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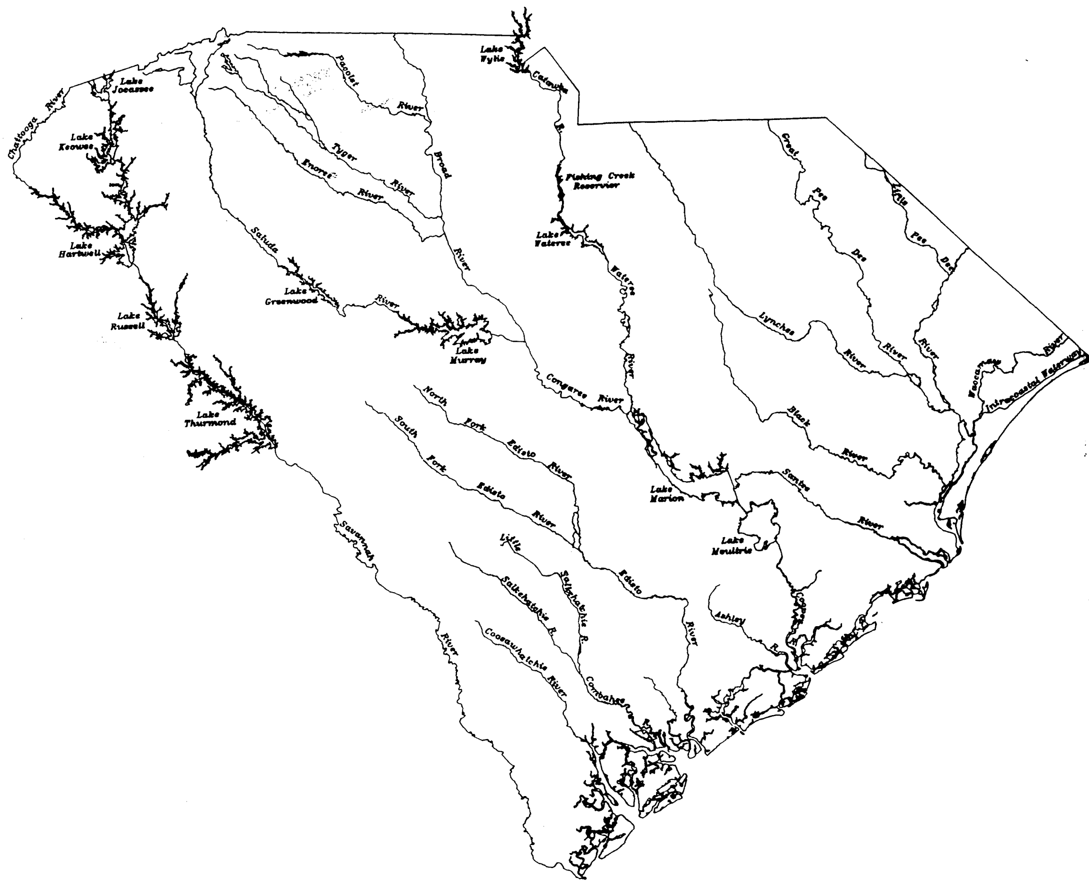

Nonmarket Valuation of Freshwater Wetlands: The Francis Beidler Forest

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NONMARKET VALUATION OF FRESHWATER WETLANDS: THE FRANCIS BEIDLER FOREST

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ABSTRACT

Contingent valuation (CV) methodology was used to estimate the public willingness to pay (WTP) for the purchase of wetlands having different functional characteristics to be added to a South Carolina wetland preserve, the Francis Beidler Forest. The dichotomous choice version of the model was used to elicit the WTP of a statewide sample of 3,600 randomly selected households. Each was presented with a dollar amount and asked if they were willing to pay that amount as a one-time contribution to the Audubon Society to assist in the purchase of 2,500 acres of wetland to be added to the Beidler Forest. Three types of adjacent wetlands which could be purchased were described: (a) frequently flooded bottomland typified by cypress-tupelo swamp; (b) infrequently flooded bottomland hardwood forest; and (c) nonbottomland pine plantation with hardwood runners. The dollar amount requested and the type of wetland were randomly assigned. A 21 percent return of usable questionnaires were received. The different formulations of the statistical model produced mean estimates of household WTP between about \$8 and \$20. Household income and the size of the contribution requested were statistically significant. Also, respondents who were members of environmental organizations were different from others in their WTP and were more interested in preserving the non-bottomland pine plantation type wetlands.

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INTRODUCTION

Public interest in wetlands in South Carolina and in most other areas of the United States is intense. The continuing controversy over revision of the "1989 Wetlands Manual" (Federal Interagency Committee on Wetland Delineation 1989), which may result in substantial changes in the acreages defined as jurisdictional wetlands, has gained the attention of the media and the general public. Although the debate is polarized between environmentalists and those often characterized as landowner/developers, it is clear that policymakers and the public at large have learned a great deal about important wetland functions and activities and about the problems of restricting private property rights in the greater public interest.

This analysis relates directly to the current debate over wetland functions and definition by seeking to ascertain valuations of different wetland types by the general public. The focus is on public willingness to pay for the purchase of wetlands having different functional characteristics to be added to an important South Carolina wetland preserve.

Wetland Functions and Activities

Wetlands are valued by man for the functions they are assumed to produce, including a) flood conveyance and storage, b) sediment control, c) pollution control, d) fish and wildlife habitat, e) recreation, f) surface water supply, and g) interaction with groundwater (Kusler 1983). Wetlands also produce measurable economic benefits to the state. Sales of timber from forested wetlands are estimated to contribute $500 million, and commercial and sport fisheries are estimated to contribute $200 million annually to the economy (Hook 1990). Lists of functions differ slightly among sources, but many, such as educational value and habitat for endangered species, may be thought of as elaborations of the shorter list. The National Wetlands Policy Forum identified 15 functions of wetlands (The Conservation Foundation 1988).

No single wetland is likely to produce all functions, nor does a given wetland perform functions equally over time. Natural ecological succession occurs with the age of the forest and other vegetation on the site, and functions performed vary accordingly. Wetland functions are also related to landform and to the degree of hydrologic connectivity to other wetlands and aquatic systems.

Wetland functions, regardless of their anthropocentric or other intrinsic values, may not be reflected well in the market values of wetlands since they cannot be internalized completely by landowners. In fact, most of the functional values of wetlands may be characterized as joint and nonrival spillovers of benefits to the public at large and, as such, are externalities from the accounting stance of the private landowner. Hence, the land market cannot be relied upon to allocate the resource in an optimal manner.

Wetland activities, on the other hand, are the actions of man within wetlands: filling, drainage, impoundment, discharges, and removal of vegetation. The effects of these activities may vary from temporary impairment to the total destruction of the functions of wetlands. However, they are necessary to make some of the important products of the wetlands available to man; examples are sites for recreation, tree farming, and waste disposal. While such economic activities are commonly used to justify wetland preservation, the activities of man in the wetlands are often thought to be in direct conflict with "ecological values." Wetlands owned or purchased by government or private nonprofit organizations are removed from private ownership and, if set aside as natural wetlands, will derive less of their values from private economic uses and more from public uses such as wildlife habitat and offsite benefits such as water quality improvement and stormwater retention.

South Carolina has a considerable stake in the allocation of wetlands. There are 4.7 million acres of wetlands in the state which cover about 23 percent of the land surface area (Hefner and Brown 1984) compared to only about five percent of the United States as a whole.

While the wetland resource in South Carolina is vast, it has decreased by about 53 percent in the lower 48 states since 1780 (Dahl 1990) and continues to decrease at a rate of about 10,000 acres per year (Dahl and Johnson 1991). Of the remaining wetlands, about 95 percent are classified as freshwater wetlands and most of these are forested wetlands. The resource appears to be relatively undamaged ecologically, although it is threatened by fragmentation, in some cases, and by relatively large annual losses. Forested wetlands are suffering the highest loss rates.

Regulatory mechanisms for coastal wetland use have become well established in South Carolina (South Carolina Coastal Council [a] and [b]). Also, within the last five years, a new, expanded emphasis on wetland control has emerged, focusing on freshwater wetlands, including those outside the Coastal Zone. A report of the National Wetlands Policy Forum proposed a national program to end, and even to reverse, the conversion of wetland to other uses (The Conservation Foundation 1988). Wetlands have been added to the litany of issues of concern to the major environmental organizations and many politicians, many of whom have endorsed the concept of "no net loss." Also, considerable powers exist in the U.S. Army Corps of Engineers (COE) and Environmental Protection Agency (EPA) permitting processes and under the strengthened "swampbuster" provisions of Title XIV (Subtitle B) of the Food, Agriculture, Conservation and Trade Act of 1990 (the 1990 Farm Bill). Legislation for wetland control in South Carolina, although defeated in the General Assembly in 1990, is expected to be reintroduced in some modified form in the near future, since pressure from environmental groups persists, and other states have enacted or are considering such legislation.

Considering the importance of the wetland resource in South Carolina, our understanding of the economic-ecologic linkages is woefully inadequate. Hydrological and ecological information is frequently unavailable for specific wetlands so it is impossible to state with any certainty which wetland functions are being performed or to determine the likely damage from proposed alterations. Even when better information is available and wetlands can be ranked on the basis of potential functions, it is not clear whether society places different values on the different wetland functions. Current federal and state policies apply the same value to all wetlands and try to provide equal protection to all, regardless of size and function. Resources of regulatory agencies are spread too thin to be effective except in the most blatant or obvious cases of destruction. Consequently, as the data of Dahl and Johnson (1991) illustrate, thousands of acres of wetlands are lost each year.

Concepts of Wetland Values and Costs

The purpose of this analysis is to determine the relative values of different types of freshwater wetlands to South Carolina residents. To those who believe that all remaining wetlands should be preserved without regard to quality or functions performed, the concept of relative values may cause some uneasiness. Advocating the preservation of all wetlands implies that all are equally and infinitely valuable, whereas relative valuation places some in positions of lesser importance. If, however, it is conceded that there are choices to be made concerning the affordability, and even relative desirability, of preservation vs. alternative use of at least some South Carolina freshwater wetlands, procedures are needed for relative valuation. Although imperfect, economic value is at least one criterion, and it is often considered a common denominator for many alternative methods of valuation.

Wetland services are economic goods in the sense that they are scarce and are not free of cost. Like most other land resources, however, wetlands are not normal market goods since the benefits and costs of consuming wetland services do not accrue solely to resource owners. Thus, market prices, determined by the interaction of buyers and sellers, often do not reflect the true value of wetlands, and resource owner decisions may not result in their most efficient use. The important issue in the relative valuation of wetlands is whether a specific wetland should be left alone to perform its natural functions, or whether man's activities should be allowed to intrude, and to what extent.

The costs of wetland preservation may be borne by the private sector and/or the public sector. Private costs to individuals and firms may take the form of transactions costs associated with regulatory compliance and/or opportunity costs in cases where land use is controlled by regulation. Opportunity cost is equal to the forgone benefits of any disallowed use. Public costs may result from payments for easements or purchase of wetlands, from enforcement costs, or from opportunity costs. The latter may be incurred in a variety of direct and indirect ways. Since budgets are limited, more funds allocated to wetland preservation must result in lower allocations to other uses. The public allocation process is likely to produce sacrifices of potential park lands, wild and scenic rivers, wilderness areas and all other environmental goods. It cannot be assumed that the tradeoff involves only some on-site farming, forestry or construction alternative.

Study Objectives

In 1989, the South Carolina Water Resources Commission and the South Carolina Water Resources Research Institute (WRRI) determined that the evaluation of available methods for assessing values of freshwater wetlands was a high priority research issue. Subsequently, this project was funded. Its purpose was to review existing economic valuation techniques and develop an economic model for wetland valuation applicable to an important decision making situation and hydrologic conditions in the state.

The objectives of the study were (1) to review the literature on the economics of wetland use, particularly that related to valuation; (2) to formulate research hypotheses related to wetland valuation within South Carolina; and (3) to develop a model for testing the hypotheses.

The results of this research include specific findings relating to the particular hypothesis tests conducted and improved information about the methods available for public valuation of wetland amenities for which established markets do not exist. The primary benefit of the research is the incremental development of valuation methodology to be incorporated later into a full system model of wetland allocation and use. It was not anticipated that this study would result in a "how to" manual for application to all types of wetland valuation.

ECONOMIC VALUATION OF WETLANDS

A procedure to determine the relative values of individual wetlands compared to other market and non-market goods is essential. Models based entirely on biological productivity or ecological importance, such as the Wetland Evaluation Technique (WET) developed for the U.S. Army Corps of Engineers (Adamus et al. 1987) or the Habitat Evaluation Procedures (HEP) developed by the U.S. Fish and Wildlife Service (1976), produce valuable inventory and other information, but they do not deal with the information necessary for the estimation of economic values.

Brief Review of the Economic Valuation of Wetlands

Some of the most important articles on economic valuation of wetlands appeared in the late 1970s in response to an attempt by biological scientists to value wetlands by placing a dollar value on the amount of energy they are capable of producing (Gosselink, Odum and Pope 1974; Pope and Gosselink 1973). The life support value of an acre of marshland was computed at nearly $82,000. This monetary value of the work of nature was computed using a methodology developed by Odum (1971; 1976). The calculation proceeded by multiplying the estimated calories of energy resulting from primary production of an acre of representative marsh by a dollar value per calorie. The dollar value was obtained by dividing the gross national product (GNP) by a national energy consumption index to calculate the average GNP produced per unit of energy use in the United States.

The energy method of evaluating wetlands has been rejected as being based on poor understanding of economic phenomena and practice of economic methods (Shabman and Batie 1978, 1980). When the same energy value methodology was applied to hay land in Virginia, a per acre value of $6,960 was computed, considerably higher than the $556 per acre average value for farmland, including buildings, in Virginia in the early 1970s. Similarly, the present value of an acre of forest land was computed by the energy value method at $207,200 (Shabman and Batie 1978). Shabman and Batie state that "...the level of GNP will be a function of the relative money prices of goods--prices that bear only a partial and inconsistent relationship to the energy content of the goods being traded" (1978, 235). They assert, correctly, that "...prices are determined by people's preferences and values and not by the energy content or energy cost of goods, as is implied by the energy based valuation procedure" (1980, 3).

The search to find connections between biological productivity and economic value continues. A considerable body of literature has developed over the past two decades that is, in a variety of ways, oriented toward wetlands assessment or valuation. A study of that literature reveals few analyses that can be considered to be good applications of economic principles and methods. Two literature reviews have been published recently which give fairly complete coverage of published research dealing with the assessment or economic valuation of wetlands. Extensive coverage is given by Leitch and Ekstrom (1989), who produced 561 citations, not all of which deal with economic valuation and some of which appear in multiple citings in the six sections of their review. The section entitled "Economic Valuation" includes 204 citations.

A more critical review of the research on economic valuation was done by Shabman and Batie (1988) for the U.S. Army Corps of Engineers. They searched 12 computerized data bases and reviewed 1,232 works published between 1970 and 1985. Their reviews were based upon evaluation criteria for evaluating which publications presented estimates of economic value, socioeconomic value, and human use value of altered and unaltered (natural) wetlands and which employed conceptually valid approaches to valuation. They found fewer than 20 articles which met their criteria. They found even these to be less than satisfactory and concluded generally that "...gaps in understanding the hydrologic and ecologic functioning of specific wetlands coupled with an inadequate value data base result in valuation estimates that may have a large margin of error" (Shabman and Batie 1988, 51).

Elsewhere, the same researchers proposed the use of "shadow values" for placing values on unaltered wetlands, on wetlands as development sites, or for intermediate wetland uses (Batie and Shabman 1982). Shadow values are "... based upon the demand and supply curves which would have been revealed by people buying and selling the resource and its services in a market, if such market were able to function under theoretically ideal conditions" (Batie and Shabman 1982, 259). The principal methods for determining shadow values are the standard valuation tools of environmental economics: (1) the use of market prices for those wetland joint products that produce measurable market prices, such as fishery products; (2) travel costs that people are demonstrably willing to incur to reach the wetland; (3) contingent valuation (willingness to pay to retain the services of the resource); and (4) land price analysis.

Using one or more of the tools for computing shadow values, a number of researchers have attempted to impute values to altered and unaltered wetlands, or conversely, to measure the opportunity costs society incurs in maintaining natural wetlands in the face of alternative economic uses. A few of these are discussed to illustrate the potential value of partial economic analysis in the absence of the ideal quantification of all of the biological values of wetlands.

Abdalla and Libby (1982) used a benefit-cost procedure to assess waterfront residential development in Michigan wetlands. The benefits of development were compared to the costs of lost water quality enhancement. In three cases they were unable to find substitute sites for altered wetland parcels, thus value was based on parcel sale prices. Alternative sites were available at one site, and here opportunity cost was used for valuation.

Bell (1989) studied the value of estuarine wetlands to marine fisheries in Florida. Estuarine wetlands are an example of joint production with unclear property rights and spillovers of benefits. This situation produces a market failure and an incentive to convert wetlands to uses consistent with organized markets such as residential development and agricultural use. The author used the marginal productivity theory of wetland valuation to discover the incremental contribution of estuarine wetlands to the marine fishery catch. He found that the capitalized values, at retail, of commercial and recreational fisheries are high enough to justify public wetland acquisition and protection. He regards his results as providing a reference point only because of the high variability of wetland value estimates and the nature of state land purchase data available.

Palmquist and Danielson (1989) studied several important aspects of the costs and returns of clearing and drainage of pocosin wetlands in coastal North Carolina. Using production budgets for selected commodities grown on coastal blacklands, the researchers measured the importance of critical economic and institutional factors that affect the profitability of wetland drainage. The importance of the various factors were determined using a hedonic pricing equation. Important factors are income tax laws, agricultural income, and commodity price support programs. Also critical to profitability are the costs of clearing and drainage, crop yields, commodity prices, the amount of timber on the land before clearing, and the value of hunting rights. Generally, the depressed agricultural prices of the 1980s have made clearing and drainage a marginal activity, but the authors concluded that the rate of return is sensitive to a number of economic and institutional factors.

Dunford, Marti and Mittelhammer (1985) assessed the marginal value of converting wetlands on the eastern shore of Virginia to recreational home lots. The marginal net returns to development are the opportunity costs of wetlands preservation. When no alternative sites were available, the opportunity costs were relatively stable around $43,000 per acre; when alternative sites were available, the figure dropped to an average of $4,790 per acre.

Two similar studies of the pressure for residential home development and water access (marinas) for the more rural areas of Virginia have been reported (Shabman, Batie and Mabbs-Zeno 1979). Again, hedonic pricing models were employed to measure the contribution of a set of land parcel characteristics, including measures of water access and waterfront location created from filled wetlands. Here, it was shown that opportunity costs varied considerably depending upon the physical and institutional constraints assumed. For a small land parcel, and with no alternative non-wetland parcel available, a value of $5,800 per acre was computed, whereas larger acreages with many alternatives produced only negligible opportunity costs.

Bergstrom et al. (1989) measured the outdoor recreational value of Louisiana wetlands using what they refer to as a "total economic value framework." This framework employs both the contingent value and the travel cost methods mentioned earlier. Aggregate consumer surplus was estimated at approximately $27 million annually, and aggregate financial value was estimated at approximately $118 million annually.

A search of several computerized databases revealed only a few listings of research in progress, and some of these had completion dates which had already expired. Two concurrent studies of wetland valuation using the contingent valuation technique were similar to the South Carolina analysis. An analysis conducted by Christopher L. Lant, at Southern Illinois University, "Methodological Development for Spatial and Economic Evaluation of Illinois Wetland Functions," focused on the public willingness to pay for several levels of wildlife habitat and water quality improvement functions. Lant plans to apply his results to a large-scale model of the wetlands of Illinois. A second closely related analysis (Whitehead 1990) employed the contingent valuation method to estimate the economic benefits of protecting the Clear Creek wetland, in Kentucky, from surface coal mining. Results indicated that households of the state were willing to pay between $6 and $13, in the form of voluntary contributions, to a hypothetical "wetland preservation fund."

Two other concurrent studies dealing with wetlands and employing the contingent valuation technique were less directly related to our analysis. A University of Florida study conducted by J. Walter Milon employed contingent valuation to determine the public willingness to pay for various levels of water quality in oyster producing areas. John Loomis at the University of California, Davis, used the contingent valuation technique to evaluate two different wildlife programs in California. He demonstrated that benefits of reducing agricultural drainage contamination and improving wildlife management in the San Joaquin Valley would be over estimated if independent benefit estimates are simply summed. A more correct holistic valuation approach was demonstrated whereby respondents valued packages of programs.

The Contingent Valuation Model

The contingent valuation (CV) technique is a method for placing values on goods and services that are not traded in normal markets. The method involves constructing an artificial or hypothetical market for a nonmarket commodity and is designed to elicit responses from a target group similar to the responses that would be forthcoming if a market for the good actually existed. Members of the contingent market are questioned using proven methods and survey instruments in a personal interview, telephone survey, or mail survey, or some combination. Prescribed survey techniques are followed to avoid known types of biases (Dillman 1978). Interviewees are asked to make valuation decisions concerning willingness to pay (WTP) or willingness to accept compensation (WTA) under certain realistic and believable conditions. Their responses are considered to represent actual valuations contingent upon the circumstances posited in the artificial market actually occurring (Brookshire, Randall, and Stoll 1980; Cummings, Brookshire, and Schulze 1986; Seller, Stoll, and Chavas 1985; Mitchell and Carson 1989).

The CV method has been improved upon by more than 20 years of research and has produced reasonable estimates for a variety of environmental and public goods. Convergent validity studies suggest that properly conducted CV studies generate valuations which are quite consistent with those produced by the travel cost method (TCM), hedonic pricing equations, and laboratory-type experiments involving actual money exchange. Detailed discussions of the advantages and disadvantages of the CV method are provided in a number of references (Brookshire and Coursey 1987; Brookshire and Crocker 1981; Brookshire, Randall, and Stoll 1980; Cummings, Brookshire, and Schulze 1986; Hoehn and Randall 1983; Mitchell and Carson 1989; Schulze, d'Arge, and Brookshire 1980; Seller, Stoll, and Chavas 1985).

Contingent valuation is superior to the other valuation methods for this analysis because of the nature of the resource being measured. Wetlands may attract some visitors who view wildlife, enjoy scenic beauty and experience other direct use values for which they presumably could be charged, but many people value wetlands primarily for their indirect use values: the environmental services (functions) wetlands are presumed to provide. Perhaps more importantly, wetlands are valued for their nonuse values.[1] The travel cost method (TCM) is more applicable to situations in which large numbers of visits are made to a site or area, e.g., to a well known destination area such as the Grand Canyon, or to areas with especially favorable hunting or fishing. The hedonic pricing model and other similar land value methods rely upon large numbers of land transactions between a variety of buyers and sellers, not all of whom are valuing the same attributes, to isolate and measure the value of the natural resource attribute of primary interest.

Partial values of wetlands may be computed by estimating the costs of providing specific services of wetlands by alternative means. Examples are the cost of structural flood control measures and waste treatment facilities necessary to replace wetland functions, should they be lost. Such shadow pricing methods may be used in lieu of, or in addition to, CV analysis in total value analysis and are under consideration for future modeling of South Carolina wetland values. In a recent important publication of the Environmental Law Institute, it is argued that economists must take a "second-best" approach to wetlands valuation, given the current unavailability of completely specified models. "This involves identifying as many of the goods and services associated with a particular wetland ecosystem as available information allows and applying economic techniques to the value of their <u>current</u> uses"

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[1]Nonuse values include option value, existence value, and bequest value. Option value is the value one receives from knowing that the environmental good is there in sufficient quantity and quality should he ever choose to make use of it. Existence value is derived from the knowledge that the good exists even though one never expects to derive use value from it. Bequest value is the value that one receives from the knowledge that the good will be available for future generations.

(Scodari 1990).

Model Specification

As CV has risen to the forefront among nonmarket valuation techniques, the statistical algorithm used and the format of questions employed in CV studies have taken on increasing importance. The questioning format in earlier studies employed some type of bidding game in which respondents were asked, often in a personal interview, whether or not they would pay or accept some specified sum. The question was then repeated using a higher or lower amount, depending on the initial response (Davis 1963, 1964). Because of the high cost of obtaining bids by personal interview, an open ended questioning format in which interviewees are asked to choose their own WTP or WTA was adopted in some studies (Horvath 1974). Both methods were subject to potential problems of "hypothetical bias;" i.e., interviewees might not be impelled to reveal their true WTP if the contingent market contains elements of unreality. To control hypothetical bias and still imitate important aspects of the bidding game, the "payment card," from which the respondent is supposed to select his true bid level, was introduced (Mitchell and Carson 1981). However, Boyle, Bishop, and Welsh (1985) concluded that results from any form of sequential bidding experiment can be biased by the "starting point" (the initial amount quoted).

Starting point bias and, to some extent at least, hypothetical bias are dealt with by using a dichotomous choice (DC) question format, alternatively referred to as discrete choice, closed ended, or referendum format (Bishop and Heberlein 1979). The DC format simulates a scenario most similar to that encountered by consumers in their usual market transactions, which may well explain its growing popularity. In this procedure, a hypothetical price is stated and the respondent merely decides whether to "take it or leave it," thereby eliminating the need for him to come up with a specific dollar value for his threshold WTP. The resulting YES/NO responses are then related to the prices offered using either a logit or probit model. The logit and probit models are utilized to predict the probability of acceptance as a function of the offer amount and other explanatory variables. The probabilities are then used to calculate a mean WTP. The DC format provides a low cost method because it lends itself to mail surveys, and it has proven to be successful in eliciting participation.

Hanemann (1984) demonstrated how the dichotomous choice contingent valuation (DCCV) method of preference revelation could be integrated into economic theory by using the random utility maximization model. Hanemann recognized the utility-maximizing choice associated with the response of the individual to the experiment. The household derives some level of benefit, or utility, from its income and from the available wetland resource depending on its specific preference set.

$$U = U(Y, Q| C) \qquad (1)$$

where U(*) represents the household utility function, Y is household income, Q is the quantity of protected wetland resource and C is a given vector of household characteristics which is assumed to affect preferences. Presented with an opportunity to increase the quantity of protected wetland from Q to Q′, the household may agree to a decrease in income (Y) equal to its WTP, and presumably, total utility remains unchanged.

$$U(Y-WTP, Q'| C) = U(Y, Q| C) \qquad (2)$$

where WTP is the household willingness to pay, Q is the quantity of preserved wetland before the purchase and Q′ is the larger quantity of wetland after the purchase. In this analysis, the difference between Q′ and Q represents the 2,500 acres of wetland described in the contingent market. WTP is considered to be the respondent's true maximum willingness to pay for the increase in the resource and includes all use and nonuse values.

When presented with a randomly assigned offer amount, A_i, which the household presumes is sufficient to help preserve the wetland, it will be compared with the true WTP of the household. If A_i is less than WTP, the household will achieve a higher utility level by answering YES.

$$U(Y-A_i, Q'| C) > U(Y, Q| C) \qquad (3)$$

If the inequality in equation (3) does not hold, the household will respond NO. If A_i is equal to WTP, the household will be indifferent. Stated in another way, the probability of a YES response, P(YES), is the probability that WTP is greater than or equal to the offer amount, A_i.

$$P(YES) = P[WTP - A_i \geq 0] \qquad (4)$$

Early empirical analyses of DCCV data include those of Bishop, Heberlein, and Kealy (1983), Bishop and Boyle (1985), Boyle and Bishop (1984), and Sellar, Stoll, and Chavas (1985, 1986). In each application, these researchers opt for a logit rather than a probit specification; this choice is a mere computational expediency since both techniques provide similar outcomes. The offer amount, A_i, is used as an explanatory variable. The cumulative probabilities are then used to estimate the "expected value" of the resource in question. Intuitively, the process is equivalent to computing estimated willingness to pay as

$$E(WTP) = \sum_i A_i P(YES)_i \qquad (5)$$

where A_i is the ith amount offered to respondents, and $P(YES)_i$ is the probability that respondents will answer YES to the bid amount A_i. The difficulty is that only a limited number of discrete values of A_i are included between 0 and A_{max}. Following the procedure of Sellar, Stoll, and Chavas (1985, 1986), the solution is to leave the probabilities in the form of a fitted algebraic expression and integrate over a continuum of values from 0 to A_{max}.

$$E(WTP) = \int_0^{A_{max}} A_i P(YES)_i dA_i \qquad (6)$$

In other model formulations, additional explanatory variables are included which, in some cases, improve the fit of the probabilities. But, at the same time, the inclusion of other variables render difficult the retrieval of estimated regression coefficients with associated standard errors which allow for some form of statistical inference about the estimates (Cameron and James 1987). The studies cited also rely on specific, arbitrary functional forms applied in a logit or probit framework.

The value of a specific wetland is dependent upon the characteristics of the users as well as upon the characteristics of the site. Therefore, it is essential to know the marginal contributions to WTP of the household characteristics as well as the attributes associated with the nonmarket resource itself. Availability of these parameters allows estimates of the changes in aggregate social value of the resource that result from changes in either population characteristics or in the resource.

Maximum likelihood procedures offer a way to utilize referendum data to estimate marginal contributions of respondent characteristics (Cameron and James 1987). Earlier interpretations of YES/NO answers to threshold value questions are inappropriate for a referendum scenario (Hanemann 1984; Seller, Stoll, and Chavas 1986). Although referendum data consist of YES/NO responses rather than a continuum of numerical WTP responses, the threshold values, or offer amounts, to which the interviewee responds, and the characteristics of the respondent, are observable. This association of dependent and independent variables distinguishes WTP referenda from other studies with no varying threshold values, e.g., "choices" of commuters between bus and car as a mode of transportation. The maximum likelihood technique proposed by Cameron and James (1987) is intended to maintain distributional hypotheses consistent with those underlying ordinary least squares (OLS), i.e., that the population error terms have the familiar normal density function. Earlier studies, however, employed conventional maximum likelihood logit models rather than the normality assumption. The models in these studies produced direct estimates of the probabilities for the YES/NO response to the offered amount, but they did not provide the wherewithal to approximate demand functions and, from thence, consumer surplus.

The assumption of normality presents a problem only from the standpoint of ease of calculation. The cumulative density for the normal distribution is not closed and therefore must be computed numerically using an iterative maximum likelihood optimization procedure. For logit models, the cumulative density for the standard logistic distribution has a closed form. Its value is simply a ratio of exponentiated quantities which can be computed rather quickly. The logistic distribution is considered acceptable since it closely approximates the normal distribution and is numerically simpler (Judge et al. 1980, 591; Capps and Kramer 1985; Pindyck and Rubinfeld 1976, 248).

McConnell (1990) compares the deterministic models suggested by Hanemann (1984) and Cameron (1988), showing them to be dual to each other. The original Hanemann model measures the difference in indirect utility functions while the Cameron response model, dual to the Hanemann model, measures the difference in cost functions. Whichever method is employed, referendum data have contributed to the acceptance of contingent valuation methods into mainstream economics. Models of preferences are normally required; that is, utility functions or cost functions ideally are specified and estimated. The choice between the methodologies of Hanemann and Cameron is as much a matter of style and convenience as it is one of known defects or merits.

THE ANALYSIS

The analysis deals with the relative valuation of wetlands of differing functional types. A dichotomous choice contingent valuation (DCCV) model of the type just described is applied to original survey data from South Carolina to test specific hypotheses relating to wetland type and household characteristics.

Study Area

The study area is the Francis Beidler Forest, a 6,000 acre freshwater wetland preserve, near Harleyville in southeastern South Carolina, owned and managed by the National Audubon Society. The Francis Beidler Forest, often identified as the Four Holes Swamp, is a wetland that is familiar to many South Carolinians. It is a part of a larger wetland area typical of the South Carolina Coastal Plain. In order to determine how society values wetlands with different outward characteristics, three distinct types of freshwater wetlands, of approximately 2,500 acres each, adjacent to the Francis Beidler Forest, were selected for consideration. The three wetland types were selected because they are adjacent to the Francis Beidler Forest and to each other, and because they are representative of Coastal Plains freshwater wetland types, from the most easily drained to the most persistently flooded. In addition, the Audubon Society is considering expanding the resources of the forest, and this assessment will assist them in making a decision about which type of wetlands to include in their expansion.

An important element in the selection of a study area for testing the applicability of this WTP methodology was that the three wetland types were distinctly different in outward characteristics and potential ecological functions, and they could be described pictorially and ecologically. Since their ecological nature and functions could be represented with relative ease, individuals not familiar with the many functional types of wetlands could understand their basic differences. The ability to present the three wetlands in a simple way was expected to allow evaluation of individual WTP based primarily on ecological traits without attempting to describe all of the intricacies of the wetlands definition debate.

Research Hypotheses

The principal findings of the study are based on the tests of null hypotheses relating to differences in WTP based on types of wetlands and on household characteristics. All survey materials and procedures and data management were designed to allow these null hypotheses to be tested statistically. The second hypothesis stated is actually a collection of hypotheses to be tested separately.

Ho_1: Household WTP to purchase additional acreage of freshwater wetlands does not differ with regard to the outward characteristics and potential ecological nature and functions of the wetlands.

Ho_2: Household WTP to purchase additional acreage of freshwater wetlands does not differ with regard to the characteristics of the household.

Alternate hypotheses, based on economic theory and literature relating to preferences, were that WTP does vary with the type of wetland and with household characteristics. The average citizen was expected to discriminate between wetlands with different outward characteristics based on wetness and to express a willingness to pay more for those that are clearly wetlands (swamps). Age and sex of the household head were not expected to be highly important variables, but they are usually included in studies of this kind, and the possibility of higher WTP by males and older citizens was considered. Years of education of the household head was expected to produce higher WTP and a greater tendency to discriminate between wetland types, based on a supposed higher level of awareness of the beneficial functions performed by wetlands. Environmental group membership was expected to increase WTP and to produce interesting evidence of discrimination between types of wetlands. Similarly, a willingness to donate a part of one's South Carolina income tax refund to wildlife conservation was expected to indicate a predisposition to contribute to environmental causes generally. Household income was expected to be a strong positive indicator of WTP and possibly a proxy variable for environmental membership, age, sex and education. Geographic region of the state and distance from Francis Beidler Forest were expected to be negatively related with WTP because of supposed greater familiarity with, and interest in, the forest by those who live closer to it and/or who live in the Coastal plain. The latter were thought to be more likely to expect to visit the forest and to have a greater appreciation for the types of terrain and ecology described.

Statistical Model

It has been noted in equation (4) that the probability of a YES response to the willingness to pay question is determined by whether or not the maximum WTP for the individual is greater than or equal to the offer amount he is presented, A_i. For empirical application, the functional representation of equation (4) is replaced by a discrete choice econometric model. The model is a standard binary logit equation of the form

$$P(YES) = 1/[1 + e^{-dV}] \tag{7}$$

where dV is the specified functional form (Amemiya 1981). The following linear specification of the functional form for dV is consistent with economic theory and the hypotheses to be tested:

$$\begin{aligned} dV = {} & \alpha_o + \beta_1 OFFER + \alpha_1 AGE + \alpha_2 MALE + \alpha_3 EDU2 + \alpha_4 EDU3 + \\ & \alpha_5 EDU4 + \alpha_6 TAX + \alpha_7 ENVIR + \alpha_8 INC2 + \alpha_9 INC3 + \\ & \alpha_{10} INC4 + \alpha_{11} INC5 + \alpha_{12} INC6 + \alpha_{13} INC7 + \alpha_{14} INC8 + \\ & \alpha_{15} WETB + \alpha_{16} WETC + \alpha_{17} DIST + \alpha_{18} SAND + \alpha_{19} PIED \end{aligned} \tag{8}$$

where

OFFER = the amount (A_i) the respondent is asked tO contribute;

AGE = the age of the head of household;

MALE = the sex of the head of household (1=Male, 0=Female);

EDU2 = high school education (1=Yes, 0=No);

EDU3 = college education (1=Yes, 0=No);

EDU4 = graduate/professional education (1=Yes, 0=No);

TAX = the household contributed to the SC Wildlife Fund on state income tax form (1=Yes, 0=No);

ENVIR = the household belongs to, or contributes to one of the listed organizations (1=Yes, 0=No);

INC2 = household income from $10,000 to $19,999 (1=Yes, 0=No);

INC3 = household income from $20,000 to $29,999 (1=Yes, 0=No);

INC4 = household income from $30,000 to $39,999 (1=Yes, 0=No);

INC5 = household income from $40,000 to $49,999 (1=Yes, 0=No);

INC6 = household income from $50,000 to $59,999 (1=Yes, 0=No);

INC7 = household income from $60,000 to $99,999 (1=Yes, 0=No);

INC8 = household income $100,000 or more (1=Yes, 0=No);

WETB = wetland "B" -- infrequently flooded bottomland hardwood forest (1=Yes, 0=No);

WETC = wetland "C" -- nonbottomland pine plantation with scattered hardwood runners (1=Yes, 0=No);

DIST = the distance of the zip code area from Francis Beidler Forest in discrete categories (1=Yes, 0=No);

SAND = household located in Sandhills region (1=Yes, 0=No);

PIED = household located in Piedmont region (1=Yes, 0=No).[2]

A discrete choice econometric model, such as logit, allows for the empirical implementation of equation (7)(Amemiya 1981). The logit model may be applied in either a linear or logarithmic form; however, since the range for the logit model error distribution can go from $-\infty$ to $+\infty$, the linear intercept may be negative and therefore result in a negative value for the estimated WTP. This negative intercept problem was encountered when the linear logit

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[2]EDU1 (household head with less than high school education), INC1 (household income less than $10,000), WETA (frequently flooded bottomland typified by cypress-tupelo swamp) and COAST (household located in the Coastal Plains region are the base variables against which other levels of education, income, wetlands and regions are measured; thus, they do not appear in the model.

was applied to our data, in spite of the fact that the offer amounts, A_i, were all positive. Thus, it was necessary to exclude the linear function from any further consideration. Using the natural log of A_i, the offer amount, the resulting error distribution is restricted to only positive values and a positive estimated WTP was ensured. A logit model utilizing the log of the offer amount results in the following logistic error equation

$$P(YES)=1/(1+e^{-(\alpha_0+\sum_{j=1}^{n}\alpha_j C_j+\beta_1 \ln A_i)}) \qquad (9)$$

where α_0, α_j, and β_1 are estimated coefficients and C_j is the vector of j = 1,...,n household characteristics that might affect the probability of a yes response.

Estimates of both the mean and median WTP can be calculated from the estimated logit coefficients generated in equation (9). Empirically, the median value of WTP is represented by the point on the logit curve where the probability of a YES response is equal to 0.5. This is the point where A_i is equal to the WTP and the household is indifferent between paying to protect the quantity of wetland specified and simply maintaining the same amount of income to be used for all other goods. The probability of a YES response is equal to 0.5 when WTP-OFFER, or

$$(\alpha_0+\sum_{j=1}^{n}\alpha_j C_j+\beta_1 \ln A_i)=0. \qquad (10)$$

The solution of this expression for the offer amount, A_i, that leads to indifference is a theoretically valid estimate of willingness to pay (Hanemann 1984; Cameron 1988). The estimate for WTP is then equal to

$$E(WTP)=e^{\frac{\alpha}{\beta}}. \qquad (11)$$

The mean value of WTP is represented by the area under the logit curve as specified by equation (9). The area under the logit curve can be found by integrating the logit equation from 0 to A_{max} as shown in equation (12). A_{max} represents the maximum offer amount used in the survey.

$$E(WTP)=\int_0^{A_{max}}\frac{1}{e^{(\alpha+\beta_1 \ln A_i)}},\ \text{where} \qquad (12)$$
$$\alpha=\alpha_0+\sum_{j=1}^{n}\alpha_j C_j$$

Survey Procedures

A mail survey of South Carolina households was conducted during the spring of 1992. A total of 3,600 questionnaires were mailed to a stratified random sample of households throughout the state. The survey methodology was designed carefully following the "Total Design Method," developed by Don A. Dillman (1978), which has been long recognized as the best strategy for maximizing participation in mail surveys. The first mailing included a cover letter (Appendix A), one of the three questionnaires (Appendix B), and a postage paid return envelope. Seven days later, a reminder postcard (Appendix A) was sent to all sample households, thanking those who had returned the questionnaire and encouraging those who had not. Three weeks later, a second questionnaire was mailed to those who had not returned the first with a more emphatic cover letter (Appendix A). A new questionnaire was sent to sample households for which any mailing was returned by the post office and for which a forwarding address was provided.

The list of sample households was purchased from a commercial mailing list firm. This purchased survey sample was selected in lieu of one generated from telephone directories, tax rolls, voting lists, or other specialized lists that are often used. The mailing list included at least the households available from telephone directory listings guaranteeing that a greater percentage of the general population was represented. The total cost of the purchased sample was less than any that could have been generated and had the advantage of being provided on mailing labels.

The questionnaire itself was relatively short so that it would not intimidate anyone. It was designed to present a professional appearance without being expensive or ostentatious. It was printed on recycled paper and so labeled. Line drawings were used instead of photographs so that no more, or less, was communicated visually than was intended. Brief, easy to read descriptions of the specific type of wetland being evaluated and a checklist of expected functions of that type of wetland were given. Clemson University was prominently identified to take advantage of our presumed favorable image compared with "government" and other institutional entities that might be associated with environmental causes or with mail questionnaires.

The questionnaire was designed to elicit a one-time willingness to pay into a private fund managed by the Audubon Society. The fund was described as being expressly designed to purchase 2,500 acres of one specific type of wetland to be added to the Francis Beidler Forest. Three distinctly different forested wetland types were described in the cover letter (Appendix A) as follows.

> They occur either in floodplains of major and minor streams or in the large areas in between. The lowest areas of the floodplain are typically wet 100 % of the growing season and are generally cypress and tupelo swamps. The higher

areas in the floodplain are mixed bottomland hardwoods and are wet 12 to 75 % of the growing season. Oaks, hickories, gums, and ash typically occupy these sites. Between the floodplains we find large areas with poor drainage where the water from rain accumulates faster than it can drain away. These sites are naturally occupied by mixed hardwoods and pine species and are wet for only brief periods during a normal rainfall year. These three forested wetlands each have unique characteristics and degrees of wetness.

Each respondent was presented with a single offer amount for only one of the three types of wetland (Appendix B). These three types of wetlands are referred to, henceforth, as wetlands A, B and C, from wettest to driest. The sample households were divided equally, by a random process, among the three types of wetlands. The questionnaire gave a limited amount of additional information about that one specific wetland and a checklist of specific functions it is presumed to perform. Each of these three groups were further divided randomly into equal numbers to receive questionnaires presenting the different offer amounts. The respondent was asked, "Would you be willing to contribute A_i to a private Wetland Preservation Fund to purchase 2,500 acres of the previously described wetland to be added to the Francis Beidler Forest?" The offer amount, A_i, for each participant was randomly generated from a uniform distribution of bids between $0 and $200. The specific offer amounts used were A_i = 5, 10, 15, 20, 25, 50, 75, 100, 150, and 200. The dependent variable was assigned a value of 1 if the response to the question was YES and 0 if the response was NO. The probability of a YES was expected to decrease as the value for A_i was increased.

In addition to the offer amount, certain demographic and other household characteristics (C_j) were also hypothesized to impact the probability of a YES response. Age, education, and sex of the household head and household income were requested, and respondents were asked if they contributed to the South Carolina Wildlife Fund on their income tax return. They were asked to circle any of a list of environmental organizations with which they were associated, or to write any other in a blank provided, and to note their annual donation to such organizations. Distance from Francis Beidler Forest was measured from the midpoint of the zip code area in which the respondent address was located.

Survey Results

A total of 627 questionnaires were returned, after all of the prescribed mailings, for an overall response rate of 21 percent of the 2,980 presumed delivered. A total of 620 questionnaires were returned as undeliverable. A wide range of response rates to mail questionnaires have been experienced by other researchers (Mitchell and Carson 1989). A lower than average response rate was anticipated since the sample was drawn from the general population rather than from a targeted group. The general population is expected to contain a large percentage of persons who are illiterate, uninterested, or for other reasons, generally unresponsive to mail surveys. Other surveys have generated larger response rates by sampling special interest groups such as hunters, campers or fisherman, or by offering incentives such as free water sample testing.

Numbers, or percentages, of total respondents and respondents to each of the three wetland questionnaires having particular characteristics are presented in Table 1. The proportions are remarkably consistent among wetlands A, B and C, and it is asserted that this consistency allows all of the planned hypothesis tests, the somewhat modest return rate notwithstanding.

Wetland Valuation Results

A simple, first approximation of valuation results can be computed as a mean (arithmetic average) of the survey responses. This simple mean depends only on the level of the offer amount and the YES or NO response, ignoring for the time being the effects of respondent characteristics. It is computed by summing the offer amounts for which a YES response was received and dividing by the total number of responses. This procedure counts all NO responses as zero WTP, thus reducing the mean. The mean amount computed in this way represents a minimum WTP for two important reasons. First, some of those who responded YES to the offer amount with which they were confronted, in fact, may have been willing to pay more. Since the offer amounts, A_i, were randomly generated, this is almost certainly the case. Likewise, some of the NO responses were only indications that the offer amount was too high and, had the respondent been faced with a smaller A_i, a positive response may have resulted. It is not necessary to rely upon intuition alone in this matter. Each respondent was asked to write in a maximum WTP if a YES response or a NO response was given and to explain if the answer were still zero. While the responses to these open ended questions were not of a type or in sufficient numbers to produce useful analytical information, it was clear that the offer amount was often out of line with the true WTP. Recall that the procedure of asking for a dichotomous (YES or NO) response to a single randomly generated offer amount is a commonly used compromise to avoid "starting point," "range," and other biases associated with payment cards.

The simple mean WTP estimates are shown in Table 2 for all responses and for wetlands A, B and C separately. Also shown are the maximum offers that elicited affirmative responses for each wetland and an assumed zero bid as a minimum WTP. The means computed in this way can be used as lower bound estimates to check the reasonableness of WTP estimates from the statistical model to be presented later. They are indeed low, only a little above the smallest offer amount, $5.

TABLE 1. Summary of Characteristics of Respondents in the Survey

Characteristic	Total	Wetland A	Wetland B	Wetland C
Age (mean)	48	49	48	47
Sex (percent)				
Male	78	74	81	78
Female	22	26	19	22
Education (percent)				
Elementary	2	2	3	2
High School	37	37	36	38
College	39	38	39	39
Graduate/ Professional	22	23	22	21
Contribute to SCWF (percent)	32	34	30	32
Environmental group member (percent)	23	23	22	23
Income (percent)				
< $10,000	11	13	11	12
$10,000 - $19,999	16	16	16	16
$20,000 - $29,999	18	14	18	20
$30,000 - $39,999	16	17	11	18
$40,000 - $49,999	13	14	15	8
$50,000 - $59,999	10	7	15	9
$60,000 - $99,999	11	14	11	9
> $100,000	5	5	3	8
Mean distance to wetland (miles)	108	108	109	108
Sample Size	505	170	155	180

Table 2. Simple Means and Ranges of Offers, by Wetland Type

Sample	N	Mean	Minimum	Maximum
Total	505	$6.64	$0	$200
Wetland A	170	6.03	0	150
Wetland B	155	6.90	0	200
Wetland C	180	7.00	0	200

Clearly, the estimate representing the lower bound is not the best estimate. Using a technique advanced by Kristrom (1990), the likelihood can be considered that some of the NO respondents might well have responded YES to a lower offer amount and those who responded YES might have responded affirmatively to an even higher offer amount. By this method, the probability of a YES response to an offer, P(YES), is calculated as the proportion of YES responses of the total number of responses at each bid level. Utilizing the probabilities at specific offer levels, the average probability of a YES response over a given range of offers can be calculated. The mean WTP over each range of offers can be calculated and summed to calculate a mean WTP for the entire sample. Values below $5 and above $200 are extrapolations for computational convenience. An example of these calculations for the total sample of respondents is presented in Table 3.

Computing similar WTP estimates for each of the three different types of wetlands separately permits a comparison of the levels of mean WTP estimates derived by the computations in Table 3 with the lower bound estimates computed initially in Table 2. These values are reproduced in Table 4 along with the estimated medians which are found by calculating the dollar amount at which half of the respondents would answer YES and half would answer NO, for each wetland type and for the total. These are the offer values at which P(YES) equals 0.5. The fact that the medians are much smaller than the means indicates a skewed distribution of responses. This skewness was not unexpected, as a small number of people will usually be willing to make rather large contributions. These few large WTPs can be expected to raise the mean above the WTP of the median respondent.

Also note that this procedure, like the initial lower bound estimate, produces a simple estimate of WTP, uncomplicated by characteristics of respondents, C_j. Consideration of the effects of these respondent characteristics on WTP requires the use of multivariate statistical analysis, and the added complication of selecting specific functional forms of the equations which relate the bid levels and respondent characteristics to the probability of a YES response. Statistical estimation procedures also allow testing among the WTP estimates for the different types of wetlands.

The full multivariate analysis of WTP was developed in equations (7) through (12). The logarithmic application of the logit equation was selected in order to assure that all estimates of WTP would fall in the positive range.

First, the equation was generated using all of the variables specified in equation (8). It was not expected that all variables would be statistically significant and, thus, contribute to household WTP, but all of the variables specified were necessary to test the research hypotheses. The results of the full log equation are presented in the right hand column of Table 5. So that all results are presented in a straightforward manner, the

Table 3. Mean WTP Computation Based on Average Probability of Response to Offers

Offer	YES	Total	P[YES]	Range	Avg. P[YES]	Mean WTP
$0.00			1.000			
$5.00	24	52	0.462	$5.00	0.731	$3.65
$10.00	26	62	0.419	$5.00	0.440	$2.20
$15.00	15	53	0.283	$5.00	0.351	$1.76
$20.00	15	44	0.341	$5.00	0.312	$1.56
$25.00	8	41	0.195	$5.00	0.268	$1.34
$50.00	7	50	0.140	$25.00	0.168	$4.19
$75.00	6	50	0.120	$25.00	0.130	$3.25
$100.00	4	48	0.083	$25.00	0.102	$2.54
$150.00	3	60	0.050	$50.00	0.067	$3.33
$200.00	3	45	0.067	$50.00	0.058	$2.92
$235.00			0.000	$35.00	0.033	$1.17
						$27.91

Table 4. Mean and Median WTP Based on Probability Computations

Sample	Mean	Median
Total	$27.91	$8.97
Wetland A	$25.09	$12.07
Wetland B	$26.19	$8.33
Wetland C	$28.48	$8.48

Table 5. Estimated Logit Coefficients for Complete Model

Variables	Logit Linear	Logit Log
OFFER	-0.0226**	
	(6.7239)[a]	
LOFFER		-1.0369**
		(7.9491)
AGE	0.0075	0.0072
	(0.9156)	(0.8514)
MALE	0.1254	0.1397
	(0.3649)	(0.3918)
EDU2	0.9151	1.0947
	(0.9932)	(1.1642)
EDU3	1.1019	1.3025
	(1.1840)	(1.3745)
EDU4	1.1834	1.3322
	(1.2557)	(1.3851)
TAX	0.5466	0.5674*
	(1.9504)	(1.9685)
ENVIR	0.6777*	0.6444*
	(2.2944)	(2.1586)
INC2	0.7168	0.6992
	(1.2943)	(1.2233)
INC3	1.4982**	1.5192**
	(3.0856)	(3.0456)
INC4	1.1982*	1.2974*
	(2.3770)	(2.5287)
INC5	1.1048*	1.2215*
	(2.0004)	(2.1588)
INC6	2.3105**	2.4042**
	(4.1877)	(4.2264)
INC7	2.3119**	2.3809**
	(4.2516)	(4.2778)
INC8	3.2109**	3.1827**
	(4.3936)	(4.5357)
WETB	-0.3167	-0.3320
	(0.9694)	(0.9945)
WETC	-0.2789	-0.2319
	(0.9067)	(0.7430)
DIST	-0.0012	-0.0023
	(0.2613)	(0.4632)
SAND	-0.3114	-0.5195
	(0.6635)	(1.5280)
PIED	-0.1738	-0.0075
	(0.3461)	(0.0149)
CONSTANT	-3.0588*	-0.7493
	(2.2943)	(0.6107)
Goodness-of-fit Measures		
Observations	505	505
Percentage of Right Predictions	83	84
Maddala R^2	0.24	0.25
Log Likelihood Function	-196.7	-192.95

[a] Absolute value of asymptotic t-statistics in parentheses.

** denotes significance at the 1% level.
* denotes significance at the 5% level.

parameter estimates for the linear equation are given in the same table, although no further use will be made of them. It is easily seen that the coefficients produced, the significant variables, and the test statistics at the bottom of the table are similar for the log and linear versions. However, when the equation is not constrained to the first quadrant (i.e., in the linear model) a statistically significant and negative constant term appears which distorts the WTP estimate. In the log equation the constant term is not significantly different from zero.

As hypothesized, with increases in the offer amount, respondents are less likely to pay to preserve the wetland type they are being asked to value. The negative sign on the estimated coefficient for the log of the continuous variable A_i, referred to in the table as LOFFER, indicates that, as the offer amount increases, WTP decreases.

The wetland types are included as dummy variables in order to determine if households valued wetlands differently as a result of perceived ecological contributions derived from the brief description and sketch included in the questionnaire. For the sample as a whole, there was no significant difference between the three types of wetlands (WETA, WETB and WETC). While this overall result suggests that there are no differences in estimated valuation for the three wetland types for all sample respondents taken together, this is not really the end of the matter; it is necessary to look at WTP with respect to certain important household characteristics.

Characteristics of the sample households were used as independent variables to determine whether or not they affected the probability of responding YES to the offer amount, thus influencing the estimated WTP. Household characteristics that did not prove to be statistically significant were the age, sex and education level of the household head (AGE, MALE, EDU2, EDU3 and EDU4) the distance of the household from the Francis Beidler Forest (DIST) and a region of residence outside the Coastal Plain (SAND and PIED). Signs on all of the nonsignificant variables were consistent with hypothesized effects; thus, there is no evidence of intercorrelated errors of the independent variables which often are suspected when sign reversal occurs.

Many of the nonsignificant variables are correlated, to a degree, with household income. While the table of correlation coefficients does not show high levels of intercorrelation, income seems to serve as a proxy for several of the other variables.[3] The sign on AGE was positive, as expected, since increasing age is typically associated with increasing levels of income and perhaps

[3]This suspicion was confirmed by fitting the model without household income and finding, as a consequence, that many of the other variables become statistically significant. This configuration of the model did not produce a better fit.

heightened awareness of the benefits of protection of environmental goods such as wetlands. The MALE coefficient was also positive, perhaps reflecting higher incomes of male headed households. The coefficients on EDU2, EDU3, and EDU4 were all positive and increasing in magnitude, suggesting an increasing probability of the household head responding YES as level of education increased. The signs on the coefficients for WETB and WETC were negative, suggesting that the wetland valued most highly by the average household as having the greatest ecological value based on functions is the typical floodplain swamp depicted by Wetland A. The coefficient on DIST was negative, as expected, indicating that interest in a particular area of concern diminishes the farther away the respondent resides. The coefficients on SAND and PIED are negative in relationship to the Coastal Plain region which contains most of the floodplain swamps; households in the Coastal Plains region were expected to be more likely to respond affirmatively across all levels of offers.

The log logit equation was rerun using only the variables which were significant in the full equation. A likelihood ratio test was used to validate the reduced form model statistically (Greene 1990). The reduced form equation produced the same statistically significant variables as the longer equation, Table 6. Estimates of WTP were recalculated using the coefficients generated in the reduced form equation. Goodness of fit measures at the bottom of Table 6 are equal to those of the full model. The Madalla R^2 is not interpreted in the same way as in the familiar ordinary least squares (OLS) equation; its values here approximate those that would be expected in this type of analysis. The "percentages of right predictions" are indicative of the degree to which the equations fit the data.

The variables which were statistically significant determinants of WTP also had the expected signs. All income levels with the exception of INC2 were significantly different from the base level of income, INC1, at the 5 percent level or higher. Moreover, the size of the income coefficient tends to increases at the higher levels of income. The estimated coefficient for ENVIR was positive and significant at the 5 percent level. It was expected that those households who were members of one or more environmental organizations would consider the issue of wetlands of greater importance and would reflect this concern in a higher probability of responding affirmatively to their offer amounts. The TAX coefficient also was positive and significant at the 5 percent level; a household willing to contribute a part of its state income tax refund to help protect wildlife habitat is statistically more likely to answer YES to the offer amount.

Median and mean values of WTP for the reduced form model also are close to those of the complete model. These values are shown near the bottom of Table 6. The median bids, except for wetland C, are lower than the lowest offer amounts used in the survey, reflecting the large number of zero bids received. The mean bids for the total sample and for the three wetlands separately seem

Table 6. Estimated Logit Coefficients for Reduced Model

Variables	Total	Wetland A	Wetland B	Wetland C
LOFFER	-0.9996**	-1.1297**	-1.1395**	-1.0184**
	(7.8597)[a]	(4.9730)	(4.0760)	(4.3023)
TAX	0.5718*	0.7982	1.2775*	0.0102
	(2.0228)	(1.5417)	(2.1487)	(0.0205)
ENVIR	0.6565*	-0.1751	0.5834	1.2282*
	(2.2496)	(0.3124)	(0.9921)	(2.3249)
INC2	0.6562	-0.3398	0.1633	1.6618
	(1.1686)	(0.2808)	(0.1421)	(1.7360)
INC3	1.5622**	1.6512*	1.1650	2.3830**
	(3.1958)	(1.9776)	(1.2373)	(2.6464)
INC4	1.3471**	1.7364*	-24.9940	1.9739*
	(2.6769)	(2.3402)	(0.0000)	(2.1298)
INC5	1.2154*	0.8769	1.7310	-23.9600
	(2.2376)	(1.0250)	(1.8210)	(0.0000)
INC6	2.4553**	2.7154**	2.8918**	2.2609*
	(4.6260)	(2.8037)	(2.9947)	(2.1310)
INC7	2.4802**	2.1080**	2.0025	3.7188**
	(4.7347	(2.5902)	(1.9192)	(3.6213)
INC8	3.3435**	1.5595	32.1600	4.1820**
	(5.1182)	(1.3795)	(0.0001)	(3.7194)
CONSTANT	0.1755	1.0870	0.3241	-0.3790
	(0.3503)	(1.3288)	(0.3153)	(0.4030)
<u>Willingness to Pay</u>				
Median	$4.38	$2.19	$1.92	$5.60
Mean	$16.74	$7.75	$6.82	$19.57
<u>Goodness-of-fit Measures</u>				
Observations	505	170	155	180
Percentage of Right Predictions	83	84	86	83
Maddala R^2	0.24	0.30	0.31	0.27
Log Likelihood Function	-196.3	-63.82	-48.25	-65.58

[a]Absolute value of asymptotic t-statistics in parentheses.

**Denotes significance at the 1% level.

*Denotes significance at the 5% level.

reasonable; i.e., they probably could be replicated in an actual solicitation of funds from the same proportional number of respondents. Again, the differences between mean and median values indicate the skewness of responses, which is not uncommon in WTP studies, nor presumably in actual solicitations.

The size of the coefficients on the income variables tends to increase at the higher levels, as in the complete equation, and all households except those in the INC2 category were significantly more likely to respond affirmatively to the offer amount than were the households of the lowest income level. Those who responded to the survey generally are those in higher income and education categories; thus, it would not be correct to attempt to estimate an aggregate WTP by multiplying any of the mean or median values by the total number of households in South Carolina. Further statistical analysis will be done to develop a defensible weighting system, but it is recognized at the outset that any such system for developing aggregate estimates must deal with the large number of nonresponses.

When the three types of wetlands are examined separately, the association with income is less clear. For respondents asked about wetland B, only INC6 is significantly related to LOFFER. Curiously, wetland B is the only wetland type for which contributors of tax refund money to the wildlife fund responded differently than other respondents. Perhaps wetland B corresponds more closely to the kind of wetland habitat for wildlife they have in mind. A further possible complicating factor here is that people willing to donate a part of their income tax refunds to the state for wildlife might feel differently than others about the relative roles of the state and private nonprofit organizations, such as the Audubon Society, in wetland preservation. This analysis was not designed to unearth such preferences. The researchers deliberately chose to use contribution to the Audubon Society as a "payment vehicle" to avoid commonly encountered bias associated with hostility toward government activity.

Members of environmental groups, on the other hand, responded significantly more favorably than other respondents to offer amounts to purchase wetland C. Note also the much higher median and mean WTP generated by the equation for wetland C. This type of wetland, described as infrequently flooded or as already drained and converted to pine plantations, is widely understood to be relatively poorer wildlife habitat and, in terms of most other wetland functions, the least important ecologically. Members of environmental organizations are presumed to be more knowledgeable about wetland functions than others. A likely explanation for their greater willingness to pay for the purchase of wetland C is that environmentalists consider the drained wetlands to be the most likely of the three types to be converted permanently and would like to see the drainage systems removed and the wetland converted back to a natural state. They were told in the questionnaire that, if left alone, the original landscape would return in 75-100 years.

CONCLUSIONS

Economic valuation of wetlands continues to be an urgent issue in South Carolina and other southeastern states. Wetlands are particularly important in the Southeast because the region contains such a large proportion of the total acreage of wetlands remaining in the United States.

The vital ecological functions performed by wetlands have been publicized widely in recent years, in the popular media and in the professional literature of a variety of disciplines. Many Americans are now aware that there are different types of wetlands which perform different, but essential, hydrological and ecological functions. They also recognize that the activities of man continue to have important impacts on wetlands and that, at least in some cases, these activities result in wetland destruction. Most thoughtful persons are inclined to believe that a level exists beyond which wetlands of different types, sizes, and locations cannot be reduced with impunity.

Beyond these basic beliefs, there is little agreement about the value of different types of wetlands, even among scientists or those who are charged with the regulation of wetlands. The public debates of wetland scientists and policymakers do little to instill confidence in the minds of the average citizen. The controversy even extends to the question of how wetlands should be identified and delineated. One way to respond to this lack of precise definition and measurement is to define wetlands as broadly as possible and protect each acre as though it were critical. While this may be a generally agreed upon procedure for dealing with rare and endangered species, it is unlikely to have broad appeal in the case of wetlands in general. South Carolina has vast amounts of wetland, and it is highly unlikely that every acre of it is in its highest and best use.

But the problem remains: how can the societal benefits of undisturbed wetlands be evaluated against the opportunity costs of their provision. Only a relatively small part of the value of a wetland is tangible and capable of being priced in normal markets. The values of harvested trees and furbearing animals and recreational benefits may be estimated more or less accurately, but what of the values of aesthetic, ecological and wildlife habitat benefits. While difficult to evaluate, these benefits may be substantial, even from the anthropocentric viewpoint usually assumed in policy studies.

Contingent valuation (CV) is a technique that has been employed by resource economists for two decades to value a variety of nonmarket goods. The technique employs carefully worded questionnaires to elicit from a sample of respondents their true willingness to pay (WTP) for the nonmarket good, comparable to their revealed preferences for market goods where consumption preferences can be observed. Comparative studies have demonstrated that CV produces estimates that are close to those obtained using the travel cost method (TCM), hedonic pricing models and controlled bidding experiments.

Contingent valuation was employed in this South Carolina study to determine the WTP for three different types of freshwater wetlands: a floodplain swamp, a bottomland hardwood forest and a pine plantation with scattered hardwood runners. Each was presented as a possible 2,500 acre addition to the Francis Beidler Forest (also known as the Four Holes Swamp). The payment vehicle was a contribution to the National Audubon Society, which owns and manages the wetland sanctuary as it now exists. Carefully structured questionnaires were sent to a random sample of South Carolina households. The three types of wetlands were described by their outward characteristics, period of inundation, and presumed differences in wetland functions performed. Each questionnaire also contained a more detailed description of one of the three wetlands, including an artist's rendering designed to convey consistent information. Respondents were then asked if they were willing to pay a specific amount to help purchase the wetland (YES or NO); the amounts were randomly assigned to the questionnaires. This is the dichotomous choice application of the CV technique: only one of several possible applications. The questionnaire also asked for such respondent characteristics as age, education, and family income. Respondents were also asked if they were members of one or more environmental organizations or if they contributed part of their South Carolina income tax refund to a wildlife fund.

A log version of the logit model was used to test the statistical significance of the independent variables on the dichotomous (YES/NO) responses to the offer amount. The statistical model was used to test null hypotheses that household WTP does not differ (1) with regard to the outward character and potential ecological nature of the three types of wetlands, and (2) with regard to a number of household characteristics. Both hypotheses were rejected statistically, at least in part.

Household WTP was negatively related to the offer amount, as expected; i.e., the higher the suggested contribution the less likely they were to respond affirmatively. Income was positively and significantly related to WTP and, apparently, served as a proxy for other household characteristics -- sex and education level of the household head -- which were nonsignificantly related to WTP as long as income was included. Other nonsignificant variables were distance from the household to the wetland and region of the state in which the household was located.

While the WTP in the full statistical model was not significantly different for the three different types of freshwater wetlands, there were some intriguing differences discovered when the three wetlands were modeled separately. Particularly interesting was the equation for the type of wetland which was already drained and converted to pine forest. Not only did this wetland produce the apparently highest mean and median WTP, but it also was the only one for which members of environmental groups were willing to pay significantly more than other respondents. The higher willingness to contribute for this type of wetland is consistent with the belief that this type of wetland is most likely to be converted permanently to nonwetland use.

The different formulations of the statistical model produced mean estimates of household WTP between about $8 and $20, and median values between about $2 and $5.60. The mean values higher than the median values indicate an expected skewness of responses. There will always be many respondents who are willing to pay little or nothing and a few who are willing to pay rather large amounts. No aggregations to determine total willingness to pay for the entire population are offered at this time, nor do we recommend that the estimated WTP values be projected in any way.

These results demonstrate that it is feasible to derive estimates of individual household values for a nonmarket good by structuring a contingent market. The nonsignificance of region and distance variables indicate that the awareness of wetland values is statewide, rather than local, and that nonuse value may be the most important component of value.

It is clear that several similar studies of different kinds of wetlands need to be made, perhaps with different questionnaire structures and model formulations. For example, the dichotomous choice CV model was selected since it seems to be the state-of-the-art choice to avoid some of the well known biases associated with range and starting point encountered in payment cards and bidding games. It is possible that the take-it-or-leave-it aspect of this exercise was at least partly responsible for the low survey response. However, the <u>a priori</u> assumption was that the DCCV methodology would produce a higher level of response since it is less complicated than any of the bidding games. Again, a high percentage response is seldom expected when a general population is surveyed.

Also, for some types of wetlands, particularly privately owned ones, it would be interesting to combine the nonuse values of nonowners who nevertheless derive external values from the wetlands, with direct use values such as the net discounted future value of forest products. The latter can be estimated easily. The former can be modeled by combinations of contingent valuation and benefit cost analyses of wetland externalities such as flood retention and waste absorption.

APPENDICES

Appendix A

Correspondence

Initial Cover Letter

April 1992

Dear Citizen:

One of the most important resource questions we face as citizens of South Carolina is how much of our wetlands to preserve. It is important that we have a balance between development and wetland preservation, but no one knows for sure what households like yours think this balance should be.

Forested wetlands in South Carolina occupy about 33% (approximately 4 million acres) of the total forested area of the state. They occur either in floodplains of major and minor streams or in the large areas in between. The lowest areas in the floodplain are typically wet 100% of the growing season and are generally cypress and tupelo swamps. The higher ground in the floodplain is mixed bottomland hardwoods and are wet 12 to 75% of the growing season. Oaks, hickories, gums, and ash typically occupy these sites. Between the floodplains we find large areas with poor drainage where the water from rain accumulates faster than it can drain away. These sites are naturally occupied by mixed hardwoods and pine species and are wet for only brief periods during a normal rainfall year. These three forested wetlands each have unique characteristics and degrees of wetness.

Your household is one of a small number which are being asked to give opinions on one of the three types of forested wetlands which could be added to the Francis Beidler Forest in our state. A picture and a brief description of the wetland we are asking you to value are given. You are also shown a chart which describes the contribution made by that specific wetland to various functions typically performed by wetlands.

Your name was drawn in a random sample of the entire state. In order that the results will truly represent the thinking of the people of South Carolina, it is important that each questionnaire be completed and returned. You may be assured of complete confidentiality. The questionnaire has an identification number so that we may check your name off the mailing list when your questionnaire is returned. Your name will never be placed on the questionnaire.

We would be most happy to answer any questions you might have. Please write or call. The telephone number is (803) 656-3374.

Sincerely,

Buddy L. Dillman
Principal Investigator

Lawrence Y. Beran
Project Director

Reminder Postcard

April 1992

Last week a questionnaire seeking your opinion on wetland values was mailed to you. Your name was drawn in a random sample of households in South Carolina.

If you have already completed and returned the questionnaire to us please accept our sincere thanks. If not, please do so today. The questionnaire has been sent to only a small, but representative, sample of South Carolina residents. It is extremely important that yours be included in the study if the results are to accurately represent the values of South Carolina residents.

If by some chance you did not receive the questionnaire, please call us collect at (803) 656-3374 and another questionnaire will be sent to you.

Thank you for your assistance.

Sincerely,

Buddy L. Dillman
Principal Investigator

Lawrence J. Beran
Project Director

Follow-up Letter

May 1992

Dear Citizen:

About three weeks ago we wrote to you seeking your opinion on the value of a specified forested wetland which could be added to the Francis Beidler Forest in our state. As of today we have not received your completed questionnaire.

Our research unit has undertaken this study because of the belief that citizen values should be taken into account in the formation of public policies which affect the balance between development and preservation of wetlands in the state of South Carolina.

We are writing to you again because of the significance of each questionnaire to the usefulness of this study. Your name was drawn through a scientific sampling process in which every household in South Carolina had an equal chance of being selected. In order for the results of this study to be truly representative of the values of all South Carolina residents it is extremely important that each person in the sample return the questionnaire.

In the event that your questionnaire has been misplaced, a replacement is enclosed.

Your cooperation is greatly appreciated.

Cordially,

Buddy L. Dillman
Principal Investigator

Lawrence J. Beran
Project Director

Appendix B

Questionnaires

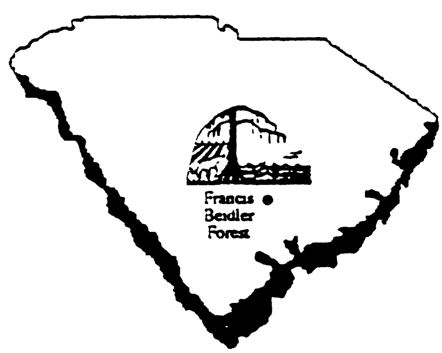
The questionnaire consisted of a title page, description page, data page, and back page. The questionnaire for Wetland A is shown in its entirety. The questionnaires for Wetland B and Wetland C are identical, with the exception of the description pages which are included at the end of the Wetland A questionnaire.

Wetland A: Floodplain Swamps

WETLAND VALUES IN SOUTH CAROLINA

Conducted by

Department of Agricultural and Applied Economics,
Department of Forest Resources
Clemson University
Clemson, SC



Francis Beidler Forest is a 6000 acre National Audubon Society nature sanctuary near Harleyville in southeastern South Carolina. Expansion is possible by purchasing adjoining wetland areas of the three types described in the cover letter. A more complete description of the wetland you are being asked to value is on the following page. It is important that you complete all the questions, even if you have no previous knowledge or experience with wetlands.

Please return the completed questionnaire in the enclosed self addressed stamped envelope.

Wetland A: (Continued)

Floodplain Swamps

Swamps occur in low areas within the floodplain of adjoining streams. They support bald cypress and smaller tupelo gum trees. They are rich in wildlife, including wood ducks and river otters. In addition to the numerous plants and animals, the swamps absorb periodic flood waters and improve water quality as the silt is dropped out. Development of these areas for human uses creates a problem when the normal floodway and drainage are altered and the floodwater goes somewhere else.

WETLANDS FUNCTIONS	Contribution			
	High	Med	Low	None
A. Flood Control	✓			
B. Flood Storage	✓			
C. Sediment Collection	✓			
D. Fish & Shellfish	✓			
E. Waterfowl and other wildlife		✓		
F. Rare and endangered species	✓			
G. Recreation, hunting & fishing	✓			
H. Water Supply	✓			
I. Food Production	✓			
J. Timber Production	✓			
K. Water Quality	✓			
L. Historic & Archeological values	✓			
M. Education & Research	✓			
N. Open space & aesthetic value	✓			

Wetland A: (Continued)

Would you be willing to contribute $OFFER to a private Wetland Preservation Fund to purchase 2500 acres of the previously described wetland to be added on to the Francis Beidler Forest?

(*Circle one*) YES NO

If you answered Yes, what is the maximum you would be willing to contribute? $________

If you answered No, what is the maximum you would be willing to contribute? $________

If you answered No and your maximum willingness to contribute was $0, please explain.

____

____

____

PLEASE COMPLETE THE FOLLOWING SECTION FOR THE HEAD OF HOUSEHOLD

AGE: ________ years old SEX M ☐ F ☐

EDUCATION: (*Circle the highest year completed*)

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17+

Elementary High School College Graduate/Professional

Do you contribute to the SC Wildlife Fund on your State income tax? YES ☐ NO ☐

Do you belong to, or contribute money to, any of the following organizations? (*Circle all that apply*)

1. The Nature Conservancy
2. World Wildlife Fund
3. National Wildlife Federation
4. National Audubon Society
5. The Sierra Club
6. Ducks Unlimited
7. Other? ________________

How much do you contribute annually to these organizations? $ ____________

Household income before taxes (1991) - (*Circle the one that applies*)

1. Less than $10,000
2. $10,000 - 19,999
3. $20,000 - 29,999
4. $30,000 - 39,999
5. $ 40,000 - $49,999
6. $ 50,000 - 59,999
7. $ 60,000 - 99,999
8. $100,000 or more

Wetland A: (Continued)

Additional Comments:

____

____

____

____

____

____

Your contribution to this effort is greatly appreciated!

This research is sponsored by the South Carolina Agricultural Experiment Station, Clemson University, with partial funding by the South Carolina Water Resources Research Institute.

The South Carolina Agricultural Experiment Station is a cooperative program financed from federal and state funds. It is the policy of the Experiment Station to comply fully with the regulations of Title VI, the Civil Rights Act of 1964. Complaints may be filed with the Director, S.C. Agricultural Experiment Station, Clemson University, Clemson, S.C. 29634-0351.

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Wetland B: Bottomland Hardwood Forests

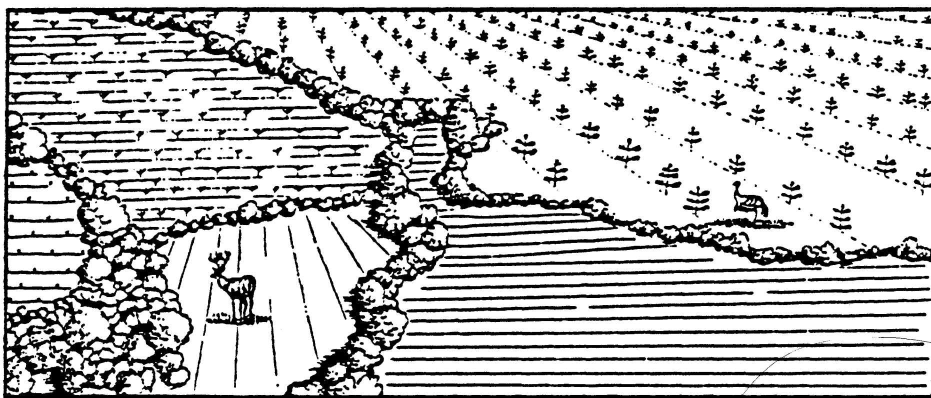
Bottomland Hardwood Forests

Bottomland hardwood forests occur where the land is slightly higher than the swamp and flooding does not occur as often. Laurel oak and ash are found on the drier land. The forests are rich in wildlife, including deer and turkey, and serve as a refuge for many other animals. Development of the bottomland hardwood forests for human use reduces periodic flooding, which causes flooding somewhere else. The native vegetation also is altered and wildlife diversity decreases.

WETLANDS FUNCTIONS

	Contribution			
	High	Med	Low	None
A. Flood Control	✓			
B. Flood Storage	✓			
C. Sediment Collection	✓			
D. Fish & Shellfish		✓		
E. Waterfowl and other wildlife		✓		
F. Rare and endangered species		✓		
G. Recreation, hunting & fishing	✓			
H. Water Supply	✓			
I. Food Production	✓			
J. Timber Production	✓			
K. Water Quality	✓			
L. Historic & Archeological values	✓			
M. Education & Research	✓			
N. Open space & aesthetic value	✓			

Wetland C: Pine Plantation With Scattered Hardwood Runners



Pine Plantation With Scattered Hardwood Runners

Many of the mixed pine-hardwood forests are cleared, bedded, and fertilized to convert to stands of a single type of tree. Softwood trees, mostly pines, have replaced hickories, oaks, and other hardwoods. Nearly 85% of the original forest is replaced with pine plantations leaving only scattered areas of hardwoods. The wildlife value of the mixed forest is significantly altered. If the area converted to pines were left alone for 75-100 years, the original landscape would return.

WETLANDS FUNCTIONS

	Contribution			
	High	Med	Low	None
A. Flood Control				✓
B. Flood Storage			✓	
C. Sediment Collection				✓
D. Fish & Shellfish				✓
E. Waterfowl and other wildlife		✓		
F. Rare and endangered species	✓			
G. Recreation, hunting & fishing			✓	
H. Water Supply			✓	
I. Food Production		✓		
J. Timber Production		✓		
K. Water Quality			✓	
L. Historic & Archeological values	✓			
M. Education & Research		✓		
N. Open space & aesthetic value		✓		

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