The Valuation of Nature: An Examination of Benefits and Costs Associated with Duck Nesting Structures and the Marginal Duck Recruit

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I. EXECUTIVE SUMMARY

Waterfowl are a valued resource in Minnesota and nationwide. However, these animals are dependent upon wetland habitats that are often converted to "more economical" uses, such as industrial, residential or agricultural development.

In the face of habitat loss, wildlife managers are employing practices to maintain and/or increase the waterfowl population. In order to optimally utilize the limited funds allocated for managing such wildlife resources as waterfowl, some managers have incorporated economic analysis into operations. Cost effectiveness analysis and cost benefit analysis are two examples of economic tools employed to measure the efficiency of a certain project or practice.

While cost effectiveness analysis compares costs to a physical measurement of benefits, such as $/marginal duck recruit[1], cost benefit analysis weighs costs against a monetary measure of benefits, resulting in a cost benefit ratio. The valuation of waterfowl as a resource involves complex variables and often requires many, and sometimes broad, assumptions to be made. Despite the limitations of economic tools, non-market valuation of natural resources provides the sort of quantitative evidence policy-makers or wildlife managers, for example, may find useful.

This study examines the body of literature related to economic analysis of waterfowl and waterfowl hunting. Through review of the literature, value estimates from previous studies are obtained in an effort to determine a monetary value of waterfowl, specifically that of the marginal duck recruit. This value is pursued to assist wildlife managers in determining the economic efficiency of the use of duck nesting structures, by comparing benefits as estimated, to costs based on those calculated by Zicus et al. (2002).

[1] The "marginal duck recruit" is defined for purposes of this study as the additional duck produced, beyond the typical or average number of recruits, as a result, direct or indirect, of management practices. In other words, it is the net gain over the natural reproduction that would occur sans management. For more on this term in the context of this study see "Discussion," p29.

The estimated mean use value*[2] of each harvested waterfowl is $53.49 (all dollar values given in 2007 constant dollars) and the median use value*, $37.20. The estimated mean total value* of each harvested waterfowl is $79.79 and the median total value*, $55.80. Additionally, state-specific numbers are calculated, yielding a Minnesota mean use value of $30.76 and a mean total value of $46.14. These numbers are based on benefits transfer* calculations involving value estimates from thirteen waterfowl studies, several of which include compilations of data from other studies. The research on which the preceding estimates are based spans roughly four decades.

Variables - geographic location, valuation method, hunter characteristics, etc. - causing deviations in the studies examined are identified and briefly discussed. Additionally, variables not taken into account in previous studies are considered. Finally, the recommendation is made for further research in the area of waterfowl valuation, including more work similar to that executed by Brown and Hammack (1972), and Rashford (2005).

II. INTRODUCTION AND PURPOSE OF STUDY

> *Waterfowl are the most prominent and economically important group of migratory birds in North America. They are highly prized as gamebirds by millions of hunters in Canada, the United States and Mexico, and attract the attention of even larger numbers of people who enjoy observing them. Waterfowl generate a direct expenditure in excess of several billions of dollars annually.*
>
> *- North American Waterfowl Management Plan (U.S. Department of the Interior, Fish and Wildlife Service, 1984).*

The above statement illustrates the significance of waterfowl in not only the United States, but also neighboring nations. The federal government of the United States has endorsed a waterfowl management plan, designed to maintain and/or increase production of migratory

[2] Throughout this report, an asterisk (*) will denote that the definition of the preceding term or phrase can be found in Appendix A: Glossary of Terms.

waterfowl, known as the North American Waterfowl Management Plan, or NAWMP (USDI 1, USDI 2). In addition, the U.S. Prairie Pothole Joint Venture Implementation Plan serves as one of many regional guides for waterfowl management.

In Minnesota specifically, migratory bird[3] hunting generated expenditures of $99,053,000 (2001 dollars) in Minnesota in 2001. Additionally, migratory bird hunting involved 177,000 state residents, including 165,000 duck hunters[4] (USDI 3). Additionally, 338,000 Minnesota state residents and 105,000 nonresidents participated in waterfowl watching in Minnesota in 2001 (USDI 3). Clearly, waterfowl are a valued resource in Minnesota, as evident from the amount of money and interest generated by waterfowl-related activities.

Unfortunately, waterfowl are losing habitat – identified as the main cause of declining numbers (NAWMP, MNDNR Division of Wildlife) -- including breeding and nesting grounds, each year, due to agricultural, industrial and residential developments. This could result in decreased numbers of waterfowl for both consumptive* and nonconsumptive* recreational activities, resulting in fewer expenditures on these activities. While there are ongoing efforts to set aside waterfowl habitat nationally, as outlined in the NAWMP, habitat destruction still occurs, and wildlife managers are forced to find other ways to assure that waterfowl populations remain at an optimal level. Additionally, Minnesota has set goals for waterfowl management, including the preservation of wetlands. These plans and actions are outlined in *Restoring Minnesota's Wetland and Waterfowl Hunting Heritage,* which is currently being updated, (MNDNR Division of Wildlife).

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[3] Migratory birds are defined in the 2001 National Survey of Fishing, Hunting and Wildlife-Associated Recreation as birds that regularly migrate from one climate to another, including bandtailed pigeons, coots, ducks, doves, gallinules, geese, rails, and woodcocks.

[4] This estimate may not reflect actual hunters. It likely reflects the total number of duck stamps sold, a portion of which are often bought by collectors or other nonhunters (Mike Zicus, personal correspondence, 2005).

To alleviate the decline in waterfowl numbers, due to the loss and deterioration of habitat, wildlife managers employ various management practices to increase waterfowl production. Duck nesting structures are used by the Minnesota Department of Natural Resources, as one method of managing the waterfowl population. These structures are designed to provide safe nesting sites within existing habitat for waterfowl. Even though duck nesting structures treat a symptom, rather than the actual problem, they have been successful in increasing waterfowl production (Lokemoen 1987, Zicus et al. 2002), by offering safe nesting grounds.

While the primary goal of waterfowl management is to maintain and/or increase waterfowl production, wildlife managers are also working under the confines of limited budgets. Therefore, wildlife managers of such state and federally funded agencies, such as the MNDNR, must also focus on allocating resources efficiently. One way to do so is to employ economic tools such as cost-effectiveness analysis and cost benefit analysis. Using cost-effectiveness analysis, costs are identified and aggregated for the project, and a physical unit, such as an acre of improved habitat or a marginal duck recruit, represents benefits. The resulting metric of comparison for alternate uses of resources is a cost-effectiveness ratio, in the form of costs per unit. There have been efforts to incorporate economic analysis into waterfowl management for the purpose of allocating resources more efficiently by Lokemoen (1984) and Zicus et al. (2002). Both studies perform cost-effectiveness analysis for duck nesting structures, with resulting cost-effectiveness ratios of $/net recruit.

When considering natural resources, specifically wildlife, in benefit-cost and other economic analyses, monetizing benefits can be a difficult task. This is especially the case for nonmarket goods, such as waterfowl. Because there are no established markets from which to determine the dollar value of waterfowl benefits, economists have developed ways to get at the

value of nonmarket goods, including such natural resources and environmental amenities as waterfowl. Two techniques commonly used to price natural resources are the travel cost method and the contingent valuation method (Cooper and Loomis 1991, Hansen 1977). There have been many studies carried out over the past few decades attempting to establish a dollar value for waterfowl through valuation of waterfowl hunting, including Martin et al. (1974), Hansen (1977), Brown and Hay (1980), Sorg and Nelson (1987), Boyle et al. (1988), Hay (1988), Boyle et al. (1990), Cooper and Loomis (1991), Duffield and Neher (1991), Walsh et al. (1992), Cooper and Loomis (1993), and Rosenberger and Loomis (2001).

These economic analyses of waterfowl hunting are beneficial for project and policy applications. However, other components of total value, including existence*, bequest* and option* value – or those values not related to either consumptive or nonconsumptive use – are not measured.

The inclusion of all values in benefit-cost considerations, including the economic analysis of waterfowl, is important, as they may account for a significant portion of people's total willingness to pay for environmental amenities (Fisher and Raucher 1984). Often times, only direct expenditures are considered when estimating the value of an environmental resource, resulting in understated benefits.

If policy makers know the full value of waterfowl, including the nonuse value, in monetary terms, perhaps they can better allocate funds to wildlife managers for waterfowl management, as well as for the preservation of waterfowl habitat. Additionally, information on the monetary benefits of waterfowl management practices may help decision-makers determine which projects would use resources most efficiently.

PURPOSE OF STUDY

The purpose of this study is to examine the body of literature related to the economic analysis of waterfowl and to derive a value for waterfowl, specifically the marginal duck recruit. The dollar value of the marginal duck recruit is pursued to assist wildlife managers in determining the economic efficiency of the use of duck nesting structures, by comparing benefits as estimated, to costs based on those calculated by Zicus et al. (2002).

The desired values are derived using data from existing research, as obtaining original data is beyond the scope of this study. The studies from which data is extrapolated focus on the economics of waterfowl, and include published journal articles, Ph.D. dissertations, research station reports, and other sources. Value estimates from these studies are compiled. Benefit transfer* was performed, with conversion to 2007 dollars[5] to allow for comparison to costs of current waterfowl management practices, and for policy applications.

In summary, waterfowl are an important resource in Minnesota, and nationwide. While the preservation of wetlands is key in maintaining waterfowl populations, waterfowl management practices, such as the use of duck nesting structures, may also increase production of waterfowl. However, because of the limited budgets of wildlife managers, resources must be allocated efficiently. Identifying a rough guide for the value of waterfowl, specifically the marginal duck recruit should assist wildlife managers in making optimal decisions, and also inform policy makers as to the value of waterfowl.

Finally, the value of waterfowl, specifically the marginal duck recruit, as estimated in this study, will aid the MNDNR in determining whether duck nesting structures are an economically sound waterfowl management practice.

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[5] Monetary values from all sources reviewed and utilized in this report have been converted to 2007 dollars using the GDP conversion factor. See "Methods" section, p25, for details.

III. LITERATURE REVIEW

This section examines the literature that is germane to the objectives of this research project, namely the valuation of waterfowl, specifically the marginal duck recruit. This dollar value is pursued to assist wildlife managers in determining the economic efficiency of the use of duck nesting structures, by comparing benefits as estimated, to costs based on those calculated by Zicus et al. (2002). While there is minimal valuation research available on the dollar value of a duck or waterfowl in general, there are numerous studies that estimate the worth of waterfowl by obtaining the value of one day or one trip hunting waterfowl, as well as several that address the costs of waterfowl management.

Those studies that form cost-effectiveness ratios for waterfowl management practices include research by Lokemoen (1984) and Zicus et al. (2002).

Lokemoen (1984)

Citing the need for efficient use of resources due to limited budgets for wildlife and natural resource managers, Lokemoen's research examines the economic efficiency of ten management practices to enhance waterfowl production. The most cost effective management practices identified in this research are various methods of predator control. Nesting structures are also cited as one of the top options. Lokemoen arrives at the conclusion that it is better to concentrate efforts on a few, larger management units versus many smaller units, as travel costs will be lower, as will initial costs to lease land, establish cover, survey, post boundaries, etc. Benefits of the waterfowl recruits are not monetized, rather cost effectiveness ratios are provided for the cost per bird. Finally, in recent communication with Lokemoen, he noted that other costs were acknowledged, such as the cost of land or administration, but that the calculation and

inclusion of these figures, as well as the expression of benefits in monetary measures, were beyond the scope of his study (personal communication 2005).

Zicus et al. (2002)

The research carried out by Zicus et al. (2002) also assesses the economic efficiency of waterfowl management practices and addresses the need for incorporation of economics in wildlife management operations. However, the focus is on duck nesting structures, and the study includes data collected over a much longer time period than Lokemoen's study. Zicus examines the cost-effectiveness of duck nesting structures, with data gathered from 1996 through 2003, on 53 single-cylinder and 57 double-cylinder nesting structures placed in Northern Minnesota wetlands. Double-cylinder nesting structures were found to be slightly more cost effective, at $24.48/net recruit, versus $24.61/net recruit for single-cylinder structures. However, the authors note that results are sensitive to slight changes in assumptions, such as the calculations for time spent servicing structures. Benefits of the project are expressed in net recruits, as opposed to dollar amounts, similar to Lokemoen (1984).

The studies summarized above provide estimates for the cost of waterfowl management practices, and in turn, the cost of each additional recruit. In order to determine whether net benefits are achieved when implementing waterfowl management practices, in this case, nesting structures, benefits must also be monetized. As stated previously, the valuation literature for waterfowl, in terms of dollars per bird, is limited to research carried out by Brown and Hammack (1973).

Brown and Hammack (1973)

The work by Brown and Hammack was the "first systematic attempt either to formulate or to empiricize a waterfowl population model." The relationship between economic and

physical aspects of waterfowl hunting was examined in order to identify the optimal use of wetlands for production and harvest of waterfowl.

A theoretical model was devised to determine the value of waterfowl to hunters and to approximate a purchase price as nearly as possible. Brown and Hammack tested the model empirically, using data obtained from a non-iterative, open-ended contingent valuation survey. This questionnaire was mailed in early 1969 to a random sample of 5,000 waterfowl hunters drawn from the U.S. Bureau of Sports Fisheries and Wildlife listing of individuals who had hunted in 1967, within the boundaries of the Pacific Flyway. The questionnaire elicited data on hunter characteristics and socioeconomic information, as well as hunter expenditures (lump-sum estimates of 1968 season). Additionally, consumer surplus[6]* was estimated by asking respondents how much greater their waterfowl hunting costs would have to be before they would have decided not to have gone waterfowl hunting at all during the 1968 season.

Some very broad assumptions are made in the models that were developed. Even so, the calculated optimal values, such as the estimated value for a marginal bagged waterfowl of $14.17, provide decision makers with some idea of the worth of waterfowl and wetlands[7]. Finally, Brown and Hammack cited the need for future research, noting that the value of wetlands and waterfowl begs for their proper management. For another account of the study, including the design of the mail questionnaire, see Brown and Hammack (1972).

Brown and Hammack took on complex tasks – modeling the optimal use of resources and essentially, attempting to measure the worth of nature. The valuation of environmental amenities, in general, is a controversial topic. On one side of the debate[8] are those who contend that not

[6] For a brief discussion of consumer surplus, see Appendix B: The Value of Valuation, p3-4.
[7] For further discussion on the issues surrounding nonmarket valuation of natural resources, including wildlife, see Appendix B: The Value of Valuation.

only is this practice unethical, but that it also reduces nature to a mere measurement on the dollar-yardstick. Erickson argues that nonmarket valuation, and resultant pricing, places natural resources on the same ground as any market good – and fails to account for "complexities and interdependencies of life," as well as lack of substitutes (2000). The counter-argument: monetizing the value of wildlife, or even more generally, incorporating economic analyses into recreation and/or natural resource planning will allow for the expression of the worth of natural resources in a tangible metric for policy- and decision-makers, (Davis 1963). Furthermore, this camp contests that valuation data is very helpful when competing for limited government resources (Loomis 2000).

Regardless of where one stands in the spectrum of opinions, there is no easy way to identify the worth of nature, specifically species of wildlife, as they are largely nonmarket environmental goods. Even so, wildlife resources have utility, as individuals gain satisfaction through recreation associated with various species, for example, walleye fishing or deer hunting (consumptive uses* of wildlife), or bird watching (a nonconsumptive use*). Attempts are often made to quantify the worth of wildlife through valuation applications such as the travel cost and contingent valuation methods. These two methods are identified in pertinent literature as the most commonly used methods for wildlife valuation (Cooper and Loomis 1991, Hansen 1977).

The travel cost method (TCM)[9], a revealed preference valuation method*, was first introduced by Hotelling in 1947, in response to needs of the National Park Service, (Hanemann 1994). It involves creating a demand curve from survey responses to questions regarding an individual's expenditures for travel to a certain destination, whether the trip is for the purpose of boating, wildlife watching, waterfowl hunting, etc., or a combination of activities. The TCM

[9] For further information on the travel cost method see Clawson and Knetsch (1966) or Dwyer et al. (1977).

relies on the assumption that travel cost can be used as a proxy for price in the formulation of the demand curve.

The contingent valuation method (CVM)[10], a stated preference valuation method*, was proposed by Ciriacy-Wantrup and first put into practice by Davis (1963) in his study of the value of hunting wildlife in the Maine woods. This method involves establishing a hypothetical market situation and utilizes survey questions to measure an individual's willingness to pay for the good being examined, or for specified improvements in the good. The set up and wording of the survey is designed to achieve a realistic scenario in order to elicit accurate responses.

There are countless examples in the environmental valuation literature of applications of the travel cost and contingent valuation methods, as well as the hedonic price method*. Most of this research focuses on valuing either the ecosystem as a whole, such as the benefits of restoring a lake or preserving a wetland, or on a specific ecosystem service or quality, such as water clarity. As it is difficult to place a dollar value on a marginal member of a certain species, estimates are often obtained by measuring the value of a recreational activity associated with the species.

Measuring the value of a recreational activity associated with a species or resource may provide a rough guide or a lower bound estimate for policy makers or wildlife managers to use, but it does not account for the total value of the species or resource. In addition to the value of natural resources derived from their use, individuals and society may also hold value for nonuse properties of resources. Even though nonuse values have been recognized since the conservation movement of the 1900's, the separation of nonuse value into specific components, including bequest value and existence value, as well as option value, has occurred more recently. The

[10] For a thorough discussion of the contingent valuation method see Mitchell and Carons (1989) or Cummings et al. (1986).

concept of option value - the value an individual holds for the opportunity to use a resource in the future, regardless of whether or not he or she actually acts on this future opportunity – was first identified by Weisbrod (1964), using the example of potential visitors to a national park, saying that these individuals valued the option to access the park. He maintained that user fees did not capture the total value of the park, that inclusion of a measure of option value would more accurately represent the value to society, and that option demand is especially relevant at marginal decisions of supply. Krutilla (1967) built on Weisbrod's work, discussing the value individuals hold for natural resources, simply because they exist, as well as for the preservation of resources for future generations.

While it is acknowledged that the worth of wildlife – waterfowl included – goes beyond that of recreational use, it is not an easy task to measure these other components of value. This is evident through related literature, as the research carried out over the last four decades on the valuation of waterfowl focuses on waterfowl hunting. Many of these studies involve original data, collected for purposes of the study, while others use data obtained by various versions of the National Survey of Fishing, Hunting and Wildlife-Associated Recreation.

A review of the literature examining the value of waterfowl is presented below in chronological order.

Martin et al. (1974)

Martin et al. (1974) estimate the demand for and value of recreation areas and activities to Arizona households. A survey was administered in 1971 to Arizona residents, sampled from a 1970 Arizona state automobile registration list. Using the travel cost method, consumer surplus was estimated for five separate hunting activities, including waterfowl hunting. The estimated average consumer surplus per household-trip of waterfowl hunting was $40.92. In addition to

estimating consumer surplus for these activities, the authors also use the nondiscriminating monopolist method*, which provides total value estimates for each activity equal to the maximum total revenue that could be collected if the optimum entry fee were charged per trip for every participant household. A nondiscriminating monopolist price* is derived from this value, and is offered as a comparison to consumer surplus values, as well as values of the recreation resource, (i.e. hunting land), in alternative uses (i.e. agriculture). The nondiscriminating monopolist price estimated for waterfowl hunting, per household-trip was $82.90, but the authors note that consumer surplus is a more conceptually correct measure of the worth of a particular recreation opportunity, in comparison to nondiscriminating monopolist values* and gross expenditures. Finally, according to Martin et al., the inclusion of prices of substitutes in this study, when estimating demand equations, marks the first time "substitute attractions have been included as an integral part of the demand estimation process," (p).

Sorg and Nelson (1982)

Similar to Martin et al. (1974), Sorg and Nelson (1982) employed valuation techniques to elicit consumer surplus. Contingent valuation and travel cost surveys were conducted by telephone to measure net willingness to pay of both resident and nonresident waterfowl hunters in Idaho. The average net willingness to pay for waterfowl hunting in Idaho was estimated at $40.02 per trip using the standard cost per mile and $58.98 per trip using the reported cost per mile. Contingent valuation surveys yielded a $30.35 per trip value for the last trip of the hunting season. CVM was not used to find the value of added trips as each additional application of the iterative bidding process would have increased sampling time and therefore, sampling costs. The authors identified the $40.02 value estimation as the appropriate per trip measure for evaluation of waterfowl management project investments. Values per day were also calculated: net

willingness to pay per day for current conditions, as measured by the TCM, was $34.81 and $21.67 using the CVM. The per day value of $34.81 will be used in this report to calculate per bird value.

The random sample of hunters holding an Idaho small game hunting license or fishing license in 1982, included 1,479 individuals. These individuals received a map in the mail of the hunting area, followed by a telephone survey which collected information on party size, hunting quality, upland game species sought and trip information. The price variable for the travel cost method analysis was the reported round-trip distance traveled to each site visited. Additionally, the number of days hunting on the trip, and the number of hours per day were obtained from respondents. This information was solicited in order to convert CVM and TCM per trip values to dollar values per day, as well as to an activity day or the 12-hour Wildlife and Fish User Day. Additional data for the last trip of the season was obtained using iterative bidding contingent valuation survey questions, with trip cost as the payment vehicle. The average values estimated by the travel cost application are equal to marginal values in this study, ("...because of the statistical properties of the demand curve estimated for waterfowl hunting...") (p1), and therefore may be more appropriately applied to project level analysis. Additionally, values for increased opportunities to shoot at waterfowl (double the chances) were determined.

Finally, similar to the other waterfowl hunting studies examined in this literature review, nonconsumptive use and nonuse values are not included in this study and the authors note that no assumptions can be made as to the percentage of total waterfowl value captured by the estimates.

Boyle, Phillips, Reiling and Demirelli (1988)

Boyle, Phillips, Reiling and Demirelli (1988) also estimated average annual consumer surplus for migratory waterfowl (including inland and coastal ducks, and Canada Geese) hunting

in Maine, for single day trips. The value estimate they arrived at was $94.90 for resident hunters. In this study, surveys were administered to elicit measurements of total economic value (the most an individual would be willing to pay rather than give up the opportunity to participate in an activity), economic impacts (the costs incurred to participate in an activity) and surplus value (total economic value minus economic impacts, often termed consumer surplus).

The survey and sampling methods are described briefly in the report, and empirical results presented for each of the categories of hunting, fishing and trapping, with additional analysis performed to calculate aggregate numbers across the three activities. Individuals were mailed a survey to determine the type of species/species group hunted in Maine in 1987, and then sent a follow-up survey specific to that type of species/species group. Even though the sample size overall was large with a high response rate, the authors caution that the $94.90 estimate for average annual surplus value per *waterfowl* hunter for residents was based on a small sample size.

Finally, Boyle et al. describe total economic values as representing the total value of fishing, hunting, and trading opportunities in Maine, but cite economic impact and surplus values as being important for policy analysis, and surplus values as especially relevant for decision-making in natural resource management – a common statement throughout the waterfowl hunting valuation studies reviewed.

Duffield and Neher (1991)

In a valuation of waterfowl hunting in Montana, carried out by Duffield and Neher (1991), average expenditures per trip and per day were calculated, as well as the mean net economic value (consumer surplus) for residents and nonresidents. Consumer surplus – again

identified as the appropriate value measure for project-level application - was estimated to be $231.51 per trip and $123.14 per day.

This data was obtained by a mail survey administered by the Montana Department of Fish, Wildlife and Parks, after the 1989 general hunting season, to a sample of hunters who had purchased a 1989 Montana hunting license as well as a 1989 waterfowl stamp. Of the 1000 surveys sent out, 941 were successfully delivered, with a response rate of 68.4%, yielding a large sample. The survey contained questions regarding hunting practices, views on waterfowl management issues, and valuation of hunting experiences. Value estimates were elicited through dichotomous choice contingent valuation questions regarding hypothetical hunting trips with improved or diminished quality.

Nonuse values for waterfowl are not included, as their estimation was beyond the scope of the study. Duffield and Neher acknowledge the significance of including nonuse and nonconsumptive use values when determining "large scale impacts to resources," but feel that the current trip values as presented in the study suffice when "examining the economic effect of incremental changes in waterfowl management," (p 1).

Cooper and Loomis (1991)

Cooper and Loomis (1991) also estimated the value of one day of waterfowl hunting, or the consumer surplus per hunter per day. The value arrived at was $82.34, by means of travel cost demand curves. This figure is the average per hunter day value for the 1987-1988 hunting season for seven wildlife refuges in the San Joaquin Valley wildlife areas. Waterfowl in this study include ducks, geese and coots.

Overall, the study examines how changes in agricultural drainage affect the recreational demand for wildlife in the San Joaquin Valley in California, specifically in the Kesterson

National Wildlife Refuge. Information on wildlife responses to selenium is analyzed (elevated levels are harmful to wildlife, and are associated with increased agricultural drainage as wetland water supply), in combination with benefit estimates for waterfowl hunting in the Kesterson National Wildlife Refuge.

The following studies likewise value waterfowl hunting, but do so based on data taken from the National Survey of Hunting, Fishing and Wildlife-Associated Recreation (the Survey), which represents a joint effort of the States and national conservation organizations. The 2001 Survey is the most recent in the series of ten Surveys, which began in 1955. The Survey collects information on both the characteristics and economic impact of the individuals involved in fish and wildlife-associated recreation, and is therefore a good source of data for applications such as the valuation of natural resources in relation to a recreation activity, such as the value of waterfowl related to waterfowl hunting.

Hansen (1979)

Hansen (1979) took advantage of the Survey as a resource when attempting to value waterfowl hunting. He used data elicited from contingent valuation questions in the 1975 National Survey of Hunting, Fishing and Wildlife-Associated Recreation State Technical Reports to estimate economic values for fish and wildlife resources on National Forest Lands in the Intermountain Region. This region encompasses areas in Utah, Nevada, Idaho, Wyoming, Colorado and California.

Value was reported in terms of wildlife user days, or total willingness-to-pay, for waterfowl hunting in various states. The weighted average for the states of Nevada, Utah, Idaho and Wyoming, calculated using user days per state, was $90.09.

Hansen addresses several disadvantages to using data from the Survey, perhaps the largest of which is its questionable reliability due to small sample size. To check reliability, a composite average user day value for each activity category is compiled, converting estimates from similar wildlife recreation valuation studies to 1975 constant dollars and user day values. The composite average user day value for waterfowl hunting was estimated at $91.52.

Finally, Hansen cautions against application of estimated values to future projects and situations where marginal values are the appropriate measure, emphasizing that results are averages over total willingness-to-pay and are subject to numerous variables that may change over time.

Brown and Hay (1987)

Similar to Hansen's 1979 study, Brown and Hay (1987) use unpublished data elicited from a series of questions (designed to measure net willingness to pay) included in the 1980 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation. The overall purpose of the study was to estimate the net economic value of deer and waterfowl hunting and trout fishing. Per day and per season estimates are presented on a state-by-state basis, along with 95% confidence intervals for both point estimates. For the state of Minnesota, the estimated net economic value per day of waterfowl hunting was $21.10 and per season, $185.68. The overall average across all states, per day, was $27.43.

Brown and Hay discuss the use of the average net economic value as opposed to the value of a small or marginal change. They cite the average value of all activity days will typically be greater than the marginal value of an additional day of activity. However, but that one or the other may be appropriate for different policy applications.

Hay (1985)

Again, the National Survey of Fishing, Hunting and Wildlife-Associated Recreation is analyzed, this time solely by Hay. Using the state-by-state estimates of net economic values of particular fishing and hunting activities based on responses to contingent valuation questions included in the 1985 Survey, Hay elicits consumer surplus for waterfowl hunting.

As many of the authors of the above mentioned studies have done, Hay explains the difference between hunter expenditures and net economic values, defining net economic value as the amount an individual is willing to pay beyond what they actually spend on the activity. He notes the applicability of net economic values (also termed net willingness to pay or consumer surplus) to a variety of uses, i.e. project evaluations.

Of particular interest in his study are the results obtained for waterfowl hunting in Minnesota. The net economic value per day of waterfowl hunting was estimated at $40.23, with a standard error of the mean of 4.3 and a 95% confidence interval of $25.75 - $54.71. The sample size was 116 hunters and median value per day, $25.75. The survey questions were in iterative bidding format, with the respondents' own estimate of 1985 trip costs as the starting point, and questions following as to whether the individual would still have hunted had costs been two, three or four times higher, contingent on responses. In order to estimate a demand curve, a final question inquired as to what per trip cost the hunter would no longer have participated because of the expense.

Finally, following presentation of empirical results, Hay enters into a discussion on the possible biases of responses, and the high occurrence of outliers and the choices made in excluding certain responses. Like Hansen, Hay noted small sample size as a drawback of using Survey data.

While the studies summarized above all deal with original or secondary data, in determining the value of recreation activities, the following two studies use benefit transfer to derive a consumer surplus value for waterfowl hunting. Benefit transfer involves extrapolating data from a "study site" and applying it to a "policy" site (Rosenberger and Loomis 2001). In other words, values or the models used to estimate values, as found in previous research, have been applied to other policies or projects.

The U.S. Department of Agriculture Forest Service periodically reviews studies that value recreation activities in Forest Regions, for the Forest Service's Resource Planning Program (RPA). Walsh et al. (1992), Sorg and Loomis (1984), and Dwyer et al. (1977) all carried out work contributing to the RPA, by gathering a range of benefit estimates for outdoor recreation activities in 1968-1988 literature.

Walsh et al. (1992)

Walsh et al. discuss benefit transfer and the problems that accompany this practice, and also focus on identifying variables that account for differences in estimates from one study to another. Benefit estimates of the value of an activity day for numerous recreation categories are presented, including migratory waterfowl hunting. The mean net economic value (consumer surplus) per recreation day of waterfowl hunting, calculated from 17 estimates, was $54.62. Along with the mean, the median, standard error of the mean, 95% confidence interval and range of values are provided.

The authors then examine 16 independent variables that may influence demand, including an inflationary adjustment variable to address the issue of whether recreation values increase at the same rate as inflation. The authors recommend further research, in order to determine which

variables may account for the variation in values from study to study, and seem optimistic about the potential of methods of controlling for the effects of sources of variation in value estimates.

Rosenberger and Loomis (2001)

Rosenberger and Loomis (2001) carry out a study similar to Walsh et al., performing extensive benefit transfer on numerous recreation activities from research over the span of 1967–1988. One of the activities included in this report is waterfowl hunting. The value estimate for waterfowl hunting, as calculated from data obtained from 13 studies, containing 59 value estimates, was $37.70. Rosenberger and Loomis also examine variables that influence fluctuation of value estimates from study to study.

IV. METHODS

The purpose of this study is to estimate the value of waterfowl. Benefit transfer is performed to extrapolate data from existing research on the value of waterfowl, similar to existing studies (Walsh et al. 1992, Rosenberger and Loomis 2001). Additionally, nonuse values are calculated, according to Fisher and Raucher (1984), to provide an upper bound estimate of the value of waterfowl. Value estimates from research spanning a period of almost four decades are considered in this study. These estimates were calculated by applying either the travel cost method or the contingent valuation method, or by performing benefit transfer.

Data was elicited in the studies referenced using the travel cost method (TCM) and contingent valuation method (CVM) by survey or interview. Surveys administered were distributed by mail or by telephone. The sampling procedures varied from study to study. Most surveys or interviews collected information on hunter characteristics and socioeconomic status, as well as hunter expenditures. Additionally, willingness to pay or consumer surplus (the amount

an individual would be willing to pay for the hunting experience above and beyond the amount currently spent) was elicited.

Using the travel cost method, information was obtained in order to formulate a demand curve for waterfowl hunting. Travel cost was used as a proxy for price. Those hunters traveling further to participate in an activity had a higher cost, and therefore a higher demand for the activity than those who traveled shorter distances to participate. In some studies, trip distance was converted to cost using either a reported cost per mile or a standard cost per mile. Otherwise, travel costs were directly reported and used to formulate the demand curve. If current expenditures were reported, consumer surplus equaled the total area above current expenditures, under the demand curve. Consumer surplus represents the amount that individuals are willing to spend on a recreation activity, above and beyond what they currently pay.

Additionally, several studies referenced perform benefit transfer. While there are many implicit assumptions made when performing benefit transfer, it is one way to obtain information that may not otherwise be used in a study, due to budget limitations or other constraints.

In this study, benefit transfer is the method used to derive value estimates. All of the value estimates from existing studies are converted to 2007 U.S. dollars using the Gross Domestic Product conversion factor*[11]. Use values for waterfowl are determined using a 1.1 ducks/hunter/day figure derived from an Minnesota state harvest surveys from 1989 – 2004 (MNDNR 2). To determine the total value of waterfowl, use values are added to calculated nonuse values. Nonuse value for each study is estimated to be ½ of use value. This factor is based on the results of a study carried out by Fisher and Raucher (1984).

[11] The GDP conversion factor/price deflator was used in this study, as opposed to the Consumer Price Index. While the bundle of market goods used to determine the CPI changes over time, the GDP conversion factor is a more stable measure by which to convert figures over time.

Finally, the costs of duck nesting structures were also examined by Zicus et al. (2002) using cost-effectiveness analysis. In this procedure, all costs are identified and monetized, in order to formulate a cost-effectiveness ratio. Results from Zicus et al. are used with calculated costs to determine a cost-benefit ratio.

V. RESULTS

Table 1. presents the results of the conversion of benefit transfer and includes the year of publication, author/s, valuation method used, region, and value estimates in 2005 dollars. Table 2. provides per bird measures of value for each study and gives an overall average of all estimates. The estimated mean use value of each harvested waterfowl was $53.49 and the median use value, $37.20. The estimated mean total value of each harvested waterfowl was $79.79 and the median total value, $55.80. Additionally, state-specific data was used, resulting in figures for Minnesota: mean use value, $30.76, and mean total value, $46.14. The mean total value for Minnesota is the recommended figure for project application in this study.

Table 1. Value of Waterfowl (Hunting) as reported by selected studies

Year of Study	Author	Method Used	Region	Value of Waterfowl Hunting (2007 $/hunter/day)
1974	Martin et al.	TCM	Arizona	$40.92
1979	Hansen	CVM	Montana	$90.09
1982	Sorg & Nelson	TCM	Idaho	$34.81
1987	**Brown & Hay**		**Minnesota**	**$21.10**
1987	Brown & Hay		U.S.	$27.43
1988	Boyle et al.	CVM	Maine	$94.90
1988	**Hay**		**Minnesota**	**$40.23**
1991	Duffield & Neher	CVM	Montana	$123.14
1991	Cooper & Loomis	TCM	San Joaquin Valley, CA	$82.34
1992	Walsh et al.	benefit transfer	U.S.	$54.62
2001	Rosenberger & Loomis	benefit transfer	U.S. & Canada	$37.70

Mean Value of Waterfowl Hunting/Hunter/Day: $58.84
Median Value of Waterfowl Hunting/Hunter/Day: $40.92

Table 2. Value of waterfowl (Minnesota ducks/hunter/day applied to various study sites)

Year of Study	Author	Waterfowl/ Hunter/Day	Value of Waterfowl Hunting	Use Value/ Bird	Total Value/ Bird
1974	Martin et al.	1.1	$40.92	$37.20	$55.80
1979	Hansen	1.1	$90.09	$81.90	$122.85
1982	Sorg & Nelson	1.1	$34.81	$31.65	$47.47
1987	**Brown & Hay**	**1.1**	**$21.10**	**$19.18**	**$23.77**
1987	Brown & Hay	1.1	$27.43	$24.94	$37.41
1988	Boyle et al.	1.1	$94.90	$86.27	$129.41
1988	**Hay**	**1.1**	**$40.23**	**$36.57**	**$54.86**
1991	Duffield & Neher	1.1	$123.14	$111.95	$167.92
1991	Cooper & Loomis	1.1	$82.34	$74.85	$112.28
1992	Walsh et al.	1.1	$54.62	$49.65	$74.48
2001	Rosenberger & Loomis	1.1	$37.70	$34.27	$51.41

Waterfowl/Hunter/day based on Minnesota state survey harvest numbers from 1989 – 2004 (MNDNR 2).

Mean Use Value/Bird: $53.49
Mean Total Value/Bird: $79.79

Median Use Value/Bird: $37.20
Median Total Value/Bird: $55.80

Table 3. Value of Waterfowl (State-specific data, for comparison)

Year of Study	Author	State	Waterfowl/ hunter/day	Use value/ Bird	Total value/ Bird
1974	Martin et al.	Arizona	2.7	$15.16	$22.73
1979	Hansen	Montana	1.8	$50.05	$75.08
1982	Sorg & Nelson	Idaho	2.3	$15.13	$22.70
1987	**Brown & Hay**	**Minnesota**	**1.3**	**$24.94**	**$37.41**
1988	**Hay**	**Minnesota**	**1.3**	**$36.57**	**$54.86**
1988	Boyle et al.	Maine	1.7	$55.82	$83.74
1991	Duffield & Neher	Montana	1.8	$68.41	$102.62
1991	Cooper & Loomis	California	2.7	$30.50	$45.74

Waterfowl/hunter/day based on 2005 – 2006 season data from "Migratory bird hunting activity and harvest during the 2004 and 2005 seasons," (USDI 5).

State-specific data, Minnesota: Mean Use Value/Bird, $30.76; Mean Total Value/Bird, $46.14

It should be noted that the values presented above are for the use value and total use value of *waterfowl*. Only a few of the studies distinguished among species of waterfowl, and

none specifically provided a per day value for ducks. However, the purpose of this study was to obtain a value for the marginal duck recruit. To get as close to this as possible, a ducks harvested/day/hunter ratio was derived using the average number of days spent hunting "per active duck hunter" in Minnesota (and state specific for Table 3). Minnesota waterfowl hunting statistics were obtained from Harvest Information Program (HIP) surveys, and state harvest survey results from 1989 – 2004 (MNDNR 2).

Total value is calculated based on a well-cited study by Fisher and Raucher (1984). Fisher and Raucher examined the percentage of total value that can be attributed to nonuse value. The authors found that an appropriate estimate of nonuse value is one half the estimated use value. Accordingly, to calculate a measure of total value for the purposes of this study, the use value was multiplied by one half. The resulting figure was then added to the use value to determine the total value, presented in the final column of Table 2.

VI. DISCUSSION, CONCLUSION, RECOMMENDATIONS

Many assumptions are made in benefit transfer regarding data quality, study site likeness, the stability of values over time, etc. The following are assumptions made in this study, in estimating the value of waterfowl:

1) *Ducks and all other waterfowl have equal worth.*
    a. Many studies define waterfowl differently – including or excluding certain species of waterfowl. Some studies do not specify which species are included in the analyses. Values held for different species of waterfowl may vary.
2) *Estimated average values of waterfowl hunting are equal to marginal values.*

a. While one study specifically states that average values are equal to marginal values due to statistical applications used, typically marginal values will be smaller than average values. By using the average value as a measure of marginal value, the true value of waterfowl, specifically the marginal duck recruit in this case, is being over represented.

3) *All hunters involved in the valuation studies, regardless of region, have similar characteristics and preferences.*

a. In Table 2., values elicited from individuals hunting in states other than Minnesota are treated with ducks/hunter/day data derived from Minnesota hunters. This implies that individual hunters from one study site to another had the same average hunting success and number of days hunting per season. Table 3. is offered for comparison, illustrating the variation among states. It would be ideal to have ample valuation information for each state and/or region of interest. This is not often the reality. Application of valuation information from other study sites may be an option for projects with limited budgets, despite the variations mentioned here, and below.

b. Hunter preferences may vary from one study site to another. Value estimates in this study are calculated using data from various states/regions in the United States. It is not known whether hunters from all regions hold the same value for waterfowl hunting, and likewise waterfowl, or have similar hunter preferences, attitudes or opinions. For this study, the assumption is made that hunters have similar preferences across regions. The National Duck Hunter Survey (2005) - which provides information on hunter satisfaction, trends, etc. – as well as

individual state waterfowl hunter surveys -- may prove helpful when examining differences among regions.

c. Likewise, hunter characteristics may differ from one study site to another. One way to account for differences in hunter income, and likewise, WTP, from one study site to another is to use a formula to adjust transfer values. The following "widely used formula" found in Bateman et al. can be used to adjust transfer values:

$$WTPj = WTPi \left(Yj / Yi \right)^{e}$$

In the equation above, Y is income per capita, WTP is willingness to pay, and e is the 'income elasticity of WTP', that is, "an estimate of how the WTP for the environmental attribute in question varies with changes in income," (p43).

4) *The value individuals hold for waterfowl hunting increases at the same rate of inflation.*

a. In order to convert the dollar values as estimated in each of the studies, the GDP inflation calculator was used. This does not take into account the effects that increased hunting pressure, crowding, decrease in natural resources, etc. may have on the stability of values over time. For a discussion of inflationary adjustment variables as applied in a benefit transfer study of outdoor recreation values, see Rosenberger and Loomis (2001).

Additionally, there are comments to be made regarding the value estimates presented in Tables 1 and 2. The value of waterfowl hunting, as determined by the various studies cited, measures use values only. To make up for this under-valuation, nonuse value is calculated and added to use value to determine total value, presented in Table 2. Even though nonuse values are calculated, the estimate of waterfowl as determined in this study may still undervalue the total

value of waterfowl. In 2001, 443,000 individuals participated in non-residential (away from home) observation of, feeding and/or photographing waterfowl in Minnesota (USDI 4). Of these, 338,000 were state residents (USDI 4). Additionally, 1,157,000 Minnesota residents participated in residential (around the home) bird observation, feeding and/or photography in 2001 (USDI 4). Residential numbers were not broken down into species groups, such as waterfowl.

Consideration of the values held by the individuals participating in waterfowl-watching activities may produce a larger total value, aggregated over a population, for waterfowl than reflected by the total values presented in this study. Also, there are assuredly many individuals in the state of Minnesota that place some value on waterfowl, even though they do not engage in any waterfowl-related activities. While the exclusion of these values may understate the value of waterfowl to Minnesotans, the use of average consumer surplus values, as estimated by waterfowl hunting studies, as a base for use and nonuse value estimates may actually overstate the value of the marginal duck recruit.

CONCLUSION AND RECOMMENDATIONS

The previous discussion leads to a significant point: duck nesting structures will marginally add to the duck population. The ducks produced as a result of the duck nesting structures are those above and beyond the current population. Nesting success with nesting structures is >80% (Rave) or 2 – 4 times greater than without (Haworth). Additionally, up to 95% of recruits produced (in west-central Minnesota) are additional recruits to the landscape (Rave). The studies from which data is taken, in order to determine an estimate of the value of waterfowl, are asking waterfowl hunters to value their whole hunting experience. Additionally, most of these studies request that hunters value their current hunting experience, not the

marginally increased chances of encountering or having the opportunity to shoot at additional waterfowl – additional waterfowl that may be produced by duck nesting structures.

Even so, this overstatement of value may be offset by the exclusion of value held for waterfowl by those involved in activities other than hunting, or those who value waterfowl, but do not participate in any activities related to waterfowl. The magnitude of under- and over-estimations of values due to these assumptions is not known.

Using the numbers for benefits per bird, derived based on consumer surplus values, and the inclusion of a correction for nonuse value, it appears that the use of duck nesting structures is validated. The mean use value for each duck harvested is $53.49 and mean total value, $79.79. The cost of nesting structures per duck is approximately $25. Even if nonuse values are not included, the costs of duck nesting structures per bird are still less than the calculated benefits. It is recommended that nonuse values be taken into account, and that the $79.79 value is used. Either way, it appears as though duck nesting structures are worth the cost. Before making this statement, it may be useful to re-examine the costs of duck nesting structures. While materials, labor and transportation were all included in cost calculations, there are other figures to consider, such as administrative expenses and the social costs associated with transportation – i.e. pollution caused by combustion of fossil fuels. Finally, there may also be opportunity costs. What would the resources used to implement and maintain duck nesting structures produce if they were instead used towards purchase, preservation or restoration of habitat? If costs of transportation increase over time, will the resources invested into duck nesting structures be increasingly more likely to produce benefits in an alternative?

Finally, because such broad assumptions are made in this study, in so many aspects, it is recommended that further research be carried out – research specific to Minnesota. If valuation

data based on consumer preferences is desired, perhaps the continuous attribute-based state choice method (CABSCM) could be implemented. This recently developed stated preference valuation method involves an interactive survey administered on the computer (Ready et al.). First tested in 2005, CABSCM lets users move sliders on a computer screen for various environmental attributes, and adjusts household costs accordingly (Ready et al). Ready et al. explain: "it generates unique marginal WTP values for each attribute for each respondent," (249). They used CABSCM to elicit data on global warming, and screen sliders included: A) option to plant trees (no change to an upper bound), B) option to improve buildings (no change to an upper bound), and C) monthly cost per household. Finally, the resultant emissions reductions were represented with a fourth graphic. A similar CABSCM could be designed for Minnesota households with management, such as nesting structures and habitat conservation as options, adjustments in household income, and resultant marginally increased opportunities for hunting and/or viewing, as well as ecosystem improvement. The program could be tested where duck stamps are sold or at state parks or refuges, under the management of the Minnesota Department of Natural Resources or the U.S. Fish and Wildlife Service.

Alternatives to focusing on valuations of waterfowl may include an increased focus on total ecosystem health, in the form of wetland services valuation or even a safe minimum standard for ecosystem functions. The latter could include numbers of waterfowl a healthy ecosystem would support. Funds could be directed toward purchasing and preserving or restoring habitat. Increasing wetlands could be the goal, with waterfowl production as one of many benefits, as opposed to management options focusing on increasing game species. While wetland restoration and preservation is a goal of regional, national and international waterfowl population plans, placing game species on par with other members of the ecosystem would be a shift in

agency planning. The management option considered in this study, a duck nesting structure, is related to a dilemma that wildlife managers often face: pressure to increase game species because a large pool of the users of this resource are easily isolated and can be taxed. Thus, game species are often the focus of wildlife management.

Finally, even though the values derived in this study are not based on original site data, they are nonetheless approximations that may be useful for wildlife managers having no other monetary guide for determination of benefits of duck nesting structures, or waterfowl in general. As mentioned in the study by Brown and Hammack (1973), and exemplified by such international agreements and planning documents as the NAWMP, U.S. Prairie Pothole Joint Venture, and "Restoring Minnesota's Wetland and Waterfowl Hunting Heritage" (MNDNR), the health of wetlands and waterfowl populations is valued by not only waterfowl hunters, but the general public – and is a topic that surely warrants further research.

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Appendix A: Glossary of Terms

Benefits transfer: The transfer of data from the original study ("study site") to a different study ("policy site"). For example, data elicited from other states, regions and/or time frames, as recorded in previous waterfowl valuation studies, was applied to a new policy site in this study. Benefits transfer can be useful when budget and/or time constraints may prevent the collection of primary data. For further discussion of benefits transfer as related to natural resources, see Rosenberger and Loomis (2000).

Bequest value: Nonuse value of a good or service. Specifically the value associated with the provision of the good or service for future generations, considered a subset of existence value in much of the literature.

Consumer surplus: The difference under the demand curve between WTP and the actual price of the good or service. Consumer surplus is identified as the conceptually correct measure of value (willingness to pay) in the waterfowl valuation studies cited in this report.

Consumptive use/recreational activities: Active use of a good or service that decreases the access to or amount of the good or service for other users, for example, hunting.

Existence value: Nonuse value of a good or service. Specifically the value placed on a good or service simply because it exists, even though the "consumer" may never use the good or service. In addition to bequest value, the other component of existence value is often referred to as stewardship value.

Gross Domestic Product conversion factor (GDP price deflator): This is used to measure the change in prices of final goods and services, domestically produced, in an economy. It is different from the Consumer Price Index (CPI) in that it is not based on a fixed set of market goods and services. The GDP conversion factor is the preferred method for calculating change in constant dollars over several decades, as was required in this study for benefits transfer. Finally, the price deflator may be viewed as the ratio of the price of a good in the current year to some

base year.

Hedonic price method: A revealed preference valuation method that elicits value of nonmarket goods and services by considering individual characteristics of market goods and services. The basic idea behind the hedonic price method is that a market good, such as a house, is related to its characteristics or services provided, such as proximity to water, presence of shade trees, quality of neighborhood, etc. It is assumed that these characteristics influence consumer decisions. Value is inferred when prices for the market good change based on changes in characteristics. Regression analysis is then used to analyze data.

Mean total value: The mean of a set of figures expressing the value of consumptive use and non-consumptive use, as well as non-use value. For example, the mean total value of waterfowl may be the mean of a set of figures expressing the value of hunting and birdwatching as related to waterfowl, as well as the option and existence value people place on waterfowl.

Mean use value: The mean of a set of figures expressing the value of consumptive use and non-consumptive use, but not including non-use value. For example, the mean use value of waterfowl may be the mean of a set of figures expressing the value of hunting and birdwatching as related to waterfowl, but not including option or existence value of waterfowl.

Median use value: The median figure of a set of figures expressing the value related to consumptive and non-consumptive use, but not including non-use value. For example, the median use value of waterfowl may be the median figure expressing the value of hunting and birdwatching as related to waterfowl, but not including option or existence value of waterfowl.

Non-consumptive use/recreational activities: Passive use of a good or service that does not impact the use of other "consumers," for example, bird watching.

Nondiscriminating monopolist method: This method determines value by calculating the optimal price that could be charged for a good or service. Likewise, the **nondiscriminating monopolist price** is the optimal price that could be collected for a good or service, irregardless

of WTP. Additionally, the **nondiscriminating monopolist value** is the value arrived at using the nondiscriminating monopolist method.

Option value: Nonuse value of a good or service. Specifically the value placed on the option to use the resource at some point in the future, whether or not this actually occurs.

Revealed preference valuation method: A tool to elicit measures of value for a nonmarket good or service through preferences expressed in the market for related goods or services. The travel cost method, which uses travel cost as a proxy for price when formulating a demand curve, is one example.

Stated preference valuation method: A tool to elicit measures of value for a nonmarket good or service through stated preferences. The contingent valuation method, which uses surveys, phone interviews or other explicit ways of obtaining data not expressed in markets, is one example.

Appendix B: The Value Of Valuation

"Not everything that can be counted counts,
And not everything that counts can be counted,"
– Albert Einstein

Introduction

The bulk of the time spent on the investigation of my thesis topic took place during the summer of 2005. At the very beginning, I needed simply to educate myself. I sifted through sometimes overwhelming amounts of information in order to find appropriate background documents and data. I read about basic economic concepts related to the valuation of nonmarket goods, the development of policies and plans focused on the conservation of waterfowl, the methods used to gather information that markets fail to impart –whatever I could find to help build the knowledge base required to proceed. As the summer progressed, I focused in on the valuation of natural resources, and finally, of waterfowl. During that summer, almost everything I read and researched was novel to me.

Now, almost two years later, I revisit essentially the same materials and concepts as before. However, I find myself contemplating principles underlying the valuation of natural resources – principles that I previously accepted without question. No drastic events have taken place or striking new evidence discovered to have altered my perceptions. Rather, fresh thoughts spurred by discussion and readings, and thoughts aged through the passage of two years, have lead to new angles on the familiar. This evolution of thought has led me to some conclusions, but more often, further questions and a growing curiosity in continuing this education.

In addition to the exposure to new ideas, I have recently more seriously considered a career in or related to natural resource economics. Training for this profession could amount to a considerable amount of time – likely years – studying topics similar to those encountered

through my research. Personally, the prospect of spending a good portion of my life considering, studying, applying, even defending or explaining any area of knowledge demands thorough examination of its basic or commonly accepted premises. If I cannot reconcile the philosophy of the valuation of natural resources with my personal philosophies, then clearly it is not a sound career choice.

I have included these thoughts as an appendix because I cannot deconstruct the link in my mind from the purpose of my study to the related issues I will raise here. To monetize the value of natural resources (of marginal members of a specific species in this case), or to speak of the price at which one can be bought with respect to nature goes against deep-rooted beliefs I hold. And to spend time searching for the best way to monetize the benefits of a natural resource to me implies that it is right to monetize the benefits of a natural resource.

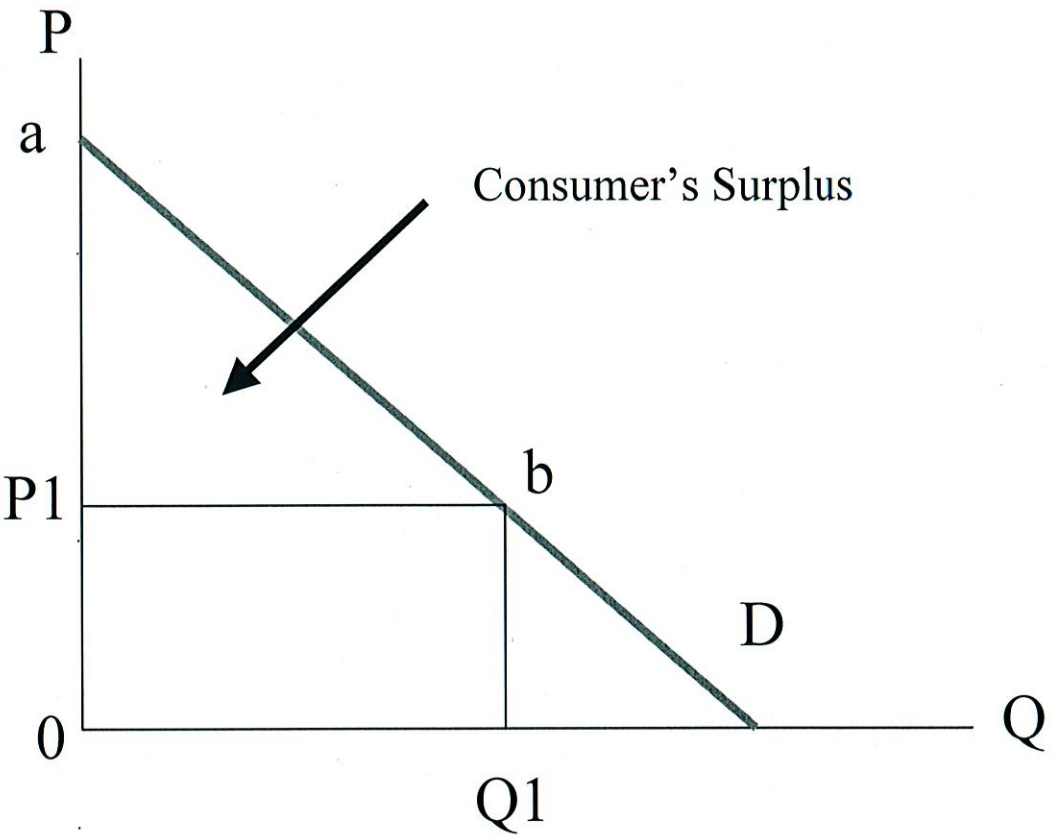
Two years ago I first exposed myself to the surface of a vast body of literature devoted to expressing, in monetary terms, the value of natural resources not captured in markets. Two years ago, I read study after study attempting to demonstrate, in dollars, the value people held for a day of hunting or increased chances to shoot at a bird. I don't recall feeling much inner strife at that time. It is curious what a difference a few years makes.

Objections

How can we describe, in tangible, applicable terms, how much Nature means to us? Setting aside the "why?" and assuming that the "how?" has been resolved, the next question may be "should we?" Is it right to try to quantify Nature in such terms, when some would say Nature is priceless?

First, let us examine the claim that Nature is priceless. For this exercise, I will employ three related concepts: consumer surplus, willingness to pay (WTP) and willingness to accept

(WTA). On the graph below,[1] P is price, Q is quantity and D is demand for a good or service, X. In this example, X will be water quality. The bold line is the demand curve.



Total willingness to pay (WTP) for Q1 = 0abQ1

Amount actually paid = 0P1bQ1

Consumer's surplus = P1ab

The above graph illustrates Marshallian consumer surplus, as well as WTP for a quantity Q of good X. Alfred Marshall was an influential economist of the late 19th/early 20th century and the originator of the concept of consumer surplus (The Library of Economics and Liberty). Marshall said that the price a consumer pays for multiple units of a good is typically the same,

[1] Adaptation of graph from PowerPoint presentation by University of Victoria Professor, Dr. Malcom Rutherford (Rutherford).

but the utility gained from each additional unit purchased declines marginally. As a result, as the quantity (Q) of good X increases, the consumer will pay less and less for each additional unit of the good. Additionally, the amount that the consumer is willing to pay for each unit of the good may be higher than the actual price. Finally, for each unit of the good priced lower than what the consumer would be willing to pay for it, the consumer reaps a benefit. This benefit, called consumer surplus (P1ab), is the difference under the demand curve between her or his WTP and the actual price of the good.

In the preceding example, good X is water quality. The consumer is willing to pay the most for the first improvement in quality, and a little less for the next, etc. Increasingly marginal improvements in water quality then have increasingly less value if value is equal to the consumer's marginal increases in utility, expressed by marginally smaller WTP to pay for each additional unit. Furthermore, if income is considered a constraint on WTP,[2] people could only choose to pay as much money as they have available, for the first unit, as well as additional units.

That is all fairly straightforward. What about willingness to accept (WTA)? If I live downstream and someone upstream wants to dump pollutants into the river, how much money must I be paid to allow this to occur? What if I claim to have an infinite WTA? In other words, I will accept no amount of money to allow any increase of pollutant X, even marginal increases (comparable to my WTP for changes in water quality of the same magnitude, but different direction – better quality, not worse.) To me, a clean river is priceless and I will not compromise.

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[2] Other considerations of WTP/WTA may include individual differences of those for whom WTP/WTA is elicited, such as age or income, and the issue of entitlement. For example, income disparity may cause the opinion of a poor majority to be overruled by that of a very wealthy, very small minority – or for the value of a statistical life of a poor person to be less than that of a wealthy individual. For a basic discussion of whether WTP should be adjusted for individual differences, see Goulder (2005). Variations in/between WTP and WTA may also depend on whether or not an individual feels he or she is entitled to either an improvement in quality or the current level of quality. For more on this subject, see Knetsch and Sinden (1984).

In "Recreation Planning as an Economic Problem" economist Robert Davis discusses this dilemma.

> *"It is commonly charged that recreation values are "priceless," that recreation is an esthetic pursuit having unique personal and spiritual values, that economic worth implies commercialization, and that economic processes serve only mass tastes. Such views are clearly erroneous in the present context and deserve refutation. No goods are priceless in the sense of having an infinite price. There is a limit individually and collectively to how much real and personal wealth we would sacrifice to obtain any recreational experience or preserve any scenic resource. This limit is defined by the incremental social gain to be realized from a unit of expenditure on recreation and from the alternatives. It would be illogical to continue pumping expenditures into recreation development if the funds could produce greater satisfaction in another purpose," (1963).*

So, with that in mind, I have an announcement. The Grand Canyon will be used as a garbage dump beginning next week. How much would a person be willing to pay to preserve the Grand Canyon? I cannot speak for others, but I can speak for my own resources. In this case, I would pay everything I possibly could to stop this from happening. Even so, my WTP would not be very large because I am a poor college student. On the other hand, if I hypothetically owned the Grand Canyon and I was offered ridiculous amounts of money to turn it into a garbage dump, I would say no deal. This would imply that my WTA does not exist, is infinite, that the Canyon is priceless to me, etc. In principle, (because I believe there are no good substitutes), I am opposed to selling the Grand Canyon for this purpose. I would say that there is no amount of money that could change my mind; however, Davis may respond that this is not efficient.

Efficient actions may include finding out how much value people (who have standing) hold for the Canyon. Perhaps the gate receipts could be tallied, surveys administered, travel costs to the Canyon approximated, etc. Once an estimate of the dollar value of the Canyon was calculated the purchaser could offer that amount or more, at which point it would be efficient for me to accept.

As a second example, consider the decision to save or let die the last breeding pair of any species, such as the polar bear. Again, my WTP to save this species is constrained by income. I would likely make the same WTA argument in this case as for the Grand Canyon – that, on principle, there is no amount of money I would accept to let polar bears go extinct.

These are both extreme - and extremely unlikely – situations. It is easy for me to say that I would never sell out and accept the money. But what if questions of the same nature, on a lesser scale of impact and perceived significance, are presented daily?

How often do we make decisions about the things that we eat, drive or buy that have bearing not only on our own lives, but also on the environment? However small the impact may be of clearing land to build a new house – perhaps a few birds lose their homes and aren't able to relocate – the cumulative effect of new development over a population or throughout the region may severely reduce the habitat for a certain species. When I buy one of the new houses, I support the efforts that have destroyed the habitat and am essentially trading a small piece of habitat for the comfort of my new home. The value I hold for it is generally represented by the purchase price. Does this imply that the value I hold for the habitat lost or the birds displaced must be less than the dollar amount at which I purchased my house?

The point is that even though I claim an infinite WTA to kill off the polar bear, my WTA for marginal destruction of species exists and is equal to the price I pay for the goods and

services that result in the destruction. In theory, I would accept no amount of money to let the polar bear go extinct, but do my stated principals hold in practice? Furthermore, in the case of bargaining over the fate of the polar bear, the outcome of my decision is explicit. I know that if I accept, the polar bear will be extinct. However, consumers or parties making WTP/WTA judgment calls may not have all of the information about the good in question. Additionally, there may be no substitute for the polar bear. Once the species is gone, it is gone, and this loss ripples throughout the food web. On the other hand, the destruction of bird habitat in exchange for my new home may be justifiable as it is likely that there is substitute habitat. Even if a few members of the species are not able to relocate, the certainty of their survival is high. The difference between theory and reality in this case may then be (perfect) information, uncertainty and substitutability, as well as the scale of the impacts of the decision. I can control conditions when making choices, in theory, based on principle. It is easy to leave dollars out of a hypothetical, such as having ownership of the Grand Canyon.

In reality, I make countless choices that result in environmental impacts. For example, almost every good or service I purchase has some impact on the environment, such as reducing the resource base or increasing pollution. The buying or selling of goods and services in the market involves the metric of money. The goods and services I buy are no different. When I purchase a good or service – using a previous example, a new house – I am trading the destruction of the habitat, and the money I pay, for the utility I will receive from my home. The amount of the purchase price is one way to express the value I place on it. Likewise, the utility I receive from Nature or from environmental amenities may be represented by the money I give to environmental organizations to save forestland or the extra cost I pay for environmentally

friendly goods over the alternative. These dollars, the metric of money, are thus employed to try to convey value.

Relatedly, WTP, WTA and consumer surplus are the conceptual representations of the decisions consumers make at the margins, and likewise, of the value of marginal changes. We often make similar tradeoffs, without knowing it, and carry out transactions daily from which value is or could be inferred.

It's All Relative

Let us return to the statement, "Nature is priceless." One interpretation of this statement is that Nature cannot be quantified using monetary terms. This seems to ignore the fact that we make decisions every day that, in effect, do just this. Assuming that I cannot live in theory, I need to face this fact. How? – By keeping in mind that it is all relative. Even though markets assign prices, and these prices are used as a measure of value, they are not absolute. Likewise, when there is no market, various methods may be used try to capture the value of this nonmarket good to consumers. The price of an improvement in the quality of a stream as negotiated between two parties is relative to what each party wants – and is representing *value at the margin.*

Even so, it still seems a little crass to put a price tag on anything in Nature – marginal change in amenity it may be. It feels a lot like putting a dollar value on life itself, which likely garners as many accusations of insensitivity as pricing Nature. Viewed from a different angle, however, maybe it is not so bad:

> *"The value of some transportation impacts, particularly crash and pollution costs, depend on the value assigned to human health and life. People are sometimes offended at the idea that human life should be assigned a monetary value, but that reflects a*

misunderstanding of the concept. Although most individuals would assign infinite value to their own life (they would not sell it regardless of how much money is offered), people, businesses and governments frequently make decisions that involve tradeoffs between monetary costs and incremental changes in risk to health and safety. Studies of the value of human health and life simply reflect what people and society seems willing to pay in monetary units for a marginal change in health and safety," (Victoria Transport Policy Institute).

Suppose I value marginally improved water quality to some said standard at $100. This relative value has been converted to a metric that is easily understood and can now be compared to the value, as measured by the market of…a pair of tennis shoes. The shoes costs $100. Wait a minute. According to the market, my clean water is of the same value/importance/worth as a pair of tennis shoes? There are substitutes for the shoes…but for clean water? If the quality of the river system declines, the whole system suffers; if humans do not have clean water, we die. If an entire line of tennis shoes is discontinued, there will be another tennis shoe to take its place.

Does the market distinguish between an exchange of $100 for increased water quality and $100 for tennis shoes? Surely we do. This begs the question: Can placing a dollar value on water quality or a visit to the state park or a forest system or a marginal duck recruit understate the true value of Nature? Maybe… if uncertainty and substitutability are not taken into account. Freese and Trauger (2000) in an article discussing concerns about "commercial markets for wildlife and other components of diversity," cite the reasoning of Clark (p43):

"…for species with a low annual growth rate the rational economic decision is to harvest the entire population and put the revenues in an investment with a greater annual return. Anyone seeking to maximize their monetary returns would liquidate the products of a

wildlife population that has a maximum growth rate of 5%/year if the revenues could be invested in a savings account that earns 6%/year," (p43).

In a world ruled by the rules of economic efficiency, it would make sense to cut down the forest and invest the profits if this investment yields higher returns than letting the forest stand. However, uncertainty exists about future environmental conditions as well as resource availability. What happens in fifty years when the forest is gone and we have money in the bank but a scarcity of wood for wildlife habitat or construction – or when scientists discover that the forest was the only such home for a particular species? Resource availability and environmental conditions of the future are often uncertain and substitutes may not be available. In these cases, valuation based on WTP elicited from consumers who do not have all the information may lead to unsound policy decisions. This is a weakness of the market model of choice (Erickson). The assumption is that informed consumers and producers will make decisions based on increasing their personal utility. However, our collective understanding of the interrelations between living things and their environment may be lacking. Furthermore, what increases personal utility may not be in line with the baseline requirements for a functioning ecosystem. Making decisions based on numbers from valuation may allow certain species or ecosystems that do not hold enough value to humans to be priced out of existence.

The Applications

My reservations about putting a price on Nature have almost been put to rest. I accept that: Nature is not priceless (Certain aspects of Nature can and do have a price assigned to them or inferred through markets, and an infinite WTA may generally hold in theoretical but not practical applications.); A dollar value inferred through markets is a relative (not absolute) measure of value; Pricing a marginal change in some aspect of the environment is different (in

means and ends) than stating that Mt. Everest or a certain species or the Grand Canyon is worth X amount of dollars.

The remaining discomfort I have about nonmarket valuation of nature stems from arguments made by Erickson and others in the field of ecological economics. In a 2000 article by Erickson, he identifies the problems with the assumptions inherent in the market model of choice: 1) that we can find or develop substitutes for the basic ecosystem services all life depends upon and 2) that our methods of valuation and pricing species or habitat does not account for "the complexities and interdependencies of life," (p36). He highlights the difference in worldviews between environmental economics (anthropocentric, humans as the top species with decisions based on human needs, wants, etc.) and ecological economics (biocentric, humans as one of many species with decisions based on variety of inputs, including complexity and uncertainty), and offers the latter as an alternative to the former (p36-38).

If ecological economics were applied to issues of valuation perhaps the question would not be how to get at the value people place on the marginal duck recruit, but rather, what is the optimal population of waterfowl, predators, plants, etc. for the wetland ecosystem and what policies regarding land use need to be developed to ensure that these conditions are achieved. Reservations about nonmarket valuation may be lesser issues and valuation may transform into more of a safe minimum standard for functioning ecosystems. That said, ecological economics is a developing field. In comparison, the practice of nonmarket valuation is quite advanced and well-established. In other words, drastic changes in valuation practices are not likely to change soon and economists will continue to look to human preferences for pricing natural resources.

After all of this discussion of the downsides of nonmarket valuation, one may ask, why all of the effort? Why the field of economics built around nonmarket valuation and specifically, valuation of natural resources?

Natural resource economist John Loomis is a strong proponent of the valuation of nonmarket environmental resources, writing:

> *"The quality of the air we breathe, the water we drink, ...valuable services of clean and natural environments...not directly priced in markets...tend to be overlooked by some policy makers who mistakenly believe that the only values that count are market revenues or local jobs. Economic valuation of environmental quality has the potential to bring a more balanced perspective to the allocation of and management of natural resources..."* *(Loomis 2005).*

The argument he makes reverberates throughout the related literature – that is, that despite reservations and/or limitations of nonmarket valuation of natural resources, there is a need for the type of data produced by it. Robert Davis, writing some forty years prior to Loomis, expressed similar, even stronger, sentiment:

"In the absence of approximate economic criteria, we can expect the social welfare to be served by no higher criteria than pork barrel economics," (Davis 1963).

Perhaps similar motivation spurred the United States government to include language in the Flood Control Act of 1936 that effectually required cost benefit analysis (CBA) of water resource projects (U.S. Flood Control Act of 1936). Economists generally recognize the Flood Control Act as "the start of systematic economic analysis of public expenditures and the initiation of the benefit-cost technique" (Hines). Early on in the application of CBA, nonmarket goods and services (such as the cultural, esthetic or recreational value of a water resource),

sometimes referred to as "intangibles", were recognized (Caulfied, Hufschmidt). However, "intangible" or "secondary" benefits of projects were often just that – secondary, and the weight they carried in project analysis varied amongst decision-making bodies. As there was no dollar value attached, there was no way to compare them objectively with other costs and benefits. The quandary of "intangibles" was not limited to water resource projects, and as cost benefit analysis became more prevalent for evaluation of government projects, so did the apparent need for a way to capture the value of nonmarket goods and services. The development of nonmarket valuation tools over the past four decades has given economists a way to do this.

Of course, professionals outside of the realm of economics also have grounds for interest in the progression of nonmarket valuation. Dr. Alan White, Coastal Resource Coordinator for a USAID-supported coastal management project writes,

> *"In our rapidly changing world, where economics is assumed to be the driving force, we should use economic tools to help people understand the value of their environmental resources – and what they stand to lose....Most important decisions in our lives are based on some kind of cost-benefit analysis, based on monetary values, and it is time to put a value on natural resources in the only terms that many people understand: money...."*
>
> He follows this with a disclaimer of sorts:
>
> *"...it will not be enough simply to put monetary values on ecosystems and expect people to start protecting them. Valuation will not change human behavior unless the monetary figure is authoritative enough and compared with the long-term costs of development alternatives," (White).*

Stanford ecologist and author of the book *The New Nature of Economy, The Quest to Make Conservation Profitable*, Dr. Gretchen C. Daily makes a slightly different case for valuation in a 2003 interview for Organica News. She cites the example of forests converted to pulp and cardboard and paper – things that have little value, versus the value of the forest as a system, and all of the services it provides. When posed with the question, "Why might we need to put a price on Nature?" her response included the following:

> *"...while it sounds crass to put a price tag on nature and pay people for saving it, if you don't do that, as someone else put it, it's like an all-you-can-eat buffet: people just go whole-hog and it's gone. So I see it as quite elegant, and an incredible challenge to find ways of harmonizing our day-to-day economic activities with protecting our life-support systems," (Butvill).*

Conclusion, Resolution

What should we attempt to monetize? Is it necessary to place a price tag on every last blade of grass and waterfall and duck? Yes, we should attempt to monetize. No, it is probably not necessary to price everything. The need for quantification for decision-making is the strongest argument for valuation. For the people making the policies and divvying out the dollars – and trying to do so objectively – it is useful to have the numbers. However, valuation needs to take place in conjunction with efforts to educate and to understand functioning ecosystems, such as how much land is needed to maintain the system or whether the land needs to be a continuous swath or patches over a larger area. If the overarching goal of nonmarket valuation of Nature is preservation, then the protection of entire ecosystems, through pricing of ecosystem services, would better serve environmental interests than valuation of game species above others. Furthermore, through the lens of ecological economics, even current methods of valuation

attempting to do these things may not be good enough. Perhaps the future of natural resource economics will stray from neoclassical foundations and evolve toward safe minimum standards for ecosystem functions and populations.

Finally, when valuation does take place, and it will until alternatives are fully developed, it should be done with care and with this disclaimer: Even though these values are admittedly quite useful, were arrived at using proven methods, can be stamped as "reliable and valid," and make a good case for the preservation of a resource or system, they may not capture the full value of the marginal duck recruit or the forest or the view of the sinking sun over the desert or the early morning tranquility of a glassy lake… There will always be something, some indescribable quality of Nature that cannot be expressed in the language of the market, which will defy measurement. Perhaps if experiences with and knowledge of Nature were more common in the general population and the mindset of the previous sentence cultivated, there would not be such a dire need to show how much everything in Nature is worth in dollar terms. Perhaps.

While Thoreau speaks of his beloved Walden being "too pure to have a market value" (182), I attempt to estimate the value of the marginal duck recruit. Others attempt to find the value of countless other ecosystems or marginal changes in environmental amenities. We arrive at a final dollar figure, put it in the report that goes to a supervisor, city council, government officials or the like. But if no mention of that which is truly intangible and immeasurable in Nature accompanies the figures, I wonder whether the environment is really better off from the effort…

Carhart, in Planning for America's Wildlands (1961), in reference to his efforts to quantify the impacts of hunting and fishing in the American economy wrote:

"... In that quarter, the dollar-data have genuine usefulness. But even as I toted the columns showing the billions spent on hunting and fishing activities, I knew there utter lack of truth as to the real value of what they only indicated. In some degree, the dollars or hours spent in the blind or number of ducks in the bag might supply a superficial measure of what a hunter procured by spending a morning on the marsh. But something else, beyond anything these data might prove, could not be summed up on any adding machine," (p31).

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Appendix C: Annotated Bibliography

1. **Beekie, Sarah Faith. "A Benefit-Cost Framework for Analyzing Waterfowl Habitat Restoration." July 1990. Master's Thesis, North Dakota State University of Agricultural and Applied Science.**

   This thesis of North Dakota State University graduate student, Sarah Faith Beekie, includes the use of the travel cost method and contingent valuation method to value waterfowl habitat restoration of Lake Christina in N. Douglas and Grant counties in Minnesota. Benefit-cost analysis resulted in a benefit-cost ratio of 1.09, indicating net benefits for society. Nonuse values were not included in the valuation calculations. Use of a CV survey is recommended to get at the full value of restoration. This may add significant weight to the benefits side, as the historic importance of the lake for its prime waterfowl hunting suggest high nonuse values.

   The analysis of data to determine the cost-benefit ratio is not extremely in-depth; however, the conceptual framework, which is the focus of the thesis, is laid out clearly. In addition to the benefit-cost analysis (BCA) and raw data, Beekie presents a BCA framework overview for public works projects, and discusses the need for BCA and the economic theory behind it.

2. **Boyle, Kevin J., Stephen D. Reiling, Marcia L. Phillips. Species Substitution and Question Sequencing in Contingent Valuation Surveys Evaluating the Hunting of Several Types of Wildlife. *Leisure Sciences*, Vol. 12, pp 103-118. 1988.**

   This study examined the implicit and explicit mention of the price of substitutes used in contingent valuation studies, stating that much attention has been placed on the issue of substitutes in nonmarket valuation literature using the travel cost method, but not in contingent valuation studies. The data was collected by surveying a stratified random sample of hunters who held a Maine license in 1987. Resident and nonresident hunters were sampled, within this stratification, and single-day and multiple-day trips were separated out. Migratory waterfowl survey response rates were low, so no actual valuations are included in this paper.

3. **Boyle, Kevin J., Marcia L. Phillips, Stephen D. Reiling and Lawrence K. Demirelli. Economic Values and Economic Impacts Associated With Consumptive Uses of Maine's Fish and Wildlife Resources. Dec. 16, 1988. Interim Report to the Maine Legislative Commission to Study the Impact of Game and Nongame Species on Maine's Economy. 41p.**

   This study by Boyle, Phillips, Reiling and Demirelli (1988) was a collaboration between the Department of Agricultural and Resource Economics at the University of Maine and the Commission to Study the Impact of Game and Nongame Species on Maine's Economy. Surveys were administered to gain economic information on hunting, fishing and trapping in Maine, including measurements of 1) total economic value (the most an individual would be willing to pay rather than give up the opportunity to participate in an

activity), 2) economic impacts (the costs incurred to participate in an activity) and 3) surplus value (total economic value minus economic impacts, often termed consumer surplus or willingness to pay).

The survey and sampling methods are described briefly in the report, and empirical results presented for each of the categories of hunting, fishing and trapping, with additional analysis performed to calculate aggregate numbers across the three activities.

4. **Boyle, Kevin J., Stephen D. Reiling, Mario Teisl and Marcia L. Phillips. A Study of the Impact of Game and Nongame Species on Maine's Economy. Staff Paper No. 423, Department of Agricultural and Resource Economics, University of Maine. Final Report to the Commission to Study the Impact of Game and Nongame Species on Maine's Economy. Dec. 1990. 122 p.**

This study is the second and final report on a three-year research effort to obtain information on the economic impact of game and nongame species on Maine's economy. Both the first and second installation of this report involved surveying samples of hunters, fishers and trappers in Maine.

The information elicited on migratory waterfowl hunting was limited to residents, and the sample size for nonresidents was small. The estimated average annual consumer surplus per hunter for migratory waterfowl (which includes sea ducks, other ducks and geese) hunting was $551. This data was obtained from a two-phase survey: the first phase designed to gather information on hunter characteristics and to develop an economic profile of the related recreation activities, the second phase involving a detailed survey. The sample of the first study was taken from those hunters who held a Maine hunting license during 1988-1989 season, and the second phase sample included those hunters who had identified themselves as migratory waterfowl hunters.

Overall, this study is rather extensive, including economic value and economic impact information for hunting, fishing and trapping of individual species and species groups, as well as many aggregated figures of economic value and economic impact. Additionally, this portion of the overall three-year study includes an attempt to measure the value of nonconsumptive uses of Maine's fish and wildlife resources. Finally, the authors report many opportunities to improve wildlife management in Maine and offer recommendations to wildlife management agencies.

5. **Brown, G.M., Jr., and Judd Hammack. Dynamic Economic Management of Migratory Waterfowl. *Review of Economics and Statistics*, Vol. 55(1), 1973, p 73-82.**

This study was the "first systematic attempt either to formulate or to empiricize a waterfowl population model." The relationship between economic and physical aspects of waterfowl hunting was examined in order to identify the optimal use of wetlands for production and harvest of waterfowl. A theoretical model was devised to determine the value of waterfowl to hunters and to approximate a purchase price as nearly as possible.

Brown and Hammack tested the model empirically, using data obtained from a contingent valuation mail survey of waterfowl hunters.

Some very broad assumptions were made in the models developed. Even so, the estimates derived, such as the value for a marginal bagged waterfowl of $3.10 (1968 dollars), provide decision makers with some idea of the worth of waterfowl and wetlands. Finally, Brown and Hammack called for future research, noting that the value of wetlands and waterfowl begs for their proper management. For another account of the study, including the design of the mail questionnaire, see Brown and Hammack (1972).

6. **Brown, Gardner, Jr. and Michael J. Hay. Net Economic Recreation Values for Deer and Waterfowl Hunting and Trout Fishing, 1980. Working Paper No. 23, 1987. 35 p.**

The purpose of this study was to estimate the net economic value of deer and waterfowl hunting and trout fishing. Per day and per season estimates are presented on a state-by-state basis, along with 95% confidence intervals for both point estimates, all in 1980 dollars. For the state of Minnesota, the estimated net economic value per day of waterfowl hunting was $10 and per season, $88. The overall average across all states, per day, was $13. The data used to derive estimates was taken from unpublished responses to a series of questions included in the 1980 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation. These questions were designed to elicit net willingness to pay for recreation activities.

Brown and Hay discuss the use of the average net economic value as opposed to the value of a small or marginal change, saying that, on average the average value of all activity days will be greater than the marginal value of an additional day of activity, but that one or the other may be appropriate for different policy applications. The net economic value or consumer surplus measure of worth was considered the appropriate representation of value for recreation by the authors of this study, who cited additional supporting documentation.

7. **Cooper, Joseph and John Loomis. Economic Value of Wildlife Resources in the San Joaquin Valley: Hunting and Viewing Values, p 447-462. As printed in Dinar, Ariel and David Zilberman, Ed. *The Economics and Management of Water and Drainage in Agriculture*. Kluwer Academic Publishers: 1991, Massachusetts; Dordrecht, The Netherlands.**

Cooper and Loomis estimated the value of one day of waterfowl hunting, or the consumer surplus per hunter day, at $55.41 (assumed to be 1988 dollars), by means of travel cost demand curves. This figure is the average per hunter day value for the 1987-1988 hunting season for seven wildlife refuges in the San Joaquin Valley wildlife areas. Waterfowl in this study included ducks, geese and coots.

Overall, the study examined how changes in agricultural drainage affect the recreational demand for wildlife in the San Joaquin Valley in California, specifically in the Kesterson

National Wildlife Refuge. Information on wildlife responses to selenium was analyzed (elevated levels are harmful to wildlife and associated with increased agricultural drainage as wetland water supply), in combination with benefit estimates for waterfowl hunting in the Kesterson National Wildlife Refuge. Additionally, the results of a contingent valuation study valuing wildlife viewing (birds and deer, with a focus on birds for purposes of this study) in California are presented.

8. **Cooper, J. and J. Loomis. Testing whether waterfowl hunting benefits increase with greater deliveries to wetlands. *Environmental and Resource Economics*. Vol. 3, 1993, p 545-561.**

   Using the travel cost method, average consumer surplus per waterfowl hunting trip for six National Wildlife Refuges in California, in the San Joaquin Valley, was estimated with a Poisson regression model to be $26.21 and $15.62 with ordinary least squares. Confidence intervals were derived from these consumer surplus point estimates, and then used to determine statistical significance for consumer surplus increases due to water delivery increases to the refuges. The data for analysis was collected for the 1989-1990 hunting season from hunters' on-site sign-up sheets, and was restricted to state residents, in order to limit the problem of multi-destination trips. The focus of the article is the comparison of benefits from water usage for agriculture to benefits from water deliveries to the refuges, by valuing the marginal value of an acre-foot of water in alternative uses.

9. **Czech, Brian. The Importance of Ecological Economics to Wildlife Conservation, p 2-3. *Wildlife Society Bulletin*, Vol. 28, No. 1. Spring 2000.**

   This brief article was an introduction for the Spring 2000 issue of the *Bulletin*. Czech discusses the need for wildlife managers to educate themselves in the field of macroeconomics and notes that the "wildlife professionals' paucity of macroeconomic expertise and total lack of involvement in macroeconomic policy is disturbing." He also strongly advocates for the application of ecological economics, as an alternative to mainstream economics.

10. **Czech, Brian. Economic growth as the limiting factor for wildlife conservation, p 4-15. *Wildlife Society Bulletin*, Vol. 28, No. 1. Spring 2000.**

    In this article, the author applies the concept of the limiting factor to the wildlife population as a whole, and states that, "economic growth and conservation are conflicting goals." Czech provides a history of economic growth theory, which leads to his discussion of economic growth developing as America's goal. He notes that the wildlife profession in the U.S. has taken a stand on many issues related to natural resources, but has stayed away from the subject of economics, and economic growth in particular. Czech recommends that wildlife professionals should have some knowledge of major economic topics, and that the wildlife profession form an opinion on economic growth.

11. **Duffield, John and Chris Neher. Montana Bioeconomics Study, A Contingent Valuation Assessment of Montana Waterfowl Hunting: Hunter Attitudes and**

Economic Benefits. Prepared for the Montana Department of Fish, Wildlife and Parks. May 1991. 37p.

The purpose of this study was to measure the net economic value of waterfowl hunting, or the amount hunters are willing to pay over and above current expenditures. The results of the study indicate that recreation values associated with waterfowl hunting in Montana were significant. In 1990 dollars, average expenditures per trip for residents were estimated at $49.35 and for nonresidents, $635.12; average expenditures per day for residents were estimated at $30.84 and for nonresidents, $193.05. Also in 1990 dollars, the mean net economic value per trip was estimated to be $167.88 and per day, $89.29. Both the truncated mean and median were estimated, however, the truncated mean was determined to be closer to the actual value

This data was obtained by a mail survey administered by the Montana Department of Fish, Wildlife and Parks, after the 1989 general hunting season, to a sample of hunters who had purchased a 1989 Montana hunting license as well as a 1989 waterfowl stamp. Of the 1000 surveys sent out, 941 were successfully delivered, with a response rate of 68.4%, yielding a large sample. The survey contained questions regarding hunting practices, views on waterfowl management issues, and valuation of hunting experiences. Value estimates were elicited through dichotomous choice contingent valuation questions regarding hypothetical hunting trips with improved or diminished quality.

Nonuse values for waterfowl were not included, as their estimation was beyond the scope of the study. Duffield and Neher acknowledged the significance of including nonuse and nonconsumptive use values when determining "large scale impacts to resources," but felt that the current trip value as presented in the study suffice when "examining the economic effect of incremental changes in waterfowl management," (p 1).

12. **Erickson, Jon D. Endangering the economics of extinction, p 34-41. *Wildlife Society Bulletin*, Vol. 28, No. 1. Spring 2000.**

In this article, Erickson addresses the issue of assigning dollar values to nonmarket environmental goods, through the use of valuation techniques. He holds the opinion that this practice can lead to the depletion of natural resources and the extinction of species, despite (and often as a result of) optimal market behavior under a "market paradigm of choice." Erickson also discusses the problems related to valuing natural resources, including that of complexity and uncertainty, the difficulty of assigning the "right price," the issue of substitutability and the comparisons drawn between necessities and luxuries. He offers ecological economics as an alternative to neoclassical economics and the current market paradigm.

13. **Freeman, A. Myrick III. *The Benefits of Environmental Improvement.* 1979. Resources for the Future: Washington, D.C.**

This book addresses the estimation of benefits, specifically related to environmental pollution control. The concept of benefits was examined, as well as the methods of

estimating various types of benefits. Freeman discusses the connection of these methods to the underlying theory of economic welfare and welfare measurement, as well as problems associated with empirical estimations using valuation techniques. This work is a good reference for those interested in benefit estimation – underlying theory, basic concepts and related concerns. While Freeman does not advocate the use of benefits estimates as calculated using valuation techniques for policy decisions, he does acknowledge the potential of benefit estimation techniques in general, and specifically for use in consideration of distributional aspects of policy

14. **Freese, Curtis H. and David L. Trauger. Wildlife markets and biodiversity conservation in North America, p 42-51. *Wildlife Society Bulletin*, Vol. 28, No. 1. Spring 2000.**

    Freese and Trauger discuss commercial markets for wildlife conservation, noting that these markets can lead to specialization and a focus on short-term goals, and in turn, a devotion of disproportional resources towards highly demanded species, ultimately leading to loss of biodiversity. While acknowledging these problems, the authors do support the use of commercial markets for wildlife conservation, stressing proper management. Three case studies are presented - consumptive use fish markets, recreational hunting markets, and nonconsumptive-use biodiversity – to allow for examination of the effects of commercial markets.

15. **Hall, Charles A.S., Peter W. Jones, Therese M. Donovan, and James P. Gibbs. The implications of mainstream economics for wildlife conservation, p 16-25. *Wildlife Society Bulletin*, Vol. 28, No. 1. Spring 2000.**

    Hall et al. identify the goal of wildlife management: to maintain levels of wildlife consistent with human wants. The argument is made that this goal is met in many cases, but as economic development becomes a top priority, these two goals come into conflict – conserve natural resources or exploit them for further economic growth. The authors contend that neoclassical economic theory is in conflict with goals of "wildlife science," and that it focuses on consumer decisions in markets. Eight problems of neoclassical economies are identified, and the application of ecological economics is offered as an alternative.

16. **Hanemann, W. Michael. *Contingent Valuation and Economics*. March, 1994. Working Paper No. 697. Berkeley, CA: California Agricultural Experiment Station.**

    This paper serves as a critical analysis of a study done by Peter A. Diamond and Jerry Hausman, "On Contingent Valuation Measurement of Nonuse Values" in Contingent Valuation: A Critical Assessment, J. Hausman, ed., NY: North-Holland, 1993, p 30. Hanemann offers a good introduction to the subject of quantifying nonuse values, including the major literature leading up to current Contingent Valuation (CV) critiques. The following sections examine economic theory, including the theory behind CV, the significance of survey design and corresponding reliability of CV results, the

comparisons of CV to voting and techniques used by market researchers. The final sections examine weaknesses in CV studies commissioned by Exxon. Overall, the author defends and supports the inclusion of nonuse values in economic valuation, with a focus on CV, citing a large body of literature on the CV Method, including over 1500 studies and papers (Carson et al. 1992, as cited in Hanemann 1994), and improvement in valuation methods.

17. **Hansen, Christopher S. A Report on the Value of Wildlife. U.S. Department of Agriculture, Forest Service Intermountain Region. Dec. 1, 1977. 23 p.**

In this study, data elicited from contingent valuation questions in the 1975 National Survey of Hunting, Fishing and Wildlife-Associated Recreation State Technical Reports (here on referred to as the Survey) was used to estimate economic values for fish and wildlife resources on National Forest Lands in the Intermountain Region. This region encompasses areas in Utah, Nevada, Idaho, Wyoming, Colorado and California.

Value is reported in terms of wildlife user days, or total willingness-to-pay, for waterfowl hunting in various states. In 1975 constant dollars, estimates were as follows: Idaho, $14.44; Nevada, $48.49; Utah, $30.95; and Wyoming, $67.15. The weighted average, calculated using user days per state, for the region was $29.53.

Hansen addresses several disadvantages to using data from the Survey, perhaps the largest of which is its questionable reliability, due to small sample size. To check reliability, a composite average user day value for each activity category was compiled, converting estimates from similar wildlife recreation valuation studies to 1975 constant dollars and user day values. The composite average user day value for waterfowl hunting was estimated at $30.

Finally, Hansen cautions against application of estimated values to future projects and situations where marginal values are the appropriate measure, emphasizing that results are averages over total willingness-to-pay and are subject to numerous variables that may change over time.

18. **Hay, Michael J. Net Economic Recreation Values for Deer, Elk and Waterfowl Hunting, and Bass Fishing, Report 85-1. July 1988. Division of Policy and Directives Management. U.S. Fish and Wildlife Service, Washington, D.C.**

This paper is a complement to the 1985 National Survey of Fishing, Hunting and Wildlife-Associated Recreation National and State reports. It contains estimates, on a state-by-state basis, of net economic values of particular fishing and hunting activities based on responses to contingent valuation questions included in the 1985 Survey.

Hay explains the difference between hunter expenditures and net economic values, defining net economic value as the amount an individual is willing to pay beyond what they actually spend on the activity. He notes the applicability of net economic values

(also termed net willingness to pay or consumer surplus) to a variety of uses, i.e. project evaluations.

Of particular interest are the results obtained for waterfowl hunting in Minnesota. The net economic value per day of waterfowl hunting, in 1985 dollars, was estimated at $25. The sample size was 116 hunters and median value per day, in 1985 dollars, $16.The survey questions were in iterative bidding format, with the respondents' own estimate of 1985 trip costs as the starting point, and questions following as to whether the individual would still have hunted had costs been two, three or four times higher, contingent on responses. In order to estimate a demand curve, a final question inquired as to what per trip cost the hunter would no longer have participated because of the expense.

Finally, following presentation of empirical results, Hay enters into a discussion on the possible biases of responses, and the high occurrence of outliers and the choices made in excluding certain responses. Also a general concern across all states was small sample size.

19. **Lokemoen, John T. Examining Economic Efficiency of Management Practices That Enhance Waterfowl Production. Trans. N. American Wildlife and Natural Resource Conference 49. p 584-607. (Northern Prairie Wildlife Research Center, No. 615). 1984.**

Citing the need for efficient use of resources due to limited budgets for wildlife and natural resource managers, this study examined the economic efficiency of ten management practices to enhance waterfowl production. The most cost effective management practices identified in this research were various methods of predator control. Nesting structures were also cited as one of top options. Lokemoen arrives at the conclusion that it is better to concentrate efforts on a few, larger units versus many smaller units, as travel costs will be lower, as will initial costs to lease, establish cover, survey, post boundaries, etc. Finally, benefits were not monetized in this study.

20. **Loomis, John B. "Test-retest Reliability of the Contingent Valuation Method: A Comparison of General Population and Visitor Responses. *American Journal of Agricultural Economics*. February 1989. p76-84.**

Loomis used test-retest (resurveying the same households) to check the reliability of contingent valuation surveys, nine months after the original study. He notes that there has been little study carried out on the reliability of CVM, and that this should change, as reliability indicates that values reported are consistent and reveal information about the respondent's behavior. The conclusion reached by Loomis is that the CV method provides reliable estimates of total willingness to pay (WTP) for the study being examined, which was comparable to results reached by a similar study. The author acknowledges that new knowledge or actual payments may result in different bids for respondents, and that tracking data over several years would be ideal to determine if WTP estimates can be projected over long time spans with accuracy.

21. Loomis, John B. Can Environmental Economic Valuation Techniques Aid Ecological Economics and Wildlife Conservation? p 52-60. *Wildlife Society Bulletin*, Vol. 28, No. 1. Spring 2000.

Loomis makes the case that market pricing will not lead to sustainable use of resources, or even efficient resource use. He advocates for full cost pricing, or adjusting prices of natural resources upwards to reflect externalities, and also for valuation of natural resources and ecosystem services, as "valuation helps society to make informed choices about the tradeoffs," p 53. Loomis recommends the use of nonmarket valuation techniques to help capture full cost of development, or full value of resources, and discusses both revealed and stated preference methods. He includes a case study on the valuation of changes in ecosystem services provided by the South Platte River to illustrate the use of nonmarket valuation techniques

22. Martin, W., R. Gum, and A. Smith. 1974. The demand for and value of hunting, fishing, and general rural outdoor recreation in Arizona. Tucson, AZ: Agricultural Experiment Station, University of Arizona.

This study estimated the demand for and value of recreation areas and activities to Arizona households. A survey was administered in 1971 to Arizona residents, sampled from a 1970 Arizona state automobile registration list. Using the Clawson-Hotelling method of valuation (commonly known as the travel cost method), consumer surplus was estimated for five separate hunting activities (one of which was waterfowl hunting), two fishing activities, and general rural outdoor recreation (including picnicking, overnight camping, hiking, swimming, boating, water skiing, bird watching and snow skiing).

In addition to estimating consumer surplus for these activities, the authors also used the nondiscriminating monopolist method, which provided total value estimates for each activity equal to the maximum total revenue that could be collected if the optimum entry fee were charged per trip for every participant household. A nondiscriminating monopolist price was derived from this value, and is offered as a comparison to consumer surplus values, as well as values of the recreation resource, (i.e. hunting land), in alternative uses (i.e. agriculture).

The authors contend that the value added by a particular recreation activity, or consumer surplus, is a more conceptually correct measure of the worth of a particular recreation opportunity, in comparison to nondiscriminating monopolist values and gross expenditures.

Also included in this study is a discussion of the reliability of the value estimates and a comparison of value estimates to gross expenditures for each of the recreation categories. Additionally, according to Martin et al., the inclusion of prices of substitutes in this study, when estimating demand equations, marks the first time "substitute attractions have been included as an integral part of the demand estimation process."

23. **Rosenberger, Randall S. and John B. Loomis. 2001. Benefit Transfer of outdoor recreation use values: A technical document supporting the Forest Service Strategic Plan (2000 revision). Gen. Tech. Rep. RMRS-GTR-72. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 59 p.**

This study is a compilation of the literature on outdoor recreation use valuation studies from 1967 to 1998, in the form of an annotated bibliography. Included are 13 studies concerning waterfowl hunting, with 59 estimates of benefits. The average consumer surplus value per activity day per person, in fourth-quarter, 1996 dollars for waterfowl hunting, as determined by the studies referenced, equaled $31.61, with estimates ranging from $2.16 to $142.82. Estimates were also determined for each recreational activity, including waterfowl hunting, for each of the USDA Forest Service Regions.

24. **Sorg, Cindy F. and Louis J. Nelson. Net Economic Value of Waterfowl Hunting in Idaho. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mt. Forest, and Range Experiment Station. Resource Bulletin, RM-14. August 8, 1982.**

This study examined the results of contingent valuation and travel cost surveys measuring the value of waterfowl hunting in Idaho to both residents and nonresidents.

The price variable for the travel cost method analysis was the reported round-trip distance traveled to each site visited. Additionally, the number of days hunting on the trip, and the number of hours per day were obtained from respondents, in order to convert CVM and TCM per trip values to dollar values per day and to an activity day or the 12-hour Wildlife and Fish User Day. Data for the last trip of the season was obtained using iterative bidding contingent valuation survey questions, with trip cost as the payment vehicle.

The average values estimated by the travel cost application were equal to marginal values in this study, and therefore may be more appropriately applied to project level analysis. Additionally, values for increased opportunities to shoot at waterfowl were elicited – information useful for cost effective management of waterfowl populations. However, nonconsumptive use and nonuse values were not included in this study and the authors note that no assumptions can be made as to the percentage of total waterfowl value captured by the estimates.

25. **U.S. Department of the Interior, Fish and Wildlife Service. May 1986. *North American Waterfowl Management Plan, A Strategy for Cooperation.***

This document speaks of the need for an international approach to managing waterfowl, and cites habitat loss due to "the impacts of agriculture, industry, flood control, navigation and recreational use," (p 9), as the main cause of concern for waterfowl populations. Likewise, preservation of waterfowl habitat is the main focus of the plan. Additionally, the value to not only humans, but also the environment, is cited as a key reason for proper management. Finally, the plan does not prescribe any particular

changes to "fiscal or regulatory processes" for funding or harvesting waterfowl, but is rather a framework for conservation and management. This framework was projected out for a fifteen-year time horizon, with recommendations for reviews and updates every five years.

26. U.S. Department of the Interior, Fish and Wildlife Service. 1994. *North American Waterfowl Management Plan, 1994 Update.*

This document is the first update to the 1986 Plan. It reaffirms the Plan's purpose: "to achieve waterfowl conservation while maintaining or enhancing associated ecological values in harmony with other human needs," (p2), and reviews the progress achieved over the years since the 1986 document was created.

27. Walsh, Richard G., Donn M. Johnson, and John R. McKean. Benefit Transfer of Outdoor Recreation Studies, 1968-1988. *Water Resources Research*, Vol. 28, No. 3, pages 707-713, March 1992.

The U.S. Department of Agriculture Forest Service periodically reviews studies that value recreation activities in Forest Regions, for the Forest Service's resource planning program (RPA). According to Walsh et al, this study serves a similar purpose as work by Sorg and Loomis (1984) and Dwyer et al. (1977), in contributing to the RPA, by gathering a range of benefit estimates for outdoor recreation activities in 1968-1988 literature. Walsh et al. discuss benefits transfer and the problems that accompany this practice, and also focus on identifying variables that account for differences in estimates from one study to another. Benefit estimates of the value of an activity day for numerous recreation categories were presented, including migratory waterfowl hunting. The mean net economic value (consumer surplus) per recreation day was presented, along with the mean, median, standard error of the mean, 95% confidence interval and range of values.

28. Zicus, Michael C., David P. Rave, and John Fieberg. Cost Effectiveness of Single- Vs. Double-Cylinder Over-Water Nest Structures. Minnesota Department of Natural Resources, unpublished research, July 2002.

This study addresses the need for incorporation of economic efficiency in wildlife management operations, and examines the cost effectiveness of duck nesting structures, with data gathered from 1996 through 2003, on 53 single-cylinder and 57 double-cylinder nesting structures. Double-cylinder nesting structures were found to be more cost effective, at $23.12/net recruit, versus $23.25/net recruit for single-cylinder structures. However, the authors note that slight changes in assumptions, such as the calculations for time spent servicing structures, produced different results.