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Economic analysis of feeding stations as a means to preserve an endangered species: The case of Griffon Vulture (*Gyps fulvus*) in Israel

Nir Becker[a,b,*], Yael Choresh[c], Ofer Bahat[d], Moshe Inbar[e]

[a]*Department of Economics and Management, Tel-Hai College, Upper Galilee 12210, Israel*
[b]*Natural Resources and Environmental Research Center, Haifa University, Haifa 31905, Israel*
[c]*Department of Natural Resources and Environmental Management, University of Haifa, Haifa 31905, Israel*
[d]*The Porter School of environmental studies, Tel-Aviv University, Tel-Aviv, 69978, Israel*
[e]*Department of Evolutionary and Environmental Biology, University of Haifa, Haifa 31905, Israel*

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Summary

In this study we used the Travel Cost (TCM) and Contingent Valuation Methods (CVM) to estimate the value of an endangered species. We also determined the break even point in the allocation of funds targeted at protection at the regional level and performed a cost benefit analysis of conservation efforts on a national level. The Griffon Vulture, *Gyps fulvus*, was the animal tested in our case study in Israel. The Griffon Vulture is an endangered species whose protection is crucial in maintaining the natural ecosystem but whose protection is quite costly. We used TCM at two nature reserves in Israel: Gamla Nature Reserve in the Golan Heights; and Hai-Bar Nature Reserve on Mount Carmel. CVM was implemented at both sites and within a sample of the general population. TCM results showed an economic benefit of 2.4 M. USD per year at Hai-Bar and of 2.94 M. USD per year at Gamla. CVM results showed a willingness to pay (WTP) for protecting vultures of 2.70 M. USD at Gamla and 0.98 M. USD at Hai-Bar. The value of the marginal vulture was found to be approximately 8500 USD at Gamla and 79,000 USD at Hai-Bar. The cost of protecting vultures was taken from the financial reports of the Israel Nature Reserves and Parks Authority and was found to be 19,000 USD per year. The economic efficiency of feeding stations was examined from two aspects:

(1) Break-even point: It was found that in order to be economically efficient, the feeding station should help increase the vulture population by an average of at

*Corresponding author at: Department of Economics and Management, Tel-Hi College, Upper Galilee 12210, Israel.
Tel.: +972 50 7252854; fax: +972 4 6900985.
E-mail address: nbecker@telhai.ac.il (N. Becker).

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least 0.24 individuals per year at Hai-Bar and by at least 2.20 individuals per year at Gamla.

(2) "Porsim Kanaf" project[1]: The cost of protecting one vulture according to the budget of the National project was calculated to be 6500 USD per year. It was shown that the project passes a Cost-Benefit test based on the valuation results.

Introduction

Using different economic valuation techniques in order to estimate the value of endangered species is a well documented concept in the literature (Brown 1993; Bulte & Van-Kooten 1999; Gonzalez-Caban et al. 2003; Jakobsson & Dragun 2001; Kontoleon & Swanson 2003; Navrud & Mungatana 1994 among others). 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 should take into account issues such as the value of the marginal individual, tradeoff analysis amongst competing goals and a feedback interaction between the size of the species population and number of visitors.

The major goal of this study was to determine whether the protective measures and the budget allocated for those measures in the case of the Griffon Vulture (*Gyps Fulvus*), are in accordance with public priorities. This was accomplished by examining one operational protection method, namely, feeding stations. We also performed a simple Cost-Benefit Analysis of the total conservation effort at the national level and compared it to the total benefit of the increased number of vultures over a given period of the national protection plan.

We envision the contribution of the study in that it measures the value of the marginal individual of an endangered species in order to conduct a Cost-Benefit Analysis of a specific management scenario. Since a policy should be judged at the margin, calculating the average values of endangered species provides the wrong signal for benefit estimation (Bulte & Van Kooten 1999; Kontoleon & Swanson 2003). In our study, we used the marginal value in order to compare it to the cost of one management tool, namely operating feeding stations. We also used the value of a marginal individual when we contrasted it to the total effort to conserve vultures. Using the value of an average individual would seem to be more consistent here. However, since the marginal value is smaller than the average, it provides a more conservative estimate which can better serve decision makers, especially when the net benefit is positive. We used three scenarios in a questionnaire which enabled us to trace a demand function for the species and thus estimate the economic value of the marginal individual. Our case study is the Griffon Vulture. Although it is mentioned on the IUCN Red List as Least Concerned (Birdlife International 2008), the Israeli Red List of threatened animals classifies the Eurasian Griffon Vulture, *Gyps fulvus*, as vulnerable (Dolev & Perevolotsky 2002). The population of the once abundant Griffon Vulture has suffered from a severe decline during the last century. In Israel, although protected by law, the population of vultures has declined from over 1000 breeding pairs in the second half of the 19th century (Mendelssohn & Leshem 1983; Tristram 1885), to a present number of less than 100 breeding pairs. This worrisome decline is a result of hunting, abuse usage of pesticides (Mendelssohn 1972; Shlosberg 2001), electrocutions (Lehman et al. 1999) and improved pastoral hygiene which resulted in less available food for vultures (Cramp & Simmons 1980; Wilbur 1983).

The Griffon Vulture is an obligatory carrion feeder which forages over extensive areas (Cramp & 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, several feeding stations have been established. Such feeding stations have proved to be successful in sustaining stable vulture populations in Israel in general and particularly in the southern part reinforcing the breed and preventing their decline (Bahat et al. 2002; Mundy et al. 1992).

Since 1996, the Israel Electric Company has joined forces with the Israel Nature and National Parks Authorities and the Society for the Protection of Nature in Israel in a mutual effort to protect the

[1]"Porsim Kanaf" is the major birds of prey conservation project in Israel.

Griffon Vulture and other endangered raptors.[2] The budget for this project is allocated to various protective measures, including the operation of feeding stations (Bahat et al. 2002).

The benefits of protecting vultures are both ecological and social. Scavengers perform a crucial ecosystem function and provide ecosystem services through their role in the removal of animal cadavers that could otherwise be hazardous to both wildlife and humans. In addition, vultures are spectacular creatures which attract people who enjoy their grandeur, soaring flight and breeding efforts. This type of observation is possible mainly at Gamla Nature Reserve in northern Israel. In other places, vultures are not a common sight.

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 estimating use and non-use values of endangered species and the methods used for such valuation. The third section will present the sites of research. The fourth section will present the Travel Cost Method (TCM) and Contingent Valuation Method (CVM) results at Gamla and Hai-Bar Nature Reserves (NRs), as well as the results of a survey at the national level. The fifth section will provide a break-even point analysis for feeding stations as a means of preserving the population at the two specific sites and a cost-benefit analysis of the total investment in vulture conservation in Israel.

Literature review

Feeding stations

One of the conservation efforts employed in the protection of the vulture and in preventing its decline is the operation of feeding stations where food quality can be assured, and the availability of food attracts vultures to areas where they once used to frequent (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. They then 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 United States, as a part of the reintroduction program of the endangered California condor (Wilbur et al. 1974). The population of the Black Vulture, *Aegypius monachus*, in Greece is recovering as a result of the operation of feeding stations (Vlachos et al. 1999).

In order to deal with rickets, the South African Vulture Study Group began to provide bone-fragments in feeding stations. Rickets came down from 16.9% in 1976 to 3.7% in 1983 (Richardson et al. 1986).

In Spain, there are tens of thousands of birds, from a low of a few 1000 around 1980 Parra & Telleria 2004). However, the Pyrenees population has apparently been affected by an EC ruling that due to dangers associated with mad cow disease transmission, no carcasses must be left on the fields for the time being. This has critically lowered food availability, and consequently, carrying capacity. Although the Griffon Vulture does not normally attack larger living prey, there are reports of Spanish Griffon Vultures killing weak, young or unhealthy living animals as they are unable to find enough carrion to eat (MacKenzie 2007).

In Israel, the Nature Reserves and Parks Authority started operating feeding stations in 1972. A net of 16 feeding stations was spread around the country. These feeding stations were placed in the foraging areas of vultures 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 amount of bone fragments found in the nests went up, and the number of nests containing foreign artifacts decreased. Furthermore, the number of nestlings suffering from rickets declined (Ben-noon et al. 2003).

The value of wildlife protection

Two of the most widely used methods for economic valuation of natural resources and amenities are the Travel Cost Method (TCM) and the Contingent Valuation Method (CVM).

[2] The Hebrew name of the project is "Porsim Kanaf".

TCM is designed to measure in monetary terms the benefits of enjoyment from visiting a recreation site. The method is based on a relationship between the non-market use value and the market goods that are purchased as a complement to the visit at the site (travel cost in this case). The variation in visit frequency among visitors living in different proximity from the site can be used to trace the demand function. From the demand curve the consumer surplus or the net WTP can be calculated.

CVM is a stated preferences method for estimating the economic value of a non-market good. The assumption here is that individuals can reveal their true WTP through their behaviour in hypothetical markets. By asking people questions, one can reveal the mean WTP of the relevant population and thus the social WTP for the good.

The drawback of CVM is being based on hypothetical situations. However, TCM cannot deal with non-use values such as bequest and existence values which are a major part of goods such as wildlife.

Indeed, this is one of the major difficulties in determining the optimal amount of wildlife. The good produces benefits associated with particular uses (direct, indirect, or passive) that carry associated values. However, only a portion of these values are reflected in market transactions associated with the good, such as trip and equipment expenditures from wildlife-associated recreation activities. The economic benefit associated with species conservation is often non-marketed. The difference between the benefits an individual receives from a wildlife-associated activity such as wildlife viewing and his or her opportunity costs of engaging in that activity represent the net economic benefit, or consumer surplus, he or she derives from the activity.

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%, was allocated to viewing elephants specifically, a value which translated to 23–27 million dollars per year. As a result, the Kenya Nature Protecting Authority came to realise the economic implications of a declining elephant population due to poaching.

The annual recreational value of wildlife viewing in Lake Nakuru National Park in Kenya was found to be 7.5–15 million dollars, using TCM and CVM (Navrud & Mungatana 1994). The flamingos in the lake, accounted for more than one-third of this value. Recognising that Lake Nakuru is only one of many parks in Kenya, and that wildlife viewing is becoming an increasingly popular form of eco-tourism, the results of this study showed that sustainable management of wildlife resources has a significant economic potential and that funds should be directed towards the preservation of wildlife.

Another application of CVM to the conservation of endangered species was done in the State of Victoria, Australia (Jakobsson & Dragun 2001). The results showed a higher value for protecting the Leadbeaters' possum (40–84 million A$) than for competing activities in the area (such as timber cut from the region).

Most of the studies conducted have dealt with the value of a habitat area, 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, at least, for the ancient temperate rainforests and Minke Whales, *Balaenoptera acutorostrata*, the threshold level should dictate if one should deal with the Utilitarian approaches (which the cost benefit analysis is based on) or rather the Kantian approach (in which there is a moral obligation to save the species). Their conclusion was that it is sometimes necessary to depart from the Utilitarian approach. Their argument, however, can be reversed in our case as in others. As long as the species has gone beyond the threshold 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 individual are Kontoleon and Swanson (2003), Gonzalez-Caban et al. (2003) and Paulrod (2004), to name a few. Paulrod (2004) tried to estimate the value of the marginal benefit of angling in Sweden for sport fishing. He found that the marginal value of a catch can vary from a few SEK (Swedish Kronas) to a few hundred SEK depending upon the site location and type of fish. Therefore, it is of great importance to take marginal values into account regarding the allocation of resources to species protection efforts.

Kontoleon and Swanson (2003) and Gonzalez-Caban et al. (2003) dealt with land-based species. Both applied the marginal valuation concept in order to estimate the value of land. However, Kontoleon and Swanson (2003) dealt with the Panda Bear, *Ailuropoda melanoleuca*, an endangered species, while Gonzalez-Caban et al. (2003) dealt with deer hunting. While in the first case-study the benefit was derived from preservation (passive use value in the Panda case), in the latter, the benefit was derived from hunting (direct use value). Still, both used marginal valuation in their analysis. Konteleon and Swanson (2003) used a CVM study in which respondents were asked to relate to three scenarios concerning the Panda's conservation: cages; pens; and free in the wild. They found strong evidence of a decreasing marginal value per hectare which ranged from 0.72 dollars per hectare to 0.00005 dollars per hectare depending upon the scenario. Gonzalez-Caban et al. (2003) estimated the value of deer hunting; the activity to increase the deer population is prescribed burning. The study was done at the San Bernardino National forest in southern California. Prescribed burning improves the deer's habitat and attracts more hunters. The value of the marginal trip was translated to the value of a marginal deer and from there to the marginal value of land. It was found that the value of land decreased from more than 7920 dollars per acre down to 1200 dollars per acre if one goes from the first acre to the 8500th acre. Again, contrasting that with the cost of prescribed burning can be of great help to decision makers as to how many acres to devote to that activity. In our study, we estimated the economic value of the marginal individual of the Griffon Vulture population, but did not translate it into hectares but instead into conservation efforts; feeding stations in particular. As in Kontoleon and Swanson (2003), respondents were presented with three scenarios which differed in the amount of soaring vultures in the sky that a respondent is able to view at a given time.

One way of estimating marginal values is to combine CVM and TCM studies. Gonzalez-Caban et al. (2003) used TCM results of additional trips as a response to increased deer numbers in order to achieve the marginal value of one deer. Other reasons for combining TCM–CVM studies can be explained as calibrating CVM hypothetical responses (e.g., Cameron 1992). If one can break down the CVM results into use and non-use values and if one can compare the use value derived from CVM to the use value derived from TCM, then the non-use value can be regarded as a reliable estimate. Carson et al. (1996) provide a comprehensive review of the literature of such studies. It is interesting to note that while one would expect CVM estimates to be larger on average (because CVM estimates are supposed to include both use and non-use values), most studies found the opposite. The mean CVM/TCM ratio was found to be 0.89 while the median is 0.75 (Carson et al. 1996).[3]

[3]Carson et al. (1996, p. 91) and Cameron (1992, p. 303) state that while CVM is based on hypothetical responses, the TCM analysis also has sources of bias such as functional forms, value of time, etc.

The study sites in Isarel

Gamla Nature Reserve is located in 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. On average, about 100,000 people visit the reserve annually.

Hai-Bar Nature Reserve is located at the south-eastern outskirts of the city of Haifa, in the heart of Mt. Carmel. Hai-Bar is a wildlife preserve which aims to breed and rehabilitate animals that were once common in the Mediterranean area and then release them into the wild. On average, about 45,000 people per year visit this reserve.

The valuation process

TCM and CVM questionnaires were distributed amongst visitors at both Gamla and Hai-Bar Nature Reserves (Choresh, 2003). CVM questionnaires were also distributed within a representative national level sample. This was done by asking people at the train lines between Haifa and Tel-Aviv. The ride lasts for about an hour and the train users can be considered as a "captured audience". They are also believed to be a representative sample of the general population which was verified by comparing the mean socio-demographic of both the sample and the general population

Travel cost

TCM was conducted in order to estimate the use values of the sites as reflected in the travel costs incurred by the visitors. According to the TCM hypothesis, the demand for visits will drop as travel costs rise. Therefore, visiting rates from distant areas will be lower than those from closer areas.

In addition, we added the following explanatory variables: membership in a "green" organisation; education; and income levels (Ward & Beal 2000).

One hundred and seventy questionnaires were distributed at Gamla from January to June 2003. One hundred and forty three were usable (85%). At Hai-Bar, two hundred and seventy out of the two hundred and ninety six questionnaires were usable (91%). The questionnaires were distributed from November 2003 to April 2004.

Estimation using TCM

Travel Cost analysis was applied by using the above mentioned socio-economic variables as well as the cost of travel, the opportunity cost of time (25% of the net income) (Cesario 1978), and entrance fee to the site. We controlled for multi-site visitation by asking the respondents to fill in how many places they had visited during their trip. Usually, the visit at both sites is the major or only reason for the trip. However, there were cases where we had to split the travel and time value proportionally among the sites visited.

We used a semi-log functional form in order to estimate visitation frequency from ten regions in which the distance between them and the site is increasing by 30 km per region. That is

$$Log(V_i/pop_i) = \alpha + \beta(TC_i) + \delta(SOC_i) + \varepsilon_i \quad (1)$$

where, V_i is the Visits from region i; pop_i is the Population from region i; α and β and δ are parameters to be estimated; TC_i is the Travel cost from region i; SOC_i is a vector of Socio-demographic characteristics; ε is an error term.

If one sets the socio-demographic variables at their respective mean values, adding the product of the mean by the coefficient of each variable to the constant leaves us with a semi logarithmic function of only one variable – the travel cost.

After estimating the functions we raised the price for each region by increments of 5 USD until the visits diminished to zero and calculated the implied visits from each region. The last step was to sum the number of visits from each region for every price level. Regressing the visits on implied prices and integrating to find the area beneath the function resulted in the use value of the site to its visitors.

The regression results of the travel frequency as a function of TC and other socio-economic variables are given in Table 1 for Hai-Bar and Gamla.

We used a zonal TCM approach which resulted in the following demand-functions for Gamla and Hai-Bar as given in (1) and (2) respectively. These demand functions were estimated after holding all significant variables at their respective mean level. They are given by:

$$P = TC_G = 4.43 - 1.86L(VI_G)$$
$$R^2 = 0.913 \quad (2)$$

$$P = TC_H = 7.65 - 6.69Ln(VI_H)$$
$$R^2 = 0.823 \quad (3)$$

where, TC_G is the Visiting price to Gamla NR; TC_H is the Visiting price to Hai-Bar; VI_G is the Number of visitors to Gamla NR; VI_H is the Number of visitors to Hai-Bar.

Table 1. Travel Cost Regression-Hai-Bar.

Parameter (variable)	Coefficient	t-stat
Intercept	0.069* (5.454)	0.31* (1.115)
No. of children	0.0016* (2.513)	0.0054* (2.1)
Green organisation membership	0.0070 (−2.476)*	0.0004 (−1.52)
Education	0.0050* (2.515)	0.04* (2.42)
Income	0.00003* (2.047)	0.0001* (2.09)
Travel cost	−1.86* (−12.639)	−3.60* (−4.63)
Adj. R^2	0.77	0.50
F	46.34	45.45

Dependent variable: Log of travel Frequency.
*Indicates significance at 95% confidence level.

Estimating the value of viewing vultures

The value of viewing vultures was calculated according to the relative importance visitors attributed to it. This was done by adding a ranking question in the questionnaire. Respondents were offered three main reasons for visiting each site. The results indicated that viewing vultures was the primary reason for 85% and 92% of visits to Gamla and Hai-Bar NRs, respectively. Integrating the quasi-demand functions given by (2) and (3) we found the value of the sites as related to viewing vultures. They are 2.94 M. USD and 2.46 M. USD for Gamla and Hai-Bar NRs respectively.

Estimation using CVM

We used a payment card (PC) type of CVM questionnaire to estimate the total value of viewing vultures and protecting them. While using a dichotomous choice (DC) seems to be the most popular approach and also the most recommended by the NOAA panel, there are studies that question the assumptions under which it turns out to be the most preferred survey method (e.g., Diamond & Housman 1994). In specific, the assumption which states that people are more aware in situations where the price is given and they have to "vote" for the purchase decision by "yes" or "no". This might work well in the USA but less likely in the Middle East. PC estimates also have a tendency to yield more conservative estimates than DC models and as such provide a common platform for agreement in cases of conflict between different stakeholders (Ryan et al. 2004; Blaine et al. 2005 among others).

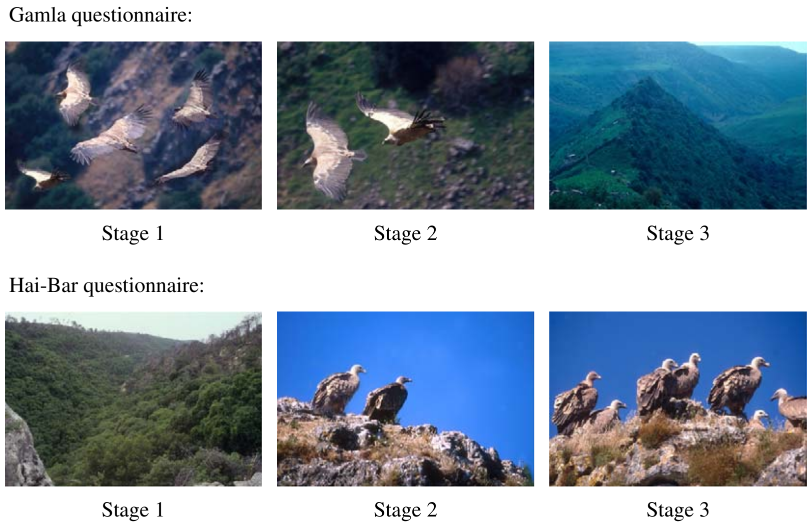

Figure 1. Three stage scenarios in each of the questionnaires. Photographs taked by Eyal Bartove.

We chose the method of direct interview, as recommended by the NOAA panel (Arrow et al. 1993). CVM questionnaires were distributed to a sample of one hundred and fifty people at each site with the assumption that they too attribute non-use values to viewing and protecting vultures, even if they were users while filling out the questionnaire (Shechter et al. 1998). Furthermore, this is indeed the relevant population which is able to value the site because of their affinity for it (Carson 2000). We approached people throughout the day to avoid ''early bird'' bias or late hour's bias if they really exist. Respondents were approached at the coffee shop and at the observation deck. The questionnaire was also distributed amongst a sample of one hundred and fifty individuals representing a national sample. Attention was also given to obtaining a representative sample by means of comparison with the most recent census data. This was an ongoing procedure with comparisons of demographics being periodically reviewed and if necessary, adjustment made to the target population. The response rate was 89%, 90% and 84% for the Hai Bar, Gamla and the sample of the general population.

Prior to administering the survey, we distributed it to four focus groups which gave their feedback on the clarity and length, etc. of the questionnaire. Their distribution of WTP was used in the final questionnaire in a form of payment-card, also according to the NOAA panel (Arrow et al. 1993).

The WTP question was presented in three scenarios, adopting the method used by Loomis (1987) at Mono Lake and by Kontoleon and Swanson (2003) for the Giant Panda. In these studies respondents were presented with three levels of the environmental attribute they were asked to value. There were two reasons for doing that within this study: 1) to get an insight to the scope issue (or embedding) in CVM; and, 2) to get the observations from which a demand function (or marginal benefit function) can be traced. Scope effect is the impact of changing the magnitude or quantity of the non-market good. Concern over scope analysis started after the NOAA panel report (Arrow et al. 1993) which mentioned that scope test should be required in order to assess whether a CV study complies with neo-classical economic theory. In addition, the influential paper of Kahneman and Knetsch (1992), sparked an empirical debate in which some studies found scope sensitivity (e.g., Smith et al. 1999) while others have not (e.g. Hammit & Graham 1999). In this study, we demonstrate how scope sensitivity was found in each site no matter if the sequence of questions was in direction of increasing the number of vultures (Hai-Bar) or decreasing it (Gamla).

Respondents were shown three levels of the vulture population density (Figure 1). Since at 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 within the sample of the general population, where vultures are not a common sight, respondents were asked about their WTP to increase their numbers in the sky.[4] Figure 1 represents the pictures shown to the respondents.

[4] It should be noted that in both cases the relevant question is WTP and not willingness to accept (WTA). The difference in the direction of change (less in Gamla and more in Hai-Bar) is based on the current property rights in the different sites. Therefore, the anomaly presented by Kahneman et al. (1991) should not be of concern here.

The population density was demonstrated by presenting the respondents with different numbers of soaring vultures at each site according to the actual situation.

At Gamla, the two scenarios were:

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 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, five soaring vultures in the picture represent ninety five vultures on site (the current situation at the year of research), two vultures represent thirty eight vultures. At Hai-Bar, 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.

This was done according to the data for daily observations which was gathered over five years, and the calculation of the average daily number of vultures in the reserves, according to that data. The staff in both reserves were also interviewed to verify this number in each of the reserves.

The purpose of using this method is two-fold. First, it checks for consistency with the economic theory of declining marginal benefit. Secondly, it enables us to derive a demand function of marginal WTP versus number of vultures.

After the WTP question, a number of reasons were enumerated and the respondents were asked to circle the ones which were relevant to them when answering the WTP question. The different reasons were meant to deal with two issues, namely, division of the total value into use and non-use and exclusion of protest bids from the survey (Bateman et al. 2002). Two reasons were given in order to divide the zero response into legitimate and protest bids:

1. Vultures' conservation is not important for me to spend money on – A legitimate zero response.
2. It is not my duty to pay for that effort – A protest bid.

The number of protest bids was 14, 17 and 21 for Gamla, Hai-Bar and the general population samples respectively.

In addition, the WTP bid function was estimated with the following controlled variables: income; education; age; gender; number of children; and membership in a "green" organisation. These variables are commonly used in many studies and some conform with economic theory (income, education and membership in green organisation) while others can be a basis for prediction and policy (i.e., the importance of children, age and gender).

It should be noted that the payment options were expressed as annual payments so the estimates are somehow biased upwards relative to the case where there is a onetime payment (Bateman et al. 2002, p. 134).

The payment card estimate yields a response of the maximum WTP amount listed on the card. However, it might be that the given respondent is actually willing to pay any amount between the stated one and the next higher one. Therefore, the estimation is based on a random maximum WTP; a usual OLS is not appropriate at this case. This should be dealt with by one of the following two ways. Either we use the mid-point between the reported payment and the next payment option as the reported maximum WTP or estimate the function by maximum likelihood (ML) procedure. Cameron and Huppert (1989) have shown that as the interval gets smaller so does the difference between the OLS and ML. We reported only the OLS results which are very similar to the ML estimates since we had fifteen payment options on the card. This is consistent also with Ryan et al. (2005) who have done their analysis on health care provision.

CVM results

Descriptive statistics are shown in Table 2 while regression results are presented in Table 3.

As can be seen from Table 2, there is a large difference between the mean and the median (besides the first WTP question at Gamla). This is probably due to the non-normal probability distribution and the large number of relatively extreme results on the right side of the probability 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 the majority rather than the mean. Therefore, the implied value of a given vulture is lower in a majority decision making process rather than on a cost-benefit ground.

Table 2. CVM questionnaire–WTP in the three samples (NIS).

	Gamla	Hai-Bar	General pop.
Mean WTP1	12.68	10.40	9.19
Median	12.50	5.00	5.00
Standard deviation	12.04	10.00	9.20
Mean WTP2	16.73	**11.30**	**9.37**
Median	12.50	5.00	5.00
Standard deviation	15.36	10.70	9.20
Total WTP	29.41	21.70	18.56

The coefficients of the variables in the WTP functions show in most cases the expected signs although not all are significant at the 95% confidence level. For example, age was found to be a significant variable at both sites but not in the general population. On the other hand, membership in "green" organisations was found to be significant only in the general population sample. Another interesting point to note is the *education* and *income* coefficients. Although having the expected sign, in almost every equation they did not turn out to be significant. Their absolute value is also relatively small, indicating that they do not have much impact on the WTP. It seems that the only influential variables are age and membership in "green" organisation.

The break down of the total value into its use and non use components is shown in Table 4.

A striking result is that the non-use value consists of about 75% of the total WTP. That might be due to a lack of people declaring another visit while at the site, whereas when the questionnaire was distributed to a non-visitor, the answer was motivated by a willingness to visit the site.

The total average and marginal values of vultures at the sites are given in Table 5. The total WTP for the site is 29.5 USD and 21.75 USD for the 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 of 2.70 M USD and 0.98 M USD for Gamla and Hai-Bar respectively.

The marginal benefit function can be derived by plotting a line through the two mean points of the change in the number of vultures in the two scenarios. For example, at Gamla, an average respondent is willing to pay 12.75 USD to prevent a decline of 60% in the number of vultures (three in the picture or 57 in reality). That means, 0.22 USD on average per additional vulture for a vulture population ranging from 57 to 95 individuals. Linear equations through these mean points were estimated. These equations represent the marginal benefit function and are presented in (4) and (5) for Gamla and Hai-Bar respectively.[5]

Marginal benefit for Gamla:

$$MB_G = 2.11 - 0.0183(VU_G) \quad (4)$$

Marginal benefit for Hai-Bar:

$$MB_H = 9.767 - 0.547(VU_U) \quad (5)$$

Hence, the marginal benefit is decreasing with an increase in the number of vultures. In order to calculate the total benefit of the site, we can integrate (4) and (5) to get (6) and (7) as follows:

Total benefit for Gamla:

$$TB_G = 2.11(VU_G) - 0.00915(VU_G)^2 \quad (6)$$

Total benefit for Hai-Bar:

$$TB_H = 9.76(VU_H) - 0.2735(VU_H)^2 \quad (7)$$

The above analysis results in a total value of 2.71 M. USD and 0.79 M. USD for Gamla and Hai-Bar respectively. These values are very similar to the mean WTP times the number of visitors (2.70 M. USD and 0.98 M. USD respectively).[6]

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

Cost of feeding stations

In order to decide if resources should be devoted to help the vulture population not to diminish we should compare the estimated benefits with the costs of establishing and operating feeding stations. The information 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 18,250 USD per year.

Break even analysis

In order to compare a cost-benefit analysis of feeding stations, one would need to know the number of vultures one station adds to the vulture

[5]It is important to note, as one referee pointed out, that the process here involves averaging values of vultures that are relatively different from one another. Therefore, it can be thought of actually as a step function on one extreme and as a linear line on the other.

[6]Since respondents were traced until the pre-specified target number was reached, all non-respondents were not assigned a zero value but rather were ignored. This might lead to an estimation which is biased upwards (See Halstead et al. 1992 for a discussion on the issue).

Table 3. Coefficients of the CVM regression estimates.

	WTP1 Gamla	WTP2 Gamla	WTP1 Hai-Bar	WTP2 Hai Bar	WTP1 General Population	WTP2 General Population
	Coefficient (t-Value)					
Constant	38.860* (2.086)	25.975 (1.523)	19.039 (1.421)	69.887* (2.467)	64.839* (2.495)	57.676* (2.182)
Gender	6.80 (1.402)	7.059 (1.599)	−7.488* (−1.974)	−7.639* (−1.951)	−2.555 (−1.352)	−8.661* (−2.049)
Age	17.356* (3.507)	16.924* (2.412)	11.963* (2.627)	13.373* (2.779)	5.012 (1.387)	4.848 (1.114)
No. of children	−6.031 (−1.472)	−4.560* (−1.806)	−2.254 (−1.454)	1.743 (1.352)	−5.304 (−1.341)	−2.159 (−1.476)
Green organisation	5.141 (1.48)	10.633 (1.708)	3.134 (1.334)	12.399 (1.261)	17.535* (2.165)	21.814* (2.291)
Education	1.939 (1.392)	1.266 (1.182)	2.979 (1.548)	5.531* (1.964)	21.852* (3.544)	21.578* (3.07)
Income	5.729 (1.27)	5.896 (1.56)	6.353* (2.109)	3.443 (1.584)	2.854 (1.624)	0.402* (2.079)
Adj. R^2	0.42	0.40	0.44	0.56	0.58	0.70
N	150	150	150	150	150	150

Dependent variable: WTP (NIS).
*Indicates significance at 95% confidence level.

Table 4. CVM questionnaire – use and non-use values in the samples (USD).

	Gamla	Hai-Bar	General Population
Use value per visitor NIS	5.5	5.055	4.565
Use value for site mil. NIS	0.67	0.25	10.00
Non use value per visitor NIS			
Existing value	13.53	8.245	6.57
Option value	0.85	1.70	2.13
Bequest value	7.80	6.20	4.29
Total non use value per visitor NIS	22.21 (80.1%)	16.20 (76.2%)	12.99 (74%)
Total non use value for site mil. NIS	2.10	0.73	23.39
Total WTP per visitor NIS[a]	29.41	21.70	18.56
Total no. of visitors	92,700	45,000	1.8 million households
Total value of watching vultures	2.70 M.	0.98 M.	33.40 M.

[a]Didn't state an importance (1.647) (1.76) (3.14)

Table 5. Total, average and marginal values of vultures (USD).

	Gamla	Hai-Bar	General Population
Scenario 1	From 5 to 2	From 0 to 2	From 0 to 2
WTP 1 per capita	12.75	10.5	9.25
Scenario 2	From 2 to 0	From 2 to 7	From 2 to 5
WTP 2 per capita	16.75	11.25	9.5
Total WTP	29.5	21.75	18.75
No. of Vultures on site	95	5	350
Annual no. of visitors	92,700	45,000	1.8 M. households
Total Value of site	2.70 M.	0.98 M.	33.75 M.
Total Value of average Vulture	28,750	195,750	96,430
WTP per Marginal Vulture per Capita	0.09	1.76	0.03
Social Value of marginal Vulture (Net value)	8610 (6940)	79,110 (73,460)	61,200 (53,087)

Table 6. Break even point under different scenarios (number of vultures).

Site	Payment			
	Mean		Median	
	Total Value	Use value only	Total Value	Use value only
Gamla	2.63	10.74	3.09	12.62
Hai Bar	0.26	1.02	0.57	2.23

Table 7. Cost-Benefit ratio (BCR) under the different scenarios.

Site	BCR			
	Mean		Median	
	Total Value	Use value only	Total Value	Use value only
Gamla	1.07	0.28	0.92	0.23
Hai Bar	11.30	2.86	5.20	1.32
General population	8.17	2.45	4.40	1.32

population. Alternatively, one could determine the number of additional vultures a feeding station would need to produce in order for it to be cost-covering. As seen from Table 5, we can estimate the value of the marginal vulture. Note that in order to compare benefits to costs, we need to subtract the travel cost from the use-value of a given visitor so that we can get the consumer surplus only. This was done by subtracting the mean travel cost to Gamla and Hai-Bar from the mean WTP part which is associated with the use-value. The net social value of the marginal vulture is given in the parenthesis in the last line of Table 5.[7] Dividing the annual cost of feeding stations by the net social value, gives us the break-even point. Table 6 presents the break-even point under four scenarios. It includes total and use value only for the mean and median WTP. As can be seen from the table for Gamla NR, the break-even point ranges from 2.63 to 12.62 vultures annually. At Hai-Bar, it ranges from 0.26 to 2.23 vultures.

Cost-benefit

There is one case in which cost benefit analysis can be implemented; this is the case of the entire vulture population increasing due to the total investment through the national project "Porsim Kanaf". 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 0.925 M. USD. This is equivalent to a cost of 6500 USD per additional vulture. Based on that, we can extrapolate the net marginal benefit for the four scenarios shown in Table 6 in order to generate a cost-benefit ratio for each scenario. This is presented in Table 7.

As can bee seen from the table, only at Gamla and only if the median respondent or the direct use values are included in the analysis is the ratio smaller than 1.

[7]Non-use values were taken in full, since there is no need to get to the site. The use value for the general population was weighted by the number of visits at Gamla and Hai-Bar in order to allocate the travel cost to the mean respondent.

Policy and conclusions

Valuing endangered species usually requires decisions to be made on the margin. This study uses TCM and CVM in order to estimate the value of the marginal individual – in this case the Griffon Vulture in Israel. A cost-benefit analysis was carried out both on the regional level with respect to feeding stations as one means of preservation effort and a total effort of preserving vultures on a national level. This was done by comparing the cost of one of the conservation measures, namely, feeding stations, to the estimated value of the marginal vulture derived from the two valuation methods. Two important results emerge from the research:

1. The general amount of effort directed to protect vultures passes a national cost-benefit test and;

2. Feeding stations are economically viable when bringing at least between 0.23–2.12 vultures annually, depending on the site.

Dividing value into its use and non-use values is of importance as well. This was demonstrated in the cost-benefit calculations if one needs to be as conservative as possible.

One shortcoming of the stated WTP which is common to many studies is the lack of respondents to capture the ecological benefits of preserving species. It is less felt in this study because vultures are large and well-known species. However, it might deserve special attention in less "popular" species. As such, the estimated values are somehow downward biased (Stevens et al. 1991).

Finally, we believe it is of major importance to create a solid data base of threshold levels for different endangered species that indicate the net benefits to be gained from increasing the respective species' populations. Once these levels have been estimated, decisions can be made on the margin, and therefore, public resources can be allocated more efficiently. However, caution should be exercised with respect to the WTP values since in many cases there are other ecosystem services provided by the species, which respondents are not aware of. The estimated value should therefore be considered as a lower bound of the true value of the species.

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