Valuing Unique Natural Resources: The Case of Endangered Species

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Abstract

The valuation of environmental goods and services is an area of significant recent interest with ramifications for environmental policy-making and natural resource damage assessments. Controversy exists over the best way to determine ***passive-use values*** , i.e., benefits accruing to individuals based on the knowledge that a specific environmental resource exists or the knowledge that it will be available for future generations. The contingent valuation method (CVM) is at present the only technique available for determining passive-use values, and it has been widely criticized. This paper describes an alternative technique based on the solicitation of expert opinion and reports the results of a preliminary study using appraisal professionals to value eight of Virginia's endangered species.

> "It may seem curious to some that the survival of a relatively small number of three-inch fish among all the countless millions of species would require the permanent halting of a virtually completed dam for which Congress has expended more than $100 million."
> --Warren E. Burger, Chief Justice of the U.S. Supreme Court
> ***Tennessee Valley Authority v. Hill et al.*** , 437 U.S. 153, 15 June 1978

In recent years, environmental concerns have had an increasing impact on property values in the United States. Owners or operators of contaminated sites on the "Superfund" list are faced with significant cleanup costs, wetlands legislation frustrates farmers and would-be developers, and the discovery of an endangered species significantly reduces property owners' options. This sea-change in attitudes towards the natural environment makes property valuation more difficult because many environmental amenities (clean air, beautiful views, endangered species) are non-marketable and thus have no observable prices.

Endangered species are the subject of growing attention within the appraisal and economic professions. Guidry and Do discuss the impact of endangered species on property valuation; McKenzie-Smith outlines issues related to the development of cost-effective habitat conservation plans.[1] The large sums involved in recent high-profile natural resource damage assessments have created a lucrative cottage industry dedicated to the valuation of environmental amenities, including endangered species.[2]

There is substantial disagreement concerning the best way to value unique environmental resources. In environmental economics, controversy centers upon use of the contingent valuation method, a technique which infers values from individuals' responses to hypothetical situations.[3] In the appraisal literature, this debate is couched in terms of `public' or `option' values versus traditional market values.[4] These discussions are likely to grow more heated as regulatory agencies and public interest groups place greater emphasis on environmental protection issues. Thus, it is worthwhile to examine alternatives to existing methodologies.

This paper presents the results of a survey conducted with a group of appraisal professionals to determine the values of endangered and threatened species. The survey was carried out as a preliminary step in developing an alternative to the dominant, but controversial, method for valuing natural unique natural resources, the contingent valuation method (CVM). Section One reviews the necessity of valuing environmental resources such as endangered species, summarizes the different kinds of environmental value which may exist, and provides a brief overview of the CVM. The survey experiment and its results are presented in Section Two. Section Three discusses the implications of this work for the appraisal community and environmental valuation in general.

Valuing the Environment

The field of economics provides tools for determining the efficient allocation of limited resources among competing human wants and needs. In order for these tools to function properly, the resources in question should be marketable, i.e., there should be some mechanism for determining prices. Unfortunately, environmental goods and services rarely meet this test. The market for clean air is in its infancy (via SO2 trading allowances), the market for beautiful views is difficult to divorce from other amenity values such as location, and the market for biodiversity is all but nonexistent. Consequently, rarely will one find prices for environmental assets and even when they can be assigned, the assets in question are frequently ***public goods*** (assets which can be jointly consumed by all and/or from which others can not be excluded), which presents additional problems.

In recent years, the valuation of environmental amenities has received increased attention due to a need for natural resource damage assessments stemming from the Comprehensive Environmental Response, Compensation and Liability Act of 1980 and the Oil Pollution Act of 1990. This legislation charges the Department of the Interior (DOI) and the National Oceanic and Atmospheric Administration (NOAA) with promulgating regulations for the recovery of losses arising from the discharge of oil and hazardous wastes. Under these regulations, federal and state governments (as trustees for their citizens' natural resources) can claim recompense based on "total economic value"--which is ***not*** the same as market value, the appraisal community's standard.

Total Economic Value

An environmental asset's total economic value is the sum of its use value and non-use values. Use value refers to value derived from actual use of an environmental resource. It can be further broken down into direct use value (game, wilderness areas, water recreation) and indirect use value (watershed protection, climate mitigation). Direct use values are rarely subject to question and numerous techniques exist for their estimation, e.g., the sales comparison and income capitalization methods.

Non-use (or ***passive-use***) values include option values and existence values. Option value arises from a willingness to pay for access to a particular environment in the future.[5] It originates from uncertainty regarding future supplies, income or preferences, and in one sense, constitutes an "insurance policy" increasing the likelihood of opportunities for prospective resource exploitation. Victoria Adams and Bill Mundy apply this concept to the valuation of natural lands, concluding that option value can be an important consideration in determining highest and best use. [6]

The most controversial aspect of environmental valuation concerns existence value. First identified by John Krutilla in 1967, existence value refers to value placed on an environmental asset unrelated to any actual or potential use of the asset.[7] Such an individual might derive pleasure from watching nature films or reading of others' exploits while on safari--a "vicarious consumer," so to speak. Since existence value does not involve the destruction or compromise of the asset

being valued, it is clearly a public good--and suggests that a market is unlikely to develop for these goods and services. Regulations promulgated by the Department of the Interior in 1986 and subsequently upheld by the D.C. Court of Appeals specifically allow the computation of passive-use values in determining recoverable losses from damaged natural resources.[8]

Contingent Valuation Method

Numerous techniques are available for the valuation of environmental amenities.[9] However, only the contingent valuation method is capable of capturing non-use values and unfortunately, it is the "least reliable" method.[10] The CVM uses surveys or experiments to discover what people are hypothetically willing to pay to acquire an environmental benefit or hypothetically willing to accept to bear an environmental cost. A well-designed experiment contains a description of the good itself as well as the context in which it is to be provided and financed. These results are tallied and aggregated across all individuals to obtain the total market willingness-to-pay, which is then used as an estimate of the value of the environmental asset in question.

Many variations have been developed, but all share the CVM's fundamental weakness--its hypothetical nature. Since respondents do not actually purchase the assets in question, there can be great disparity between what they ***say*** they would do and their ***actual*** behavior. An additional weakness relevant to the current project concerns the level of knowledge prevalent in the sample population. The more familiar respondents are with the asset being valued, the greater the reliability of the results. Thus, survey results can differ markedly depending upon respondents' information set.[11]

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type="section"> [12] A preliminary study (discussed in the next section) was conducted with a group of these "valuation experts" with interesting results.

Appraisers consider four factors in determining value: 1) Utility, or the ability of a good or service to satisfy a need; 2) Scarcity, i.e., the relative availability of a particular good or commodity; 3) Desire or willingness to pay for a particular good or service; and 4) Ability to pay for a particular good or service.[13] I argue that these factors can appropriately capture both use and non-use values of environmental resources.

The Delphi Method

Several group judgmental forecasting techniques exist that could be used in estimating passive use valuation. One of the most widely studied and applied group forecasting techniques is the Delphi method. It is based on the notion that while single experts may hold incorrect opinions, the collective opinions of a group of experts can provide an improvement in information. Developed in the 1950s by the Rand Corporation as a means of forecasting future technological developments, the Delphi method has since been applied to many different kinds of problems. It

overcomes information processing limitations associated with individual judgmental forecasting techniques and reduces bias and intimidation associated with face-to-face group judgmental techniques.

The widespread use of the Delphi method has led to a wide variety of procedures; however, in its most basic form the Delphi method uses a survey approach to solicit the opinions of a panel of experts.[14] A well-defined questionnaire is submitted independently to each expert, requesting his or her response to a single issue or a number of issues. Those responses are returned to an administrator who summarizes the responses, typically calculating means, medians, and ranges. An additional questionnaire including the summary of responses from the first questionnaire is returned to the same group with a request to revise or explain their responses. Succeeding rounds continue until responses converge.

The Preliminary Story

A preliminary application of a modified Delphi method in valuing an environmental resource (endangered species) was conducted in July 1994 with members of the Virginia Association of Assessing Officers, an organization of municipal real estate appraisers practicing in Virginia. As part of a professional education seminar, respondents were presented with a survey instrument containing information on the value of endangered species and then asked to value eight species identified as endangered or threatened in the Commonwealth of Virginia.[15] Endangered species were selected as an example of an environmental resource for valuation because the use of endangered or threatened species is proscribed by law and thus the vast majority of their total economic value should be in the passive-use component.

The Role of Information and Experimental Design

It was unlikely many of the respondents were experts in both valuation ***and*** the biology of endangered species. The role of information in determining respondents' willingness-to-pay for the protection of endangered species has already been established.[16] To reduce bias, participants were presented with a short history of the U.S. Endangered Species Act and six brief arguments for and against the protection of endangered species.

The survey was administered at the end of a three and one-half hour seminar on the impact of environmental issues on valuation. Prior discussion during the seminar had focused on methods for valuing contaminated property and a brief introduction of several techniques useful in the valuation of non-marketed goods, e.g., travel cost, hedonic pricing, household production functions and the contingent valuation method.

After the surveys had been distributed, respondents were asked to complete the background information section and to read the introductory material. Next, color slides of each species were shown one at a time as the accompanying information paragraph was slowly read out loud by the facilitator. Participants were then asked to write their ***best judgment of the monetary value to***

society of a single individual of each species . This question was deliberately posed without reference to willingness-to-pay or willingness-to-accept, the operative notion being that this sample group of appraisers were working on society's behalf in applying the skills of their profession.

Summary of Results

Fifty-one usable responses were obtained, representing over 90 percent of those in attendance. Appraisal values varied with species type. Bald eagles were valued most highly with a median value of $500 each, while four species (Tennessee dace, swamp pink, snuffbox mussel and smooth coneflower) were valued at $1 per individual (Table 1).

Table 1: Valuation of Species

	Median	Mean	Range	Coefficient of Variation
Bald Eagele	$500	$25,339	$0-1 million	5.54
Northern Flying Squirrel	$10	$383	$0-8,000	3.46
Eastern Chicken Turtle	$5	$157	$0-3,000	3.11
Shenandoah Salamander	$3	$205	$0-7,500	5.12
Tennessee Dace	$1	$212	$0-5,000	4.61
Swamp Pink	$1	$67	$0-1,500	3.76
Snuffbox Mussel	$1	$35	$0-800	3.39
Smooth Coneflower	$1	$26	$0-400	3.00

High correlations between appraisal values were observed, although it was possible to identify four distinct groups of species values. Bald eagles were valued more highly than northern flying squirrels, which were valued more highly than either the eastern chicken turtle or the Shenandoah salamander, which were valued more highly than any of the remaining four species. In general, "charismatic" species were valued more highly than non-charismatic species.[17]

Appraisal values were remarkably robust across various demographic characteristics of the respondents, including gender, professional certification, membership in environmental groups and participation in most forms of outdoor recreation. There was strong evidence for two biases, however. First, individuals identifying themselves as having ***not*** participated in nature observation even once during the past two years valued most species significantly lower than persons who had engaged in this activity at least once in the past two years. Second, hunters and fisherpersons (individuals who participated in these activities at least once during the past two years) appraised endangered species at significantly lower values than their non-hunting or non-fishing counterparts.

Comparisons with Other Estimates: The Bald Eagle

There is no legal market for endangered species, but illegal trade in rare animals and plants remains a thriving business. The U.S. Fish and Wildlife Service estimates the value of a bald eagle on the black market at $2,500.[18] This is five times the median value for a bald eagle in Table 1, but well under the high estimate of $1 million per animal.

An alternative valuation approach is to add up all the services provided by the species in question, using surrogate markets to estimate prices. German researcher Frederic Vester determined the value of a songbird in this manner.[19] He estimated the material value of a single ***Blaukelchen*** (a species similar to a robin) at $.02 based on the phosphorus content of its skeleton, the use of its feathers in decorations, etc. He then added in approximately $25/year for tranquillity and relaxation services (arising from the bird's soothing song), $36 for insect removal, $12 in tree planting, $60 for environmental monitoring services (the "miner's canary" function), $22 for general symbiosis functions, $0.96 for serving as an example of bionic engineering and a few other miscellaneous services. The final tally in 1983 dollars was $180.47 per bird. Of all the species listed in Table 1, only the bald eagle approaches this value, though it is quite likely similar arguments could be made for many other species.

Valuation issues frequently arise out of a need to establish compensation in legal proceedings. A 1988 case in Albemarle County, Virginia provided the impetus for the valuation of protected (but not endangered) species. In this instance, it was alleged a number of red-tailed hawks had been shot on a large farm because the shooters believed they posed a threat to the farm's livestock. In assessing damages, the Court considered information prepared by the Wildlife Center of Virginia, a statewide animal rehabilitation center.[20] Three alternative methods of valuation were provided. The replacement cost of a hawk was estimated at approximately $3,500 based on actual costs incurred by the Peregrine Fund's captive breeding and release programs for peregrine falcons. A market value of $500 was ascertained by considering the value of birds for falconry or exhibition use. Finally, the Wildlife Center's experiences in rehabilitating and injured birds were used to obtain a figure of $500 per bird. These two latter figures compare quite well with that for the bald eagle in the preliminary study.

Comparisons with the Contingent Valuation Method

The contingent valuation method has been the primary means for estimating the existence value of endangered species. Table 2 presents values for endangered and other wildlife species obtained by other researchers using this method.

Table 2: Approximate Existence Values of Endangered Species and Wildlife[26]

	Average	Range
Atlantic Salmon		
Stevens, Echeverria, Glass, Hager & More (1991)	$8	
Bald Eagle		
Boyle & Bishop (1987)	$43	
Stevens, Echeverria, Glass, Hager & More (1991)	$20	$5-75/yr
Stevens, More & Glass (1994)	$21	

Bighorn Sheep		
Brookshire, Eubanks & Randall (1983)	$18	$17-23
Grizzly Bear		
Brookshire, Eubanks & Randall (1983)	$18	$10-22/yr
Striped Shiner		
Boyle & Bishop (1987)	$5	$1-6/yr
Whooping Crane		
Bowker & Stoll (1988)	$44	$21-149
Wild Turkey		
Stevens, Echeverria, Glass, Hager & More (1991)	$12	

It is tempting to compare the figures from Table 2 with those from Table 1 to cross-validate the two methods of valuation. Unfortunately, they are not directly comparable, though the attempt to do so leads to some interesting observations. The CVM figures (Table 2) are expressed in terms of willingness-to-pay for continued existence of a ***species*** . To obtain the total value of a given species resource to society using this method, one multiplies the reported value by the estimated population of human individuals expressing this preference. For example, Stevens et al. (1991) report an average willingness-to-pay to preserve bald eagles at $20 per person. Multiplied by Virginia's 1991 population of 6.286 million persons, this comes to a total value of about ***$126 million*** for the bald eagle resource.[21]

To arrive at a total resource value using the appraisal figures, one multiplies the values reported in Table 1 by the estimated remaining population of species under consideration. In 1994 there were 168 nesting pairs of bald eagles in the Commonwealth of Virginia.[22] Multiplied by the median appraisal value of $500 per bird, this results in a total resource value of $164,000 using the survey method. The difference between the two figures is staggering!

Part of the explanation for this disparity lies in the nature of the asset being valued. Many economists would argue that the total resource approach more fully captures the nature of the valuation problem, as bald eagles are public goods. Many individuals can derive satisfaction from knowing the ***same*** bird is alive; each person need not have his or her own eagle to obtain these benefits. $126 million is an awfully large number, however, and validation has been difficult.[23]

Sources of Bias

Survey research suffers from several well-known biases and care should be exercised in its design, implementation and analysis. This section reviews five major sources of bias which have been identified in connection with the valuation of natural resources using the contingent valuation and survey methods described in this paper.[24]

The CVM's chief weakness is that it suffers from ***hypothetical bias*** -individuals may not be able to accurately predict how they would behave in a real-world situation (for instance, if they were required to actually pay for the goods being valued). This form of bias lies at the heart of the alarmingly large total resource values assigned to populations of endangered species and provided the initial motivation for surveying the opinions of appraisal professionals. The survey

method also is subject to hypothetical bias (appraisers are generally not asked to value endangered species in the course of their daily work), but it is of a different kind and can perhaps be overcome with greater experience.

Strategic bias refers to problems associated with getting individuals to reveal their true preferences. Little strategic bias was believed to exist in the preliminary study because 1) Participants indicated a high level of interest and involvement by asking many questions before and during this exercise, 2) The survey was administered as part of a voluntary professional development seminar and 3) Nearly 100 percent of the participants requested a copy of the completed study.

Survey bias is affected by differences in interviewer behavior or self-selection on the part of responders. Because the survey was administered simultaneously to all seminar participants, the former issue was not a concern. The survey was administered immediately after a break and approximately one hour before the close of the seminar day. A very small percentage (less than ten percent) chose to leave early without participating in the survey exercise.

Flaws in the experimental design itself give rise to ***design bias*** . Several issues are relevant here. First, there is ***information*** bias. Knowledge affects preferences and seminar participants most likely knew very little about endangered species. To reduce this bias, respondents were provided with arguments for and against the preservation of endangered species, a review of the Endangered Species Act and specific information regarding the appearance, characteristics and rarity of each species. Another form of design bias concerns the ***order*** or ***aggregation set*** in which information is presented. In one CVM study, mean willingness-to-pay for preservation of the gray whale by itself was $39.80. When the gray whale was presented at the end of a hierarchy of endangered species, its value dropped to $0.28.[25] This issue was not addressed in the preliminary survey, but would be easy to incorporate in future studies.

There was no ***starting-point bias*** in this study, as appraisers were instructed to simply assign the value they thought most appropriate, rather than being asked, "Do you think a Shenandoah salamander is worth $10 to society?" A large number of $0 and $1 (nominal) bids suggested survey participants were ***very*** concerned with the absence of legal markets, however. Respondents may have been unable to overcome a disciplinary tendency to assign zero or nominal values to assets with no legal market value, although any of the standard appraisal approaches--sales comparison, cost or income approach--could have been applied, given enough knowledge. Moreover, it is quite possible real estate appraisers might view a population of endangered species as a ***liability*** , rather than an asset. Section 10(a) of the Endangered Species Act prohibits the incidental "takings" of listed species. A taking is defined as any act likely to harm or harass an endangered species and of course includes most forms of land development. Negative values were therefore possible (though none were offered). Losses in value brought about by Federal or state legislation constitute "regulatory takings" and are the subject of substantial recent interest.

Finally, ***operational bias*** measures how well experimental conditions approximate actual market conditions. An argument might be made that less operational bias exists for the survey method versus the CVM, as appraisers are formally engaged in the valuation of assets for which money is never exchanged on their behalf.

Extensions and Conclusions

In valuing endangered species, the survey method has both advantages and disadvantages vis-á-vis the contingent valuation method. On the one hand, the survey method directly addresses the chief weakness of the CVM, hypothetical bias, by substituting the opinions of valuation experts. On the other hand, real estate appraisers are unlikely to be experts with regard to ***endangered species*** . One extension of the current work might be to use the same survey instrument with a group of wildlife biologists.

Of course, appraisal experts are biased, both by training and perhaps by the types of outdoor activities in which they engage, and there is little reason to believe wildlife biologists would not be similarly handicapped. A true Delphi approach involving both groups might relieve these difficulties. The participants in this study were asked only one round of questions, for logistical reasons and because further rounds would seem to have only served to tighten the distribution of responses without appreciably affecting median values. With two dissimilar populations of survey respondents (appraisal professionals and wildlife biologists), multiple rounds of questioning could result in a "melding" of the two groups' areas of expertise. Preferably, this experiment should be run again using a larger sample size and in different locations. This would allow more powerful statistical tests to be performed. Sensitivity to order and perception bias might be uncovered using different combinations of species types.

This project is significant because it highlights the role of experts in valuing unique natural resources. Property tax receipts (or more appropriately, the services these taxes provide, e.g., police and fire protection) are public goods, as are many environmental amenities, including endangered species. Yet few, if any, municipalities resort to contingent valuation surveys of their citizenry to establish values for the underlying real estate, even for assets of unique historical significance. Instead, valuation "experts"--appraisal professionals--are pressed into service for reasons of cost, convenience and consistency. Real properties are easier to appraise than endangered species (because established markets exist for close substitutes), but it is not totally farfetched to believe appraisers might develop a similar valuation expertise over time.

Second, this research introduces a new technique for valuing unique natural resources. Survey methods have a long history of use in managerial forecasting and would seem to have applicability in this instance. The results of this method's application in the preliminary study are at great odds with figures derived in earlier CVM studies, although they are in line with values obtained from other techniques. These discrepancies merit additional investigation.

Finally, this technique invites comparison with existing methodology, primarily the CVM method. The usefulness of the Delphi technique in establishing natural resource damage assessments for accidental animal deaths, for instance, may be little better than the CVM method because it requires, in addition to expert valuation opinion, estimates of the size of the affected population. On the other hand, it should be much less susceptible to the "adding up" problem, a current concern among CVM practitioners. Knowledge gained from this exercise should increase our understanding of stated preference methods for valuing environmental assets and may provide a more robust and cost-effective alternative to the contingent valuation method currently in use.

Summary

The survey method described and applied in this paper provides a useful and potentially appropriate technique for assessing the value of endangered species, a class of environmental resources whose value is primarily composed of existence value. The predominant technique for estimating the existence value of non-marketable environmental amenities, the contingent valuation method, is subject to substantial hypothetical bias and arrives at unusually high values. The survey method suffers from less hypothetical bias, but may be itself handicapped by disciplinary constraints. More specifically, appraisal professionals are concerned with "value in use" or "value in exchange," and endangered species have neither. Rather, their value lies in "non-use." Future research incorporating the opinions of wildlife biologists may help address this weakness. Investors, real estate developers, conservationists and federal regulators are expected to benefit from improved estimates of endangered species values.

Notes

1. Krisandra A. Guidry and Quang Do, "Appraisal Assignments Involving Endangered Species," ***The Appraisal Journal*** (January 1994): 98-102 and Robert H. McKenzie-Smith, "Endangered Species Habitat and Urban Development," ***The Appraisal Journal*** (January 1994): 129-137.

2. In late 1991, the Exxon Corporation settled natural resource damage suits stemming from the 1989 ***Exxon Valdez*** oil spill with federal and state governments out of court for $1.1 billion. Official figures valued the "existence value" losses alone at nearly $3 billion! See Richard T. Carson, et al., "A Contingent Valuation Study of the Lost Passive Use Values Resulting from the ***Exxon Valdez*** Oil Spill: A Report to the Attorney General of the State of Alaska," 1992.

3. For a highly readable account, see Paul R. Portney, "The Contingent Valuation Debate: Why Economists Should Care," ***Journal of Economic Perspectives*** (Fall 1994): 3-17.

4. See for instance, Victoria Adams and Bill Mundy, "The Valuation of High-Amenity Natural Land," ***The Appraisal Journal*** (January 1991): 48-53, and Richard J. Roddewig and Gary R. Papke, "Market Value and Public Value: An Exploratory Essay," ***The Appraisal Journal*** (January 1993): 52-62.

5. See Richard C. Bishop, "Option Value: An Exposition and Extension," ***Land Economics*** (February 1982): 1-15, and Adams and Mundy, ***op. cit.***

6. Adams and Mundy, ***op. cit.***

7. John V. Krutilla, "Conservation Reconsidered," ***American Economic Review*** (1967): 777-786.

8. ***State of Ohio v. Department of the Interior*** , 880 F.2nd 432 (D.C. Cir. 1989)

9. See A. Myrick Freeman, ***The Measurement of Environmental and Resource Values*** (Washington: Resources for the Future, 1993), and Raymond J. Kopp and V. Kerry Smith, Eds., ***Valuing Natural Assets*** (Washington, DC: Resources for the Future, 1993).

10. See Ronald G. Cummings, David S. Brookshire and William D. Schulze, Eds., ***Valuing Environmental Goods: An Assessment of the Contingent Valuation Method*** . (Totowa, NJ: Rowman and Allenheld, 1986) and Robert C. Mitchell and Richard T. Carson, ***Using Surveys to Value Public Goods: The Contingent Valuation Method*** (Washington, DC: Resources for the Future, 1989) for thorough explanations of the CVM. See Jerry A. Hausmann, Ed. ***Contingent Valuation: A Critical Assessment*** (New York: North Holland, 1993) for critiques.

11. These and other issues are discussed in Kenneth Arrow, Robert Solow, Edward E. Leamer, Paul R. Portney, Roy Randner and Howard Schuman. "Report of the NOAA Panel on Contingent Valuation," ***Federal Register*** (15 January 1993): 4601-4614.

12. Guidry and Do, ***op. cit.*** ; McKenzie-Smith, ***op. cit.***

13. American Institute of Real Estate Appraisers. ***The Appraisal of Real Estate*** , 9th Ed. (Chicago: AIREA, 1987).

14. Harold A. Linstone and Murray Turoff, ***The Delphi Method: Techniques and Applications*** (Reading, MA: Addison-Wesley, 1975) provides a good treatment of this method.

15. The eight species valued in this study were the bald eagle, northern flying squirrel, eastern chicken turtle, shenandoah salamander, tennessee dace, swamp pink, snuffbox mussel and smooth coneflower. A copy of the survey instrument is available from the author.

16. Karl C. Samples, John A. Dixon and Marcia M. Gowen, "Information Disclosure and Endangered Species Valuation," ***Land Economics*** (August 1986), pp. 306-312.

17. Donald Coursey, a professor at the University of Chicago, notes in his 1992 working paper, "Endangered and Threatened Species: How Important is Conservation to You?" that Federal expenditures to preserve endangered and threatened species are greatest for mammals and least for amphibians and other lower life-forms. He reports data from an experiment in which participants were presented with a list containing names and a two-line description of 231 endangered or threatened animals and asked to evaluate the importance or unimportance of conservation efforts associated with these species on a scale of 1.0 (extremely important) to 5.0 (not important at all). The results ranged from 1.4 (bald eagle) to 3.1 (noonday snail).

18. U. S. Fish and Wildlife Service, ***Endangered Species Update*** (March 1990): 7.

19. Frederic Vester, ***Der Wert eines Vogels*** , 4th Ed. (München: Kösel, 1987).

20. Edward E. Clark, Jr., President, The Wildlife Center of Virginia. Letter to US Fish and Wildlife Service Agent Don Patterson, 6 June 1988.

21. The nation's total willingness-to-pay for the preservation of bald eagles, assuming a 1992 population of 252,524,000, is approximately $5 billion! This is known as the "adding-up" problem."

22. William Portlock, Director, Institute for Chesapeake Bay Studies. Personal communication. 29 March 1995.

23. Hausmann, ***op. cit.***

24. Arrow, et al., detail additional forms of bias associated with the CVM and offer suggestions for their minimization.

25. Coursey, ***op. cit.***

26. The original studies used various methods and techniques in obtaining and aggregating these numbers, which are not directly comparable with one another. In some cases, this table compounds these errors by aggregating multiple results into a single number (typically the average of "high" and "low" estimates reported by the original authors). Nonetheless, they provide a rough baseline from which to begin discussion). Sources: J. M. Bowker and John R. Stoll, "Use of Dichotomous Choice Nonmarket Methods to Value the Whooping Crane Resource," ***American Journal of Agricultural Economics*** (May 1988): 372-381; Kevin J. Boyle and Richard C. Bishop, "Valuing Wildlife in Benefit-Cost Analysis: A Case Involving Endangered Species," ***Water Resources Research*** (May 1987): 943-950; David S. Brookshire, Larry S. Eubanks and Alan Randall, "Estimating Option Prices and Existence Values for Wildlife Resources," ***Land Economics*** (February 1983): 1-15; Thomas H. Stevens, Jaime Echeverria, Ronald J. Glass, Tim Hager and Thomas A. More, "Measuring the Existence Value of Wildlife: What Do CVM Estimates Really Show? ," ***Land Economics*** (1991): 390-400; Thomas H. Stevens, Thomas A. More and Ronald J. Glass, "Interpretation and Temporal Stability of CV Bids for Wildlife Existence: A Panel Study," ***Land Economics*** (August 1994): 355-363.