratic societies in which the outcome is based on majority rather than the mean voting.

Table 11.4 *CVM questionnaire – WTP in the three samples (in NIS)*

	Gamla	Hai-Bar	General pop.
WTP1	50.72	41.61	36.77
Median	50.0	20.0	20.0
Mode	50.0	20.0	20.0
Maximum	200.0	150.0	200.0
Minimum	0.0	0.00	0.0
Standard deviation	48.17	39.82	36.7
WTP2	66.93	45.19	37.48
Median	50.0	20.0	20.0
Mode	50.0	20.0	20.0
Maximum	300.0	200.0	150.0
Minimum	0.0	0.0	0.0
Standard deviation	61.45	42.79	36.5
Total WTP	117.65	86.8	74.25

Table 11.5 *CVM questionnaire – use and non-use values in the three samples (in New Israeli Sheqels, NIS)*

	Gamla	Hai-Bar	General pop.
Use value per visitor NIS	22.00	20.22	18.26
Use value for site mil. NIS	2.68	1.0	40.01
Non use value Existing value	54.12	32.98	26.28
per visitor Option value	3.41	6.94	8.53
NIS Bequest value	31.30	24.82	17.15
Total non use value per visitor NIS	(75.5 %) 88.83	(74.6 %) 64.74	(70 %) 51.96
Total non use value for site mil. NIS	8.26	2.91	93.55
Total WTP per visitor NIS*	117.65	86.7	74.25
Total no. of visitors	92,700	45000	1.8 million households
Total value of watching vultures	10.94 mil. NIS	3.91 mil. NIS	133.6 mil. NIS
Didn't state vulture viewing as important (%)	1.65 %	1.76 %	3.14 %

The breaking down of the total value into its use and non-use components is shown in Table 11.5.

One of the most striking results from this table is that non-use value consists of about 75 per cent of the total WTP. There are a few plausible explanations for this result. One is that people at the site already exercised

their use value (by being there). Hence, their immediate reaction is to declare a non-use value. However, people surveyed off site might want to ensure a possible visit there so their immediate reaction is to declare a use value.

Results of the regression analysis for Gamla, Hai-Bar and the general population samples are given in Tables 11.6, 11.7 and 11.8, while a comparison of the general impact of key variables on WTP is given in Table 11.9.

The total, average and marginal values of the vultures at the sites are given in Table 11.10. As the table shows, the total WTP for the site is 118 NIS and 87 NIS for an average visitor at Gamla and Hai-Bar NRs respectively. If we multiply this value by the number of visitors at the sites, we can derive the total value which is 10.94 M. NIS and 3.91 M. NIS for Gamla and Hai-Bar NRs respectively.

Furthermore, the marginal benefit function can be derived from these results. This was done by plotting a line through the two mean points of the change in number of vultures in the two scenarios. For example, at Gamla NR, an average respondent is willing to pay 51 NIS to prevent a decline of 60 per cent in the number of vultures (i.e. three in the picture or fifty-seven in reality). This entails that 0.894 NIS represents the value for the mean vulture between the fifty-seventh and the ninety-fifth vulture. After completing this analysis, straight-line equations that pass through these mean points were calculated. These equations represent the marginal benefit function and are presented in equations (5) and (6) for Gamla and Hai-Bar NRs respectively.

$$MB_G = 2.11 - 0.0183 (VU_G) \quad (5)$$

$$MB_H = 9.767 - 0.547 (VU_U) \quad (6)$$

As can be seen from both equations, the marginal benefit decreases with the number of vultures. In order to calculate the total benefit of the site, we can integrate (5) and (6) to get (7) and (8) as follows:

$$TB_G = 2.11 (VU_G) - 0.00915 (VU_G)^2 \quad (7)$$

$$TB_H = 9.76 (VU_H) - 0.2735 (VU_H)^2 \quad (8)$$

The above analysis results in a total value of 10.84 M. NIS and 3.16 M. NIS for Gamla and Hai-Bar NRs respectively. This amount is very similar to the mean WTP times the number of relevant population (10.94 M. NIS and 3.91 M. NIS respectively).

In contrast to what one would expect, the value derived from the CVM is smaller than that derived from the TC analysis. One way of explaining

Table 11.6 CVM questionnaire – regression results of Gamla

	WTP1				WTP2			
	Coefficient	St. error	t-value	Sig.	Coefficient	St. error	t-value	Sig.
Constant	38.860	35.768	1.086	.280	25.975	49.663	.523	.602
Gender	3.435	8.540	.402	.688	7.059	11.789	.599	.551
Age	17.356	4.949	3.507	.001	16.924	7.016	2.412	.017
Origin	8.991	10.566	.851	.397	-8.795	14.696	-.598	.551
Marital status	-35.764	12.211	-2.929	.004	-27.023	16.864	-1.602	.112
No. of children	-6.031	4.097	-1.472	.144	-4.560	5.658	-.806	.422
Residence	5.313	10.917	.487	.627	11.812	15.042	.785	.434
Green organisation	-5.141	10.702	-.480	.632	10.633	15.014	.708	.480
Education	-1.939	4.949	-.392	.696	-1.266	6.951	-.182	.856
		$R^2 = 0.215$				$R^2 = 0.90$		
		$F = 3.595$				$F = 1.272$		
		$Sig. = 0.001$				$Sig. = 0.260$		

Dependent variable: WTP

Table 11.7 CVM questionnaire – regression results of Hai-Bar

	WTP1				WTP2			
	Coefficient	St. error	t-value	Sig.	Coefficient	St. error	t-value	Sig.
Constant	19.039	45.242	.421	.675	69.887	47.629	1.467	.145
Gender	-7.488	7.690	-.974	.332	-7.639	8.034	-.951	.344
Age	11.963	4.553	2.627	.010	13.373	4.812	2.779	.006
Origin	-14.879	9.404	-1.582	.117	-17.635	9.892	-1.783	.077
Marital status	34.231	15.432	2.218	.029	37.357	16.277	2.295	.024
No. of children	-2.254	4.960	-.454	.650	1.743	4.954	.352	.726
Residence	-15.078	11.105	-1.358	.177	-26.257	11.834	-2.219	.029
Green organisation	-3.134	9.395	-.334	.739	-12.399	9.836	-1.261	.210
Education	-2.979	5.433	-.548	.585	-5.531	5.738	-.964	.337
Income	6.353	5.729	1.109	.270	-3.443	5.896	-.584	.560
		$R^2 = 0.22$				$R^2 = 0.28$		
		$F = 14.57$				$F = 20.10$		
		$Sig. = 0.017$				$Sig. = 0.045$		

Dependent variable: WTP

Table 11.8 CVM questionnaire – regression results of general population

	WTP1				WTP2			
	Coefficient	St. error	t-value	Sig.	Coefficient	St. error	t-value	Sig.
Constant	-64.839	43.370	-1.495	.138	-57.676	48.814	-1.182	.241
Gender	-2.555	7.258	-.352	.726	-8.661	8.254	-1.049	.297
Age	5.012	3.613	1.387	.169	4.848	4.352	1.114	.268
Origin	-10.029	9.115	-1.100	.274	-5.971	10.300	-.580	.564
Marital status	6.140	9.005	.682	.497	12.493	10.074	1.240	.218
No. of children	-5.304	3.954	-1.341	.183	-2.159	4.535	-.476	.635
Residence	12.928	8.986	1.439	.154	5.525	10.205	.541	.590
Green organisation	17.535	15.051	1.165	.247	21.814	16.891	1.291	.200
Source of knowledge	21.852	6.166	3.544	.001	21.578	7.029	3.070	.003
Education	2.854	4.575	.624	.534	.402	5.097	.079	.937
Income	2.287	5.490	.417	.678	.869	6.190	.140	.889
		$R^2 = 0.35$				$R^2 = 0.29$		
		F = 3.788				F = 4.554		
		Sig. = 0.028				Sig. = 0.049		

Dependent variable: WTP

Table 11.9 CVM questionnaire – comparing socio-economic variables of the three samples and their relation to WTP

	Gamla		Hai-Bar		General pop.	
	Significance	Relation to WTP	Significance	Relation to WTP	Significance	Relation to WTP
Gender		Women have a higher WTP		Men have a higher WTP		Men have a higher WTP
Age	significant	Older people have a higher WTP	significant	Older people have a higher WTP		Older people have a higher WTP
Origin		Non-Israelis have a higher WTP	significant	Israelis have a higher WTP		Israelis have a higher WTP
Marital status	significant	Not married have a higher WTP	significant	Not married have a higher WTP		Not married have a higher WTP
No. of children		Few children have a higher WTP		Few children have a higher WTP		Few children have a higher WTP
Residence		Rural have a higher WTP	significant	Urbanites have a higher WTP	significant	Rural have a higher WTP
Green organisation		Non-green have a higher WTP		Non-green have a higher WTP	significant	Non-green have a higher WTP
Source of knowledge						Previous knowledge associated with higher WTP
Education		Lower WTP		Lower WTP		Lower WTP
Income	significant	Higher WTP		Higher WTP		Higher WTP

Table 11.10 *The value of the marginal vulture at each site (in NIS)*

	Gamla	Hai-Bar	General population
Scenario 1	From 5 to 2	From 0 to 2	From 0 to 2
WTP 1	51	42	37
Scenario 2	From 2 to 0	From 2 to 7	From 2 to 5
WTP 2	67	45	38
Total WTP	118	87	75
No. of vultures on site	95	5	350
Annual no. of visitors	92,700	45,000	1.8 M. households
Total value of site	10.94 M.	3.91 M.	135 M.
Value of average vulture	115,000	783,000	385,714
WTP per vulture	0.37	7.03	0.13
Value of marginal vulture	34,438	316,440	244,800

this is the fact that respondents were approached at the site after actually having incurred the costs associated with visiting the site, a fact that might have influenced their responses.

5 Break-even point, cost-benefit and other policy implications

5.1 *Costs of feeding stations*

The information on the costs of establishing and operating feeding stations was taken from the financial reports of the Israel Nature and National Parks Authorities (Hatzofe 2003). The annual operating cost of a feeding station (amortised fixed costs plus variable costs) is estimated to be 73,000 NIS.

In order to perform a cost-benefit analysis, we should know how many vultures can be added to the population as a result of operating a feeding station in the area. However, this information is not available at the moment.⁷ Therefore, we can instead focus on the number of vultures that the feeding station should add to the population in order for it to cover its costs. As seen from Table 11.10, we can estimate the value of the marginal vulture. Dividing the annual cost of feeding stations by this value gives us the break-even point. Table 11.11 presents the break-even point under four scenarios. Total and use values are calculated only for the mean and median willingness to pay. As can be seen from the table at Gamla, the break-even point ranges from 2–9 vultures annually. At Hai-Bar it ranges from 0.2–2 vultures.

⁷ This is a topic for further biological research.

Table 11.11 *Break-even point under different scenarios (number of vultures)*

Payment site	Mean		Median	
	Total value	Use value only	Total value	Use value only
Gamla	2.12	8.65	2.49	10.17
Hai-Bar	0.23	0.91	0.50	1.97

Table 11.12 *Cost-benefit ratios (CBR) under the different scenarios*

CBR site	Mean		Median	
	Total value	Use value only	Total value	Use value only
Gamla	1.32	0.34	1.13	0.28
Hai-Bar	12.21	3.09	5.62	1.43
General population	9.42	2.82	5.07	1.52

5.2 Cost-benefit

The benefit of the entire vulture population in Israel could be estimated through a cost-benefit analysis of a national project to increase their number. This project is called 'Porsim Kanaf', a conservation project on the major birds of prey in Israel which has been operating since 1996. During the first five years of the project, the number of breeding couples increased from 70 to 140 (Bahat *et al.* 2002). The total budget of the project was estimated to be 3.7 M. NIS. This is equivalent to a cost of 26,000 NIS per additional vulture. Based on that, we can extrapolate on the marginal benefits received by the four scenarios in Table 11.11 to get a cost-benefit ratio for each of them. These results are presented in Table 11.12.

As the table illustrates, only at Gamla and only under the use value criterion is the ratio smaller than 1.

5.3 Some policy implications of valuation techniques

The most evident policy implication of valuing endangered species is the cost-effectiveness of preserving them, as shown earlier. However, combining TC and CV techniques can serve as a basis for further policy

decision making such as (i) optimal revenue consideration and (ii) allocating conservation efforts among competing sites.

5.3.1 *Revenue estimation*

Revenue or profit consideration is a vital part of nature organisations. In times of budgetary cutbacks, the government will give higher priorities to more pressing issues even though nature conservation can produce positive net benefit results. In this case, the alternative is to manage the given nature reserve as a commercial entity, at least to complement declining government funds. Sometimes the situation is even more complicated. In Israel, for example, some of the sites are open to the public free of charge while others charge a fixed price without taking into consideration the demand for the site. In such situations, a cross subsidy is the only (or main) source of financing the free sites.

TC studies can be of use if the nature conservation authorities would want to consider some flexibility with respect to their pricing policies. We illustrate this kind of analysis for the two vulture colonies in Gamla and Hai-Bar NRs.

There are two extreme options the nature conservation authorities can implement. They can either allow visitors free of charge or charge an entrance fee in order to maximise revenues. There are various in-between pricing possibilities such as covering operation costs or pricing in a way that the number of visitors will not pass some critical ecological threshold. In this study we considered the following options:

- current situation
- maximise revenues
- charge entrance fee such that total operating costs would be covered.

Based on equations (1)–(4), we can calculate the characteristics of each of the four scenarios. Results are presented in Table 11.13. The current entrance fee in all nature sites which charge a price is 18 NIS. Table 11.13 shows the number of visitors as well as revenues and benefit associated with scenario 1 (current situation).⁸ Since we are dealing with linear functions, revenues are maximised at the point where the marginal revenue is equal to zero. With respect to scenario 2 (revenue maximisation), entrance fees should be raised by a significant amount (814 per cent at Gamla and 1,406 per cent at Hai-Bar) so that total revenues (across both sites) will go up from 2.01 M. NIS to 10.67 M. NIS (an increase of

⁸ All calculations are done on the estimated demand function so there is a slight change between the reported results and the actual ones. It was decided to keep to the functional form even in the current situation in order to be consistent with the estimation error in the TCM demand functions.

Table 11.13 *Pricing, revenues and welfare*

Site scenario	Gamla	Hai-Bar
1. Current situation:		
Visitors (000)	74	38
Price (NIS)	18	18
Revenue (M. NIS)	1.33	0.68
Welfare (M. NIS)	11.76	9.84
2. Maximum revenue:		
Visitors (000)	40	19
Price (NIS)	146.5	253
Revenue (M. NIS)	5.86	4.81
Welfare (M. NIS)	8.69	7.27
3. Zero profit:		
Visitors (000)	76	37
Price (NIS)	13	20
Revenue (M. NIS)	1	0.74
Welfare (M. NIS)	12.12	8.96

531 per cent). However, welfare measures (aggregated across both sites) go down from 21.6 M. NIS to 15.96 M. NIS at the most (a decrease of 26 per cent). Finally, if the goal is to cover costs, we can see in scenario 3 that entrance fees should be lowered slightly at Gamla and modestly raised at Hai-Bar.

The tradeoff between maximum revenue and maximum welfare can be shown graphically (Figure 11.2) where the two tradeoff functions for Gamla and Hai-Bar NRs are shown. The horizontal axis represents welfare while the vertical axis shows revenues (both in M. NIS). The first two scenarios are also shown. Note that the relevant area in which policy-makers need to make a decision is at the region where the function is downward sloping. Though raising the admission price to its revenue-maximising level may be impractical, choosing a price between the current low level and the revenue-maximising level may prove a viable policy compromise.

5.3.2 *Species-visitors interaction*

Deriving the demand function for the marginal vulture can allow us to address further policy questions. Some of these questions include: what is the optimal investment policy in two competing sites with and without budget limitations? How should we take into account the interaction

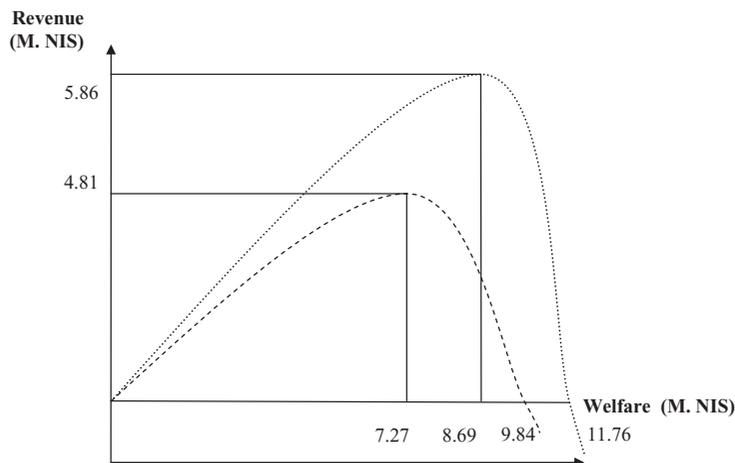


Figure 11.2. Revenues versus welfare in two alternatives

between the quantity of vultures at a given site and the number of visitors associated with that quantity?

Vultures fly over long distances in search of food, so a well-managed regional effort allocation could shift vultures to more desirable sites.⁹ Visitors are also affected by the number of Griffon vultures in a given colony apart from the pricing approach implemented in the nature reserve. However, in this section we assume that revenue maximisation is not a viable option and the sites should be open to the public and financed from the central government like other public goods.

Based on the marginal and total function for number of Griffon vultures at each site presented in equations (5)–(8), we can calculate the benefits of the four scenarios presented in Table 11.14. All scenarios are based on the CV equations (and not TC functions) in order to keep the same size of error. Furthermore, CV functions include number of vultures while TC functions include number of visitors. In the last scenario, however, we will combine the two functions.

Scenario 1 refers to the current situation. The total value of vultures at each site is 10.84 M. NIS and 3.16 M. NIS for Gamla and Hai-Bar NRs respectively. Scenario 2 presents the ‘no restriction case’. That is, by how much should we increase the population at the two sites if the only

⁹ It should be stressed that we still have a long way to go in order to understand these dynamics so this kind of interaction can serve only as a method of thinking. Furthermore, we are still far away from knowing the marginal costs of preserving vultures at each site and in particular whether they are equal or not.

Table 11.14 *Summary of scenarios for species–visitors interaction*

Site scenario	Gamla	Hai-Bar
1. Current situation:		
Visitors (000)	79	38
Vultures	95	10
Benefit (M. NIS)	10.844	3.164
2. No restriction scenario:		
Visitors (000)	79	38
Vultures	115	18
Benefit (M. NIS)	11.19	3.92
3. Max. welfare subject to same number of vultures for total number of visitors:		
Visitors (000)	79	38
Vultures	89	16
Benefit (M. NIS)	10.60	3.91
4. Max. welfare with change in number of vultures <i>and</i> number of visitors:		
Visitors (000)	71	52
Vultures	94	11
Benefit (M. NIS)	10.79	8.37

criterion is to equate marginal benefits to zero (assuming a negligible marginal cost)? This entails an increase of ten (11 per cent) and eight (80 per cent) vultures at Gamla and Hai-Bar NRs respectively. It should be noted that the number of visitors in this scenario remains constant relative to the baseline current situation. The increase in the total benefit of the two sites is 3.2 per cent and 24.4 per cent respectively. This is due to the already low marginal benefit of the marginal vulture. There are, of course, other reasons for further increasing the number of vultures (e.g. insurance policy) but these are ignored here.

Scenario 3 describes the case where the number of visitors is fixed at the base-line level and for a representative visitor we equate the marginal benefit of vultures at the two sites and then multiply the result by the current number of visitors. This was accomplished by equating the marginal benefit between the two sites subject to the constraint of an aggregate number of 105 vultures across both sites. The main result here is that more effort should be allocated towards the Hai-Bar NR rather than the Gamla NR. By reshifting six vultures we would be able to increase the total welfare of both sites from 14 M. NIS to 14.51 M. NIS (about 4 per cent).¹⁰ This scenario can be used also if we want to analyse the

¹⁰ The underlying assumption here is that the marginal cost of preserving one vulture is equal between the two sites. If not, we should equate each marginal benefit function to its

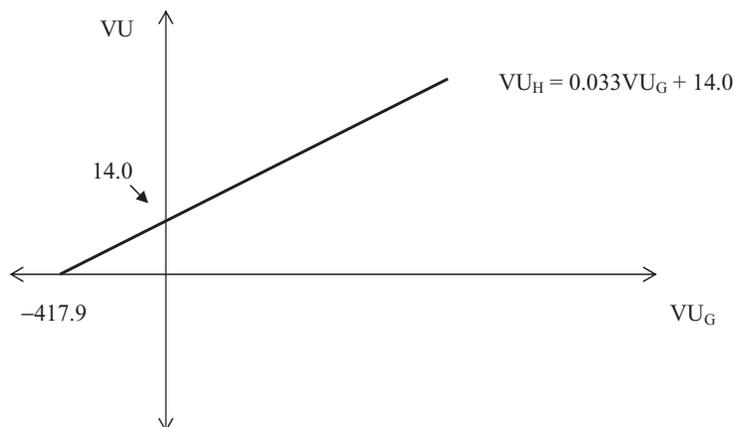


Figure 11.3. Expansion path

optimal investment path in nature conservation by not limiting ourselves to a given number of vultures. Deriving the expansion path can prove useful both in cases where policy-makers are concerned with increasing the population and in cases where there is a decline in their number and decisions have to be made as to how to prioritise conservation funds from a limited budget. Solving for the expansion path by equating the marginal benefits at both sites without a constraint on the number of vultures results in equation (9):

$$VU_H = 14.0 + 0.033(VU_G) \quad (9)$$

This equation is also illustrated in Figure 11.3.

As we can see, there is an absolute priority to invest in Hai-Bar NR until we reach a stable population of fourteen vultures. From there on, there is a linear relationship of 1:30 for vulture conservation at Gamla NR vs. Hai-Bar NR.

Finally, the last scenario (scenario 4) is the most flexible one. Here we allocate conservation efforts while taking into account the impact on the number of visitors. There is an interaction between TCM and CVM functions of each site which should be utilised. The linkage is given by the fact that if we invest in vulture conservation, we increase the welfare of a representative visitor. This was made known from equations (2) and (6). If we substitute the benefit difference in the travel cost equation we can get the impact on the number of visitors. This number can now serve

own marginal cost. In fact, the marginal cost at Hai-Bar is greater than the one at Gamla, which points out that allocating six more vultures to Hai-Bar NR is an overestimation had we known the true marginal cost function at each site.

as the basis for a new summation when calculating the marginal benefit of an additional vulture and multiplying by the (new) number of visitors.

For a representative site, the total benefit difference between the current and optimal number of vultures is given by:

$$\Delta TB_i = [a(VU_i^*) - b(VU_i^*)^2] - [a(\bar{V}U) - b(\bar{V}U)^2] \quad (10)$$

where: VU_i^* = optimal number of vultures

$\bar{V}U$ = current number of vultures

and a and b are the marginal benefit function parameters.

In order to apply this value to the representative visitor, we insert the result of equation (10) into the demand function derived from the TC analysis and we obtain

$$VI_i = e - f(\Delta TB_i) \quad (11)$$

where e and f are the demand function coefficients of the TC function and the cost difference is the LHS of equation 10 (assuming as before that admission was free).

Applying the model to Gamla and Hai-Bar NRs, we see that at Gamla NR the decline of vultures by 1 per cent reduces the number of visitors by 10 per cent. This, however, is compensated by increasing the number of vultures at Hai-Bar NR by 10 per cent which increases the number of visitors by 27 per cent. It is obvious that since Hai-Bar NR is closer to metropolitan areas, this would be an expected result. The overall benefit from the two sites combined is now 19.16 M. NIS, which is the largest figure obtained from all scenarios considered.

6 Policy and conclusions

Valuing endangered species usually requires decisions to be made on the margin. This chapter reports on the results of a study that uses TC and CV techniques in order to estimate the value of the marginal species – in this case the Griffon vulture in Israel. A cost-benefit analysis was also carried out both on the regional level with respect to assessing the welfare implications of one particular conservation activity (namely feeding stations) and on the national level with respect to assessing broader vulture conservation policy options. The former of these analyses was undertaken by comparing the costs of feeding stations to the estimated value of the marginal vulture derived from the two valuation methods. It was found that protecting vultures passes a national cost-benefit test and that feeding stations are economically viable in generating on average 0.23–2.12 vultures annually.

In the latter analysis two additional policy issues were analysed: entrance fee policy and effort allocation. With respect to pricing policy it was shown that by charging the revenue-maximising entry fee level, policy-makers can generate a large increase in revenues compared with the current situation, but at the same time this will bring about a substantial welfare reduction. The region where the tradeoff between the revenues and welfare is relevant to the policy-makers was identified.

Further, effort allocation was shown to be important, especially when a change in population size can bring different numbers of visitors. It was shown how combining CVM and TCM results can provide insights as to the overall optimal allocation of vultures and visitors between the two competing sites analysed in the study.

In sum, the chapter makes the following broader policy contributions. First, there are solid economic arguments to invest in 'charismatic' wildlife species, even if their population size is above its critical survival threshold level. Second, assuming we have good ecological appreciation of the cost-effectiveness of feeding stations, there is a welfare-enhancing rationale for differentiating efforts among different ecotourism sites. Third, pricing mechanisms can be used as a management tool for decision makers in order to achieve different goals. Finally, our research highlights the importance of creating a comprehensive database of critical survival threshold levels of different species which would allow wildlife policy decisions to be made at the margin which will lead to a more efficient allocation of conservation funds and efforts.

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