Estimating and Questioning Economic Values for Endangered Species: An Application and Discussion[1]

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Abstract

*The economic costs of Endangered Species Act provisions receive substantial attention, but the economic benefits of species protection are often overlooked. This paper presents an overview of the theory and methods necessary to estimate public values for threatened and endangered species. Results are presented from a contingent valuation study that estimates economic values for the peregrine falcon (*Falco peregrinus*) and shortnose sturgeon (*Acipenser brevirostrum*) in Maine. Using empirical evidence about what motivates economic values for threatened and endangered species, questions about what the numbers truly represent are pursued. The intention is to provide a perspective that highlights potential advantages and limitations of estimating economic values for threatened and endangered species.*

Introduction

The federal Endangered Species Act (ESA) is frequently accused of prioritizing the well-being of fish and wildlife over people. ESA provisions designed to protect threatened and endangered (T&E) species are rarely free of criticisms for adverse economic impacts. As critical habitats are protected, these impacts may be associated with short-run effects such as decreased employment. Long-run effects may be associated with opportunity costs from foregone resource uses and higher production costs. Thus, ESA provisions frequently spark controversies pitting species protection against economic concerns.

While substantial attention is given to the economic costs of protecting T&E species, there is less recognition of the economic benefits of ensuring species survival. Protection of T&E species is typically justified on the basis of ecological importance, yet studies in the economics literature demonstrate how people value a wide variety of species, ranging from the bald eagle (*Haliaeetus leucocephalus*), to the gray whale (*Eschrichtius robustus*), and the obscure striped shiner (*Luxilus chrysocephalus*) (Boyle and Bishop 1987; Loomis and Larson 1994). A benefit-cost analysis of northern spotted owl (*Strix occidentalis caurina*) protection in the Pacific Northwest, for example, found the economic benefits of protection to exceed the highly publicized costs (Rubin et al. 1991).

As species protection efforts continue to conflict with economic development, measuring public values for T&E species becomes more important. Documentation of the real and positive benefits resulting from species recovery helps avoid the false implication that things not readily measurable in dollars are without value. Estimation of these values, however, must be approached with caution. Economic techniques for estimating public values for T&E species have been advancing, but disagreement remains about theoretical underpinnings and applied methods. Questions are also raised as to the appropriateness of these values for influencing public policy.

The intent of this paper is to highlight some of the advantages and disadvantages of placing monetary values on seemingly priceless resources. There is initial discussion of why estimating economic values for T&E species is important, followed by an overview of possible economic values for T&E species. Results are presented from an application to the peregrine falcon (*Falco peregrinus*) and shortnose sturgeon (*Acipenser brevirostrum*) in Maine. Using empirical evidence, these results are analyzed from the perspective of what the numbers truly represent.

Why estimate economic values?

Why is it important to estimate economic values for T&E species? There are those who cite the difficulties of eliciting such values, and those who believe that ascribing values is actually devaluing. While this perspective is undoubtedly valid in various circumstances, many, if not most, environmental advocates and

economists approach the question differently. Estimating economic values is perceived as necessary, rather than something to pursue in its own right. As described by Costanza et al. (1997), whether we acknowledge it or not, we implicitly or explicitly value environmental or ecological resources every day. Every decision with potential impacts on the environment is directly or indirectly based on the relative weights we give to aspects of the decision problem. The choice is whether or not we decide to make these weights explicit, taking into account the best available science and recognition of uncertainty. Since we are in effect doing valuation while making societal decisions, the prudent course is to be as informed as possible.

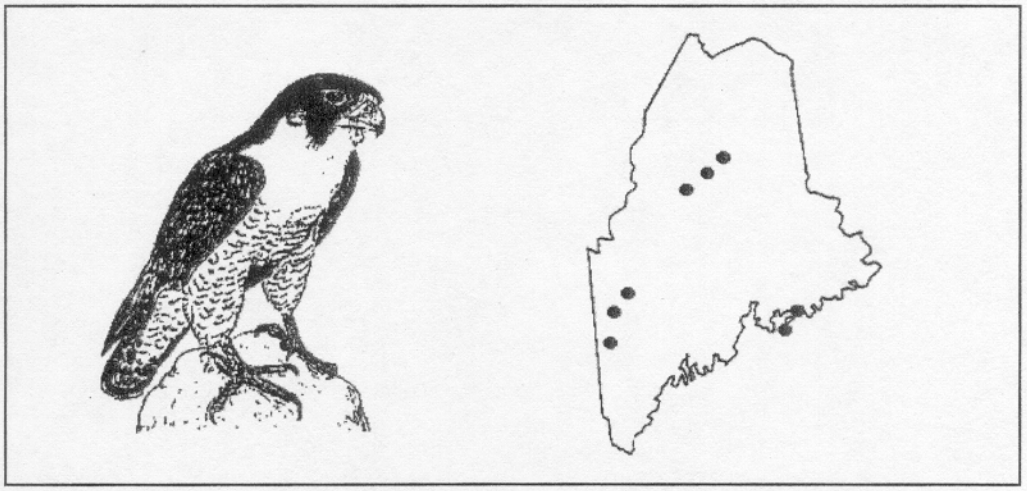

Figure 1. Peregrine falcon (*Falco peregrinus*) and locations of pairs in Maine.

Considering wildlife or T&E species specifically, less virtuous reasons for estimating economic values also exist. First, Congress has not only considered lifting prohibitions on using economic analyses in ESA listing decisions; recommendations have been made to require benefit-cost analysis (U.S. Congress 1996). Although these recommendations violate the original intent of ESA legislation, they underscore the importance of refining valuation techniques and communicating information about benefits associated with species protection. Second, whether involving T&E species or not, natural resource damage assessments have become increasingly important to mitigating adverse environmental effects of human activities. The Valdez oil spill in Prince William Sound, Alaska, provides a well-known example, in which Exxon was forced to pay compensation for their damages. While the justness of the final outcome is debated, one thing is certain: without research into the economic value of afflicted wildlife species, there would have been no compensation for such damages.

Economic values for endangered species

People value endangered species for different reasons and therefore benefit from their protection in different ways. The total benefits of protection are generally partitioned between those arising from "use" or "nonuse" values, which together comprise a species' "total" value. Use values may arise from consumptive, non-consumptive and indirect activities (Boyle and Bishop 1987). Consumptive activities involving wildlife may include hunting and fishing, but these activities are prohibited for species officially listed as threatened or endangered. Therefore, use values for T&E species and not their habitat are limited to nonconsumptive and indirect uses, which include activities such as observation (e.g., bird watching) and photography. While both observation and photography require on-site, active use, individuals may also benefit from indirect use activities, such as enjoyment gained by reading about or viewing photographs and motion pictures of the species.

Temporal and intergenerational dimensions of use values are captured by two additional sub-value categories: option and bequest values. Option values arise from uncertainty about the future and the desire to preserve options for either direct or indirect uses. Someone who has never seen a particular endangered species, for example, may want to maintain options to do so in the future. Bequest values arise from concern about future generations. Someone holds a bequest value if they gain satisfaction from knowing protection of an endangered species today ensures the species continued existence for the benefit of future generations.

Nonuse values are different from use values because they arise in the absence of any past, present, or intended future use. In other words, nonuse values are derived from the satisfaction of *simply knowing* that an endangered species has a sustainable population in its native habitat. John Krutilla (1967) is credited with first introducing this economic concept by explaining that "there are many persons who obtain satisfaction from the mere knowledge that part of the wilderness of North America remains even though they would be appalled by the prospect of

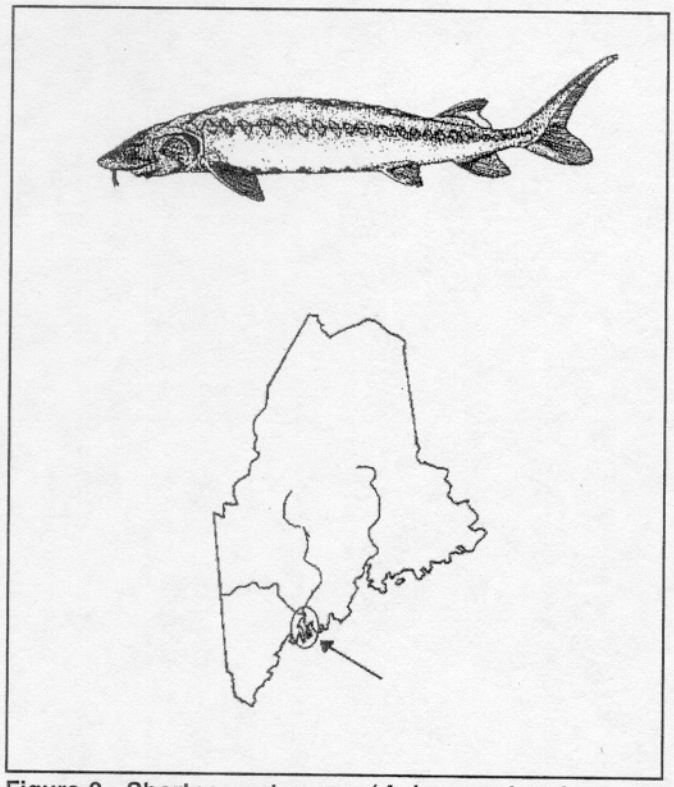

Figure 2. Shortnose sturgeon (*Acipenser brevirostrum*) and location of population in Maine.

being exposed to it." Subsequently, numerous studies have demonstrated that many people are willing to pay a certain amount to ensure the continued existence of unique environmental resources, regardless of the fact that they may never personally use them. Loomis and White (1996) provide a review of studies investigating T&E species in particular.

Given this theoretical outline of potential economic values for a T&E species, how feasible is it to derive estimates? Considering direct and indirect use values, one might look at actual economic transactions. While this is not an easy task, methods have been derived to estimate direct values (see Freeman 1993). The travel cost method, for example, estimates the cost people incur to travel for specific purposes related to a threatened or endangered species. These costs are then used to infer values. Estimating indirect values, which are inherently more diffuse, is more difficult. Nevertheless, there are market transactions involving indirect uses of many endangered species that could be accounted for one way or another. The more controversial values to estimate are option, bequest, and nonuse values. Such values are difficult to estimate because they are not observable through economic activity and are not measurable through market transactions. Therefore, estimation requires the use of hypothetical markets by a method known as contingent valuation (CV). CV uses surveys to directly question people about their economic values (see Mitchell and Carson 1989). This technique is described in the next section for an application to the peregrine falcon and shortnose sturgeon in Maine.

Economic values for peregrine falcon and shortnose sturgeon in Maine

The peregrine falcon and shortnose sturgeon are both endangered species in Maine. Their total economic value to Maine residents was estimated from a mail survey administered during the Spring of 1997 to a general population sample of 1,200 Maine residents over the age of 18 (Kotchen 1997). Mailing procedures were conducted in accordance with the Total Design Method (Dillman 1978). A total of 194 surveys could not be delivered due to incorrect or incomplete addresses, and 635 were returned for a response rate of 63.1 percent.[2] In addition to questions about economic values, the survey contained a variety of questions about environmental attitudes, prior knowledge of the species, outdoor activity participation, and socioeconomic characteristics.[3] Bias that may have resulted from asking respondents to value more than one species was avoided by stratifying the sample such that one-half received questions about peregrines and the other half received questions about sturgeons.

The CV section was constructed according to guidelines established by a panel of economists assembled by the National Oceanic and Atmospheric Administration (Arrow et al. 1993). Background information and a proposed recovery plan based on consultations with the Maine Department of Inland Fisheries and Wildlife and the Department of Marine Resources was provided in each survey for either the peregrine falcon or the shortnose sturgeon. Recovery for both species involved restoring a self-sustaining, breeding population. For the peregrine falcon, this involved increasing the State's current population of 8 resident pairs to 15 resident pairs. For the shortnose sturgeon, this involved protecting a population at the mouth of the Kennebec River from future dredging and water pollution. A technical drawing of the species and map indicating its present range in Maine was also included (Figures 1 and 2). The question format was a voter referendum to approve establishment of a statewide species protection fund. After reading background information, respondents were asked to:

Suppose this proposed fund to increase Maine's [species name] population

*was on the next State ballot. If it would cost you $_____ **in a onetime payment** through increased taxes, would you vote to approve the proposal? (CIRCLE ONE NUMBER)*

1 YES
2 NO

Specified dollar amounts were randomly assigned to respondents and correspondingly printed in survey booklets. These ranged from $2 to $50 for the peregrine falcon and $1 to $35 for the shortnose sturgeon. The ranges of specified dollar amounts were based on focus group results and a review of studies having valued similar species.

Several variables were hypothesized to influence the probability of a respondent answering "yes" to this question. Consistent with economic theory, one would expect higher prices (or specified dollar amounts) to result in lower probabilities of responding "yes." Based on established relationships between attitudes and behavior, respondents with stronger pro-environmental attitudes were expected to have higher probabilities of responding "yes" (Kotchen and Reiling in review). Moreover, those with prior knowledge of the species in Maine were expected to have higher probabilities of responding "yes." Using this framework and multivariate logistic regression, an econometric model was estimated to determine the effect of each variable on respondents' actual decisions. The approach enables evaluation of each variable for its partial effect on the probability of "yes" responses while holding other variables constant.

Results from this model for the peregrine falcon and shortnose sturgeon are presented in Table 1.[4] All coefficients are significant at the 95% level and have signs in the expected direction. The specified amount respondents were asked to pay (*BID*) is negative, indicating that higher prices decrease the probability of a "yes" response. The coefficient on environmental attitudes (*ATTITUDE*), as measured with the New Ecological Paradigm (NEP) Scale (Dunlap and Van Liere 1978; Dunlap et al. 1992) is positive, confirming the notion that stronger environmental attitudes increase the probability of "yes" responses. Prior knowledge of the species in Maine (*KNOWLEDGE*) also has a positive and significant influence on the probability of respondents answering "yes." The overall percentage of variation in responses explained by the independent variables is captured by the pseudo *R* squares of .18 for the peregrine and .237 for the sturgeon. The percentages of correct predictions are 66.1% and 66.5%, respectively.

Estimates of mean willingness to pay (WTP) for species protection are derived from these equations. The technique is explained by Hanemann (1989) and assumes no negative values. Mean WTP for the peregrine is approximately $29, and mean WTP for the sturgeon is approximately $23. Note that these values represent a onetime payment to increase populations to a level that ensures continued survival of the species in Maine. Confidence intervals around these means are also estimated to account for uncertainty (Park et al. 1991). These indicate that with 90% certainty the mean WTP is between $17 and $93 for the peregrine and between $17 and $39 for the sturgeon.

An estimate of the total economic value of the peregrine falcon and shortnose sturgeon to Maine residents is readily estimated from these ranges. Multiplying the high and low bounds of mean WTP by Maine's population of roughly 1.2 million yields values somewhere between $20 million and $111 million for the peregrine and $20 million and $47 million for

Table 1. Logistic regression results and mean willingness to pay for responses to a dichotomous-choice, contingent valuation question for the peregrine falcon and shortnose sturgeon.

	Peregrine falcon		Shortnose sturgeon	
	Coefficient	Standard Error	Coefficient	Standard Error
Constant	-3.207*	1.012	-3.976*	1.081
BID	-0.040*	0.013	-0.064*	0.020
ATTITUDE	0.067*	0.018	0.091*	0.019
***KNOWLEDGE* (1=yes, 0=no)**	0.598*	0.288	0.762*	0.377
Pseudo *R* squared	.180		.237	
Percent correct predictions	66.1		66.5	
Log-likelihood	-142.11		-122.29	
Number of observations	230		212	
Mean WTP	$29.15		$23.32	
90 percent WTP interval	$16.99-$92.85		$17.48-$39.48	

* indicates significance at the 95 percent level.

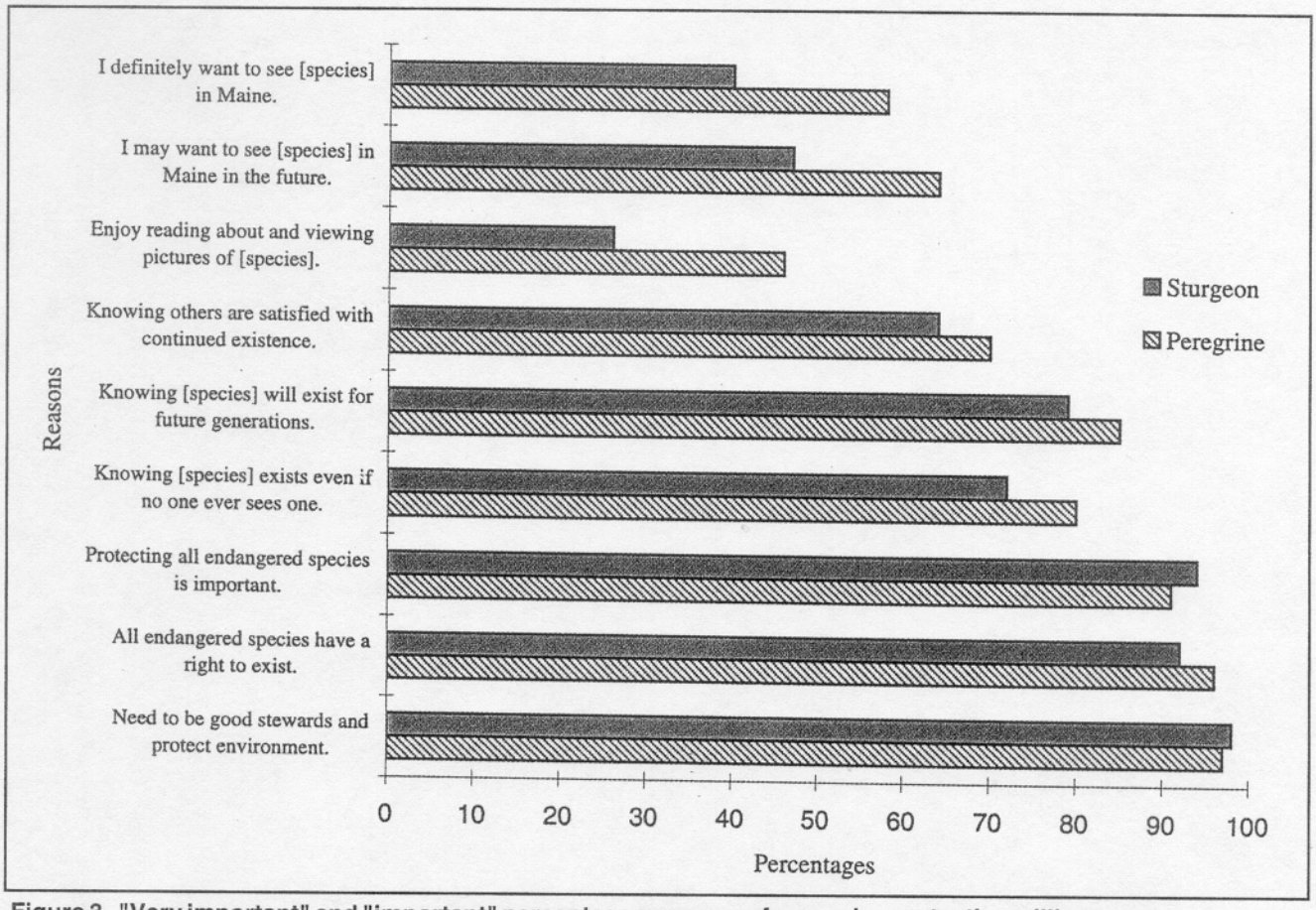

Figure 3. "Very important" and "important" percentage responses for species protection willingness to pay reasons.

the sturgeon. Thus, protection of these species is associated with substantial economic benefits. Moreover, failure to protect these species would be associated with substantial economic losses. The values presented here should, however, be recognized as underestimates because only Maine residents are included. Non-residents may also value the continued existence of these species in Maine, but capturing their values would require broader samples to account for potential distance-decay factors.

What's behind the numbers?

Most valuation studies for an endangered species stop after presenting the final numbers. The additional question of what the numbers truly represent is pursued in this paper. The intention is to provide a somewhat different perspective that highlights potential limitations of estimating economic values for endangered species and that leads to a discussion of policy implications.

Economists have repeatedly shown that obtaining reliable estimates of economic values for resources such as endangered species requires an examination of underlying motivations (e.g., Bergstrom and Reiling 1997; Johansson-Stenman 1998). Nevertheless, there has been surprisingly little applied research on what motivates people to hold resource and environmental values. This lack of information is most likely due, in part, to the difficulty of accurately measuring motivations. Such difficulties, however, should not limit common sense approaches. In this application to the peregrine falcon and shortnose sturgeon, respondents were asked to directly rate the importance of potential motivating reasons for reporting a WTP.

Abbreviated versions of these reasons are shown in Figure 3, along with the percentage of responses that were either "very important" or "important." Lengths of the bars, therefore, are a heuristic measure of the relative importance placed on each reason. Many of these reasons correspond to the resource and environmental values previously described.[5] "I *definitely* want to see the species in Maine" and "I *may* want to see the species in Maine" are statements with different probabilities for future option values. Note how these two statements are more important for the peregrine falcon than for the shortnose sturgeon. Indirect use values are one of the least important reasons, as shown by the relatively small importance of enjoyment gained from reading about and viewing pictures of the species. Moving to the somewhat more abstract motivations,

altruistic concern for others of the current generation are more important, although less important than concern for future generations. Motivations for nonuse values are relatively important. Between 70% and 80% of the respondents felt that protecting the species even if *no one* ever sees it was either "very important" or "important." Together, these motivations for use and nonuse values cover the topology of general resource and environmental values previously described, and the results provide empirical evidence that each comprises a meaningful component of the total economic value for these particular endangered species.

The remaining reasons for reporting a WTP in Figure 3, however, warrant further consideration. Unlike the motivations discussed above, the last three listed in Figure 3 are somewhat problematic for the theoretical economic framework, yet these motivations appear most important. The first reason, "Protecting all endangered species is important," reveals what economists identify as an embedding effect (Mitchell and Carson 1989). Embedding occurs when hypothetical responses represent something larger than the resource actually being valued. In this case, respondents think all endangered species should be protected, and the fact that the two species are being valued is only incidental. Thus, difficulties arise when trying to attribute reported values exclusively to the subject species. Moreover, questions arise as to whether respondents can accurately think in terms of valuing a single species. The reason that "We need to be good stewards and protect the environment" reveals a similar effect. Protection of peregrine falcons or shortnose sturgeons is embedded in larger opinions about what is important, thereby making it difficult to interpret what WTP responses truly represent.

This task is complicated further with evidence of a biocentric, or nonanthropocentric, perspective in the statement that "All endangered species have a right to exist." This motivation demonstrates how many respondents made their decision on moral and ethical grounds. Such rights-based approaches to decision-making are distinguished from utilitarian, or economic, approaches (Spash and Hanley 1995). The fundamental difference between the two approaches is the degree to which tradeoffs are possible. Because rights-based decisions are based on moral and ethical beliefs, tradeoffs jeopardizing a species survival are unlikely to occur. A utilitarian perspective, on the other hand, may acknowledge benefits and costs of protecting a particular species and be willing to accept tradeoffs in order to maximize personal or social utility. Economic analysis, however, is based on the latter approach, and many economists recognize the limitation of applying analytic techniques, such as valuation, to decisions with substantial moral and ethical components (e.g., Brookshire et al. 1986; Rosenthal and Nelson 1992; Nelson 1996; Spash 1997).

So what does the motivational analysis of this application to the peregrine falcon and shortnose sturgeon imply? Consistent with the framework of resource and environmental values, people value protection of these species for many reasons compatible with economic analysis. Nevertheless, there are difficulties in assessing the accuracy of WTP estimates, and many people hold values for moral and ethical reasons. That is, people believe T&E species are priceless and should be protected at any cost. Unfortunately, the problem in reality is not so simple. Environmental managers recognize that other people make opposing arguments, and trying to balance opposing moral and ethical arguments leaves little room for compromise. Such positions leave environmental managers with polarized decision spaces of "jobs" or "environment." Nevertheless, there is a middle ground, and this is reflected in the way most people recognize the need to make tradeoffs on some level. Economists may argue that estimating economic values is the way to determine such middle ground, but the analysis presented here demonstrates limitations of this technique. Attempts to measure economic values for T&E species inherently become tangled in moral and ethical positions, and problems with methods still exist. Economic research may find ways to resolve empirical problems, but resolving policy differences based on ecological uncertainties and moral and ethical positions requires more than economic analysis.

Conclusion

Estimating economic values for T&E species is important to better understand the ramifications of decisions. There are several types of economic values, and this application to the peregrine falcon and shortnose sturgeon in Maine provides evidence of the existence of such values. At the same time, the economics framework has empirical limitations and cannot incorporate all potential values for T&E species, as shown by the importance of moral and ethical considerations. Therefore, societal decisions affecting T&E species must be worked out as part of a dynamic political process, be informed by the best available science, and take advantage of economic analysis as a *policy tool* and not a *decision rule*. This, of course, is not a revolutionary conclusion, but this paper attempts to provide structure to the subject of estimating economic values for T&E species. The problem is not as simple as saying economic valuation is inappropriate and should be abandoned. Moreover, economic analysis does not have all the answers. In the end, economic analysis is a

powerful tool for promoting the conservation of T&E species, and just as diverse ecosystems are more stable and persistent, taking advantage of the full range of tools to promote conservation may lead to more stable and persistent solutions.

Acknowledgements

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Notes

[1]This paper is based on a presentation given to the University of Michigan Chapter of the Society of Conservation Biology, March 26, 1998, Ann Arbor, Michigan.

[2]The sample was obtained from the Maine Bureau of Motor Vehicles in Augusta, Maine, and this rate of undeliverable surveys is expected when sampling from Maine State drivers' licenses and registration cards, which only require renewal every seven years.

[3]Copies of the survey instrument are available upon request from the authors.

[4]Note should be taken that not all respondents are included in this analysis. As is customary in CV studies, respondents identified as providing "protest" no responses are excluded. These responses are those thought to arise from rejection of the hypothetical scenario, rather than from the absence of value (for details see Mitchell and Carson 1989).

[5]One category not included is direct use values. Information about direct use motivations was obtained elsewhere in the survey. Forty-four respondents had seen a peregrine falcon in the wild, and ten had made a special trip to view the species. Only sixteen respondents had seen a shortnose sturgeon in the wild, and due to limitations imposed by the species' habitat, a question about special trips was not asked.

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