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# KNOWLEDGE ABOUT A SPECIES' CONSERVATION STATUS AND FUNDING FOR ITS PRESERVATION: ANALYSIS

**Abstract**

Using a species' population to measure its conservation status, this note explores how an increase in knowledge about this status would change the public's willingness to donate funds for its conservation. This is done on the basis that the relationship between the level of donations and a species' conservation status satisfies stated general mathematical properties. This level of donation increases, on average, with greater knowledge of a species' conservation status if it is endangered, but falls if it is secure. Game theory and other theory is used to show how exaggerating the degree of endangerment of a species can be counterproductive for conservation.

**Keywords:** Conservation campaigns, conservation funding, conservation status, flagship species, game theory, prisoners' dilemma, threatened species, value of information.

# KNOWLEDGE ABOUT A SPECIES' CONSERVATION STATUS AND FUNDING FOR ITS PRESERVATION: ANALYSIS

## 1. Introduction

Information about the conservation status of a species influences the willingness of the public to donate funds or support changes in allocation of funds for its preservation, e.g., public funds (Samples et al., 1986; DeKay and McClelland, 1996; Tkac, 1998; Gunnthorsdottir, 2001). Other things constant, the more endangered members of the public believe a species to be (if it is a threatened species), the larger is the financial sum that members of the public are willing to commit for its conservation. Bandara and Tisdell (2005) found that this sum increases at an increasing rate as the endangerment of a threatened species rises, when endangerment is measured by reduced abundance of the species.

Although there is evidence that financial support for conservation programs for a species increases as its perceived degree of endangerment rises (Samples et al., 1986; DeKay and McClelland, 1996; Tkac, 1998), there is no systematic study of how reduction in uncertainty about the conservation status of a species might alter the public's support for programs to conserve it. This note explores this issue using a general mathematical property of the willingness to pay for the conservation of a species as a function of its abundance of the type obtained empirically by Bandara and Tisdell (2005) for the Asian elephant.

The change in the public's expected willingness to pay for programs to conserve a species as its information improves may be used as a measure of the value of information (or reduction in uncertainty) about its conservation status. The analysis measures the comparative value of reducing this uncertainty in different conservation situations and therefore has policy relevance. This note outlines the basis of the analysis and the general procedures adopted and then presents the analysis and results. A discussion and conclusions follow.

## 2. Procedure and Analytical Basis

The population level of a species is used to indicate its conservation status. Bandara and Tisdell (2005) found that a sample of Sri Lankans, when confronted with a hypothetical decrease in the population of the Asian elephant in Sri Lanka (compared to its current population), were willing to increase their stated willingness to contribute funds for the conservation of the elephant at a rate increasing with its posited population decrease. On the other hand, while this sampled group was willing also to increase its financial contribution for funding the conservation of the Sri Lankan elephant population when the level of this population was hypothetically increased (compared to its current level), the stated amount they were willing to donate increased at a decreasing rate.

Thus, the function relating their aggregate willingness to donate funds for the conservation of the Asian elephant had two branches of the nature illustrated in Figure 1 by function *ABCDE*. Bandara and Tisdell (2005) hypothesized that the nature of the branch *ABC* reflects the fact that as the level of population of the species declines, it becomes more endangered. Respondents, therefore, probably assumed that increasingly urgent 'conservation' action would be needed on an increasing scale to save elephants in Sri Lanka from extinction with greater declines in the elephant population. They may have also assumed that at the current level of elephant population ($x_c$) in Sri Lanka, survival of the elephant in Sri Lanka is relatively assured. Thus for higher levels of populations, there is virtually no risk of extinction of the elephant in Sri Lanka.

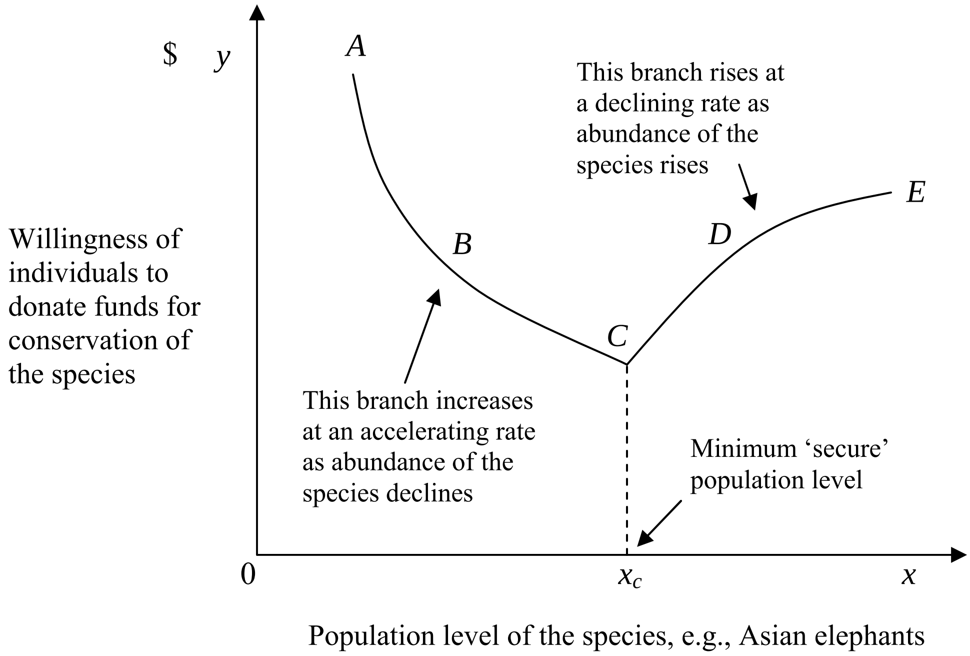


**Fig. 1.** Hypothetical relationship of the willingness of individuals to donate funds to conserve a species as a function of its abundance based on Bandara and Tisdell (2005).

If this is so, the risk of extinction of the elephant will not be an influence on the willingness of individuals to contribute funds for conservation of the elephant if its population is $x_c$ or greater. Support for conservation of larger populations of the elephant depends in this case mainly on the utility that individuals obtain from its greater abundance. This utility seems to increase with rises in the level of the population of elephants but at a decreasing rate. This is reflected in the nature of the relationship *CDE* showing the willingness of individuals to donate funds for sustaining high population levels of the elephant. However, at high population levels of the species, its increased abundance may reduce the utility obtained by individuals from its presence. This would mean that the right hand branch of the function shown in Figure 1 would eventually turn downwards. But this extreme will not be considered here.

Assume that the type of function illustrated in Figure 1 applies for the relevant range of population levels of a focal species, where $x_c$ represents its minimum relatively safe population level. In the case illustrated in Figure 1, the function of the willingness to fund conservation of the species has a cusp at point *C*. However, an alternative possibility is the type of function illustrated in Figure 2. This function is differentiable everywhere but that in Figure 1 is not differentiable at point *C*.

Generalizing from the results obtained by Bandara and Tisdell (2005), the left hand branch of the willingness to donate curve appears typically to be more convex than its right hand branch is concave. It seems also to be steeper than the right hand branch.

The implications of the elimination of uncertainty about the population level of a focal species will now be explored mathematically for the type of relationships indicated by Figures 1 and 2.

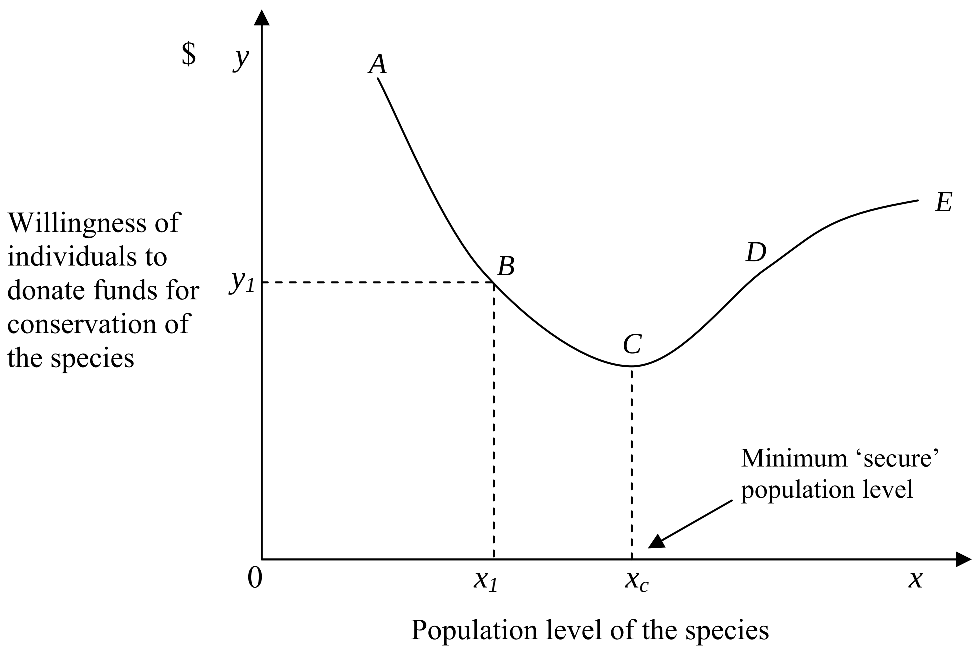


**Fig. 2.** An alternative possible form of the relationship shown in Figure 1.

## 3. Analysis and Results

For simplicity, assume that the 'true' mean or expected value of the focal species' population is initially known but not its actual level of population. Suppose that the level of donations for the conservation of the species in this uncertain situation will be the same amount as when the actual population level of the species equals its expected population. For example, if the expected level of the population is $x_1$ in Figure 2, the corresponding level of donations would be $y_1$.

How would the expected level of donations for the conservation of the species alter if its exact level of population happened to be known by donors? The difference between the expected level of donations if the exact population of the species happened to be known and the previously mentioned sum indicates the impact of knowledge on level of donations for the species' conservation. Its absolute value measures the value of knowledge in terms of adjustment of conservation funding.

Mathematically,

$$D = E[f(x)] - f(E[x]) \tag{1}$$

represents the expected change in the level of donations for conserving a species as a result of having perfect information about its population level rather than imperfect information.

If values of $x$ occur only for $x \le x_c$, and not all $x$ are equal, then $D > 0$. When the species is threatened at all possible levels of population, increased knowledge of the species' population level raises the amount donors are willing to donate on average for the species' conservation. This follows because $f(x)$ is strictly convex for $x \le x_c$. See theorem 90 in Hardy et al. (1934, p.74).

On the other hand, $D < 0$ if $x \ge x_c$ because $f(x)$ is strictly concave for $x \ge x_c$. Thus, for a species known to be secure but for which the exact level of its population is unknown, perfect knowledge about its population level can be expected, on average, to reduce the level of donations for its conservation.

A third case is possible. It may be unclear whether the species is threatened or not. In such a mixed case, $D$ may be positive or negative. $D$ is more likely to be positive, the higher is the likelihood that the species is threatened or the lower is the possible level of its population, other things constant.

If $|D|$ is used to measure the value of information about the species, this will be greater if the species is threatened than if it is secure because the degree of convexity of the left hand branch of $f(x)$ is greater than the degree of concavity of its right hand branch. This can be illustrated easily if each branch of $f(x)$ is approximated by a quadratic function.

Let the left hand branch of $f(x)$ be represented by

$$y_L = a - bx + cx^2 \text{ for } x \leq x_c \tag{2}$$

and let its right hand branch be specified by

$$y_R = k + rx - sx^2 \text{ for } x \geq x_c \tag{3}$$

The expected value of a quadratic function depends only on the mean and variance of its independent variable. For example,

$$E[y_L] = a + bE[x] - cE[x]^2 - c \operatorname{var} x \tag{4}$$

where var $x$ represents the variance of $x$.

In this case, lack of knowledge or uncertainty about the population of the focal species can be measured by the size of var $x$. Relationship (2) shows that eliminating uncertainty about the population of a threatened species will increase donations for its conservation, on average, by $c$ var $x$, $E[x]$ constant. Similarly, if the species is secure, eliminating uncertainty will reduce donations for its conservation by $s \operatorname{var} x$.

Furthermore, given the theoretical relationship presented in the previous section, $c > s$. Therefore, the change in the expected level of donations resulting from the elimination of uncertainty is greater when the species is threatened than when it is not, if var $x$ is the same in both cases. If the variation in the expected level of donations for the conservation of a species is used to measure the value of information about its conservation status, the value of obtaining or providing information about its status is usually higher when it is threatened than when it is not.

**4. Discussion and Conclusion**

The results indicate that if a species is threatened, reduction in uncertainty about its conservation status is likely to increase the amount of donations or support for conservation programs for it on average, but reduce these if it is not threatened. However, in both cases the extra information will be of value but more so if the species is threatened. Furthermore, the expected increase in the value of donations for conservation of the species as a result of elimination of uncertainty tends to be higher if the species is threatened than the reduction in the expected level of this support if the species is secure. These results depend upon the donation or willingness-to-pay function having the general form indicated by Figures 1 or 2.

This type of relationship should be investigated further. For example, the relevant function could exhibit hysteresis. There could, for instance, be tendency to want to pay increasing amounts to avoid any reductions in the current population level of a species provided it is not regarded as a nuisance. If so, there would be opposition to reducing the level of the current population of a species even if it is not threatened. This would be consistent with the endowment effect (Thaler, 1980) and prospect theory (Kahneman and Tversky, 1979).

Note that when $x$, the population level of a focal species, becomes very low and survival of the species becomes increasingly improbable, $f(x)$ could begin to fall with reduced levels of population of the species. This case is not covered here. However, DeKay and McClelland (1996, pp. 70-71) found that members of the public may still continue to financially support programs for the conservation of an endangered species even when they are unlikely to succeed in conserving the species, even though, according to Possingham et al. (2002, p. 503), "spending the most money on species with the highest extinction probabilities is not the most efficient way of promoting recovery or minimizing global extinction rates…"

If a species is threatened, bodies that want to maximize support for species' conservation might think it is advantageous to convince the public that the species is more endangered than it really is. However, such an approach is risky.

First, if the degree of endangerment of a particular species is exaggerated by a conservation body and the public become aware of this, they may discount the reliability of all the information provided by the body and overreact in doing so.

Secondly, if individual conservation bodies champion different species and exaggerate the threat to them, the net result could be that the inflated claims offset one another as far as the level of donation of funds is concerned.

For example, suppose that only a constant sum is available from the public or government for the conservation of threatened species and that there are two different conservation bodies promoting the conservation of different threatened species. Suppose that each has two alternative strategies to obtain conservation funds for its chosen species: (1) accurately communicate the likely conservation status of its chosen species or (2) exaggerate the threat to the species. This can be modeled as a two-person constant sum game. Table 1 illustrates.

The entries in the body of the matrix in Table 1 specify hypothetical donations in millions of dollars for conservation of the species as a function of the strategies adopted by the conservation bodies. Both conservation bodies have an incentive to exaggerate. Otherwise, if one exaggerates and the other does not, the one that does not exaggerate loses funds. The adoption of exaggeration strategies by the players results in a Nash equilibrium in this game (Nash, 1951). However, the strategy of exaggerating the threat to species does not increase the amount of available funds for conservation of either of the species in this case. In fact, if extra funds are needed to promote the exaggerated threat to a species, the funds available for the species' conservation are reduced. The problem is therefore equivalent to a prisoners' dilemma problem (Poundstone, 1992) and the outcome is socially sub-optimal.

**Table 1** Hypothetical game theory matrix involving two conservation bodies with two alternative strategies: either do not exaggerate or exaggerate the threat to each of the species they champion.

Strategies of body two →

Strategies of body one ↓

| | | Do not exaggerate<br>$\beta_1$ | Exaggerate<br>$\beta_2$ |
|---|---|---|---|
| Do not exaggerate | $\alpha_1$ | (5, 5) | (2, 8) |
| Exaggerate | $\alpha_2$ | (8, 2) | (5, 5) |

This two-species case is, of course, a simplification. When a larger number of species are considered, the set may include some species that are threatened but which do not have social bodies advocating or strongly advocating their conservation. Conservation funds may, therefore, be drawn away from conservation of their species in favor of the species that have bodies strongly advocating their conservation and which may even exaggerate the threat facing their favored species. As a result, the overall wildlife conservation effort becomes distorted.

The promotion of a particular flagship species, as described by Waddell (2002, p. 243), may increase the total conservation funding available to it but at the expense of some other species because of the presence of a financial substitution effect. However, if the flagship species is also an umbrella species, and if the species experiencing reduced conservation funding obtain conservation benefits under its umbrella, there maybe no problem. In fact, conservation outcomes for the flagship species and all those species under its umbrella may improve with no other species disadvantaged. Nevertheless, this outcome is more likely to be a happy coincidence than a regular event.

The influence of information provision about the conservation status of wildlife species can be complex. Nevertheless, as a threatened species becomes more endangered and this becomes known, the public can be expected to increase the level of their donation and support for its conservation. If the conservation status of a species is uncertain, reducing or eliminating uncertainty about this can be expected, on average, to raise the willingness of the public to donate funds for its conservation. Exaggerating the degree of endangerment of a threatened species is liable to be a short-sighted policy. It can spark off inflated claims of endangerment and result in discounting of accurate information by those who become aware of the exaggeration, and may draw conservation funds away from other threatened species, some of which may be more endangered than the favored species. It has little to recommend it.

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