Economic Linkages Between Coastal Wetlands and Hunting and Fishing: A Review of Value Estimates Reported in the Published Literature

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Summary

This manuscript summarizes a total of 12 peer-reviewed studies,[1] published from 1978 to 2001, reporting 32 separate estimates for the disaggregate[2] value of hunting and fishing services provided by coastal and non-coastal wetlands. Estimates ranged across three orders of magnitude and are highly dependent on the specific geographic site providing the service, the target species of the hunting and fishing activity, and the measurement technique. Considering only coastal zone wetlands across all study categories, the value of wetlands to single-target hunting and fishing (oysters, menhaden, etc.) ranged from $1.05/acre/year to $663.74/acre/year, with a mean and median of $113.95/acre/year and $10.03/acre/year, respectively. Considering only coastal zone wetlands across all study categories, the value of wetlands to aggregate hunting or fishing (both commercial and recreational) ranged from $16.76/acre/year to $1,025.03/acre/year, with a mean and median of $233.37/acre/year and $106.54/acre/year, respectively.[3, 4] By comparison, the range of reported estimates of willingness-to-pay (WTP) values for recreational hunting and fishing services were somewhat more narrowly bounded across studies,[5] ranging $83.99 to $616.46, with a mean and median of $303.67 and $207.79, respectively. The importance of a wetlands geographic location, its relationship to the target fishery or animals species, and the differing relationships with commercial and recreational consumptive users suggests that coastal wetland benefits need to be carefully examined within a spatially disaggregated context.

Introduction

Coastal wetlands are increasingly recognized as essential to natural systems and human activities because of the environmental services that they provide. However, this recognition has not resulted in capitalized economic value for landowners (Heimlich et al. 1998). Nonmarketed wetland benefits may be important to society, but the lack of a market value for the services means that they are often

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1 To the author's knowledge this represents all the peer-reviewed published studies that explicitly seek to value the linkage between wetlands and disaggregate hunting and fishing services, both commercial and recreational.

2 From a theoretical economic perspective, the services provided by wetlands generally should not be disaggregated and valued separately due to the potential for double counting and offsetting effects (see Pendleton and Shonkwiler [2001] for a discussion of this in a different context). For example, the provision of hunting and fishing services may, in many cases, simultaneously provide for increased habitat and species protection. Valuing each of these services separately (when, in fact, they may be inseparable) and summing will lead to overestimating total potential wetland value.

3 All values in year 2000 dollars (see Table 1).

4 In a partial review of wetland valuation studies, Heimlich et al. (1998) calculated a much broader range on the per acre value estimates, in part because they considered the provision of a number of different services besides hunting and fishing, but also because they converted household and individual willingness-to-pay (WTP) values to per acre values using various assumptions not necessarily contained in the original studies. The review presented in this manuscript does not take this approach, and instead lists the WTP values separately (if not originally presented on a per acre basis) for comparison purposes.

5 Note that the WTP estimates were not, in general, estimated on a per acre basis, and thus should not be directly compared with the per acre values estimated from non-WTP studies.

deemphasized relative to physical loss or the private economic gains that can arise from conversion of wetlands to other land uses (van Vuuren and Roy 1993). While the search for quantitative measures of wetland values is challenging due to the diversity, socioeconomic context, and complex hydro-biological functions of wetlands (Scodari 1990), informed policy requires that both market and nonmarket wetland values be incorporated into the decision making process.

One important, but only partially marketed, service provided by Louisiana's coastal wetlands is ecological support for species that are the target of commercial and recreational hunting and fishing. Dockside revenues for commercial fisheries in Louisiana were $317 million in 1997, which were second only to Alaska.[6] The most important commercial species included shrimp ($144 million), menhaden ($63 million), blue crab ($28 million), and oyster ($30 million). In addition, inshore and offshore fish stocks support a large recreational sector. In 1996, this sector harvested an estimated 23.4 million pounds of fish during the 3.14 million trips taken by 607,000 participants. Estimated recreational expenditures totaled $450 million in 1996, surpassing the value of the commercial fishery. Problems, however, lie in the fact that little information exists about the relationship between functioning coastal wetland ecosystems and the related hunting and fishing resources.

This report documents the current status of knowledge concerning the economic value of the commercial and recreational hunting and fishing services generated by coastal and other wetlands. In particular, studies that focus on valuing hunting and fishing services as unbundled products of wetland function are highlighted.[7] A brief overview of the economic linkages between wetland ecosystems and hunting and fishing is first presented, thus providing a basic framework for understanding why specific variables and measurement methods are of interest. Second, the common methods used to value services of wetlands are outlined, along with their major advantages and disadvantages. This information can help the reader evaluate the usefulness of any particular estimate. Next, the results of individual hunting and fishing service valuation studies are presented and summarized. Lastly, the report concludes with a complete list of the literature cited.

Relationship Between Wetlands and Hunting and Fishing

Policymakers face complex, multi-objective trade-offs when attempting to develop strategies for coastal restoration and protection.[8] Implementation of any specific strategy will result in benefits and costs that will, in general, be different than those experienced under alternative strategies. Economics can be used to help inform policymakers about the relative benefits and cost of different strategies, but analysts require information on (1) the relationship between anthropogenic activities and coastal wetland loss, (2) the costs imposed on society from coastal wetland loss, and (3) the costs of taking action to prevent coastal wetland loss. In the typical environmental management scenario, human activities are considered to be a cause of degradation, and the management of these activities via regulation or the use of economic instruments has the goal of reducing environmental impacts. Changing established human activities is potentially costly, and the cost will vary by the specific type of activity and its interrelationship with the environment. While some Louisiana coastal wetland loss can be attributed to traditional human industrial, municipal, and agricultural activities, natural environmental processes on a regional, hemispheric, and global scale are also important. Complicating the identification of causal linkages and their importance to hunting and fishing resources is the heterogeneity of existing wetlands.

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[6] The statistics reported in this paragraph come from Keithly and Ward (2001).

[7] A substantial part of the wetland valuation literature attempts to measure the theoretically correct multi-product value of wetlands and not the individual service components. An overview of the results generated by these studies is presented in the report (Table 2) for comparison to the single-product hunting and fishing value estimates.

[8] The following discussion was adapted from Keithly and Ward (2001) and Heimlich et al. (1998).

Some wetlands perform many functions, but some may perform few or even none. In addition, many of the environmental services are generated simultaneously in varying degrees by the same wetland function. From this perspective, both commercial and recreational hunting and fishing services of wetlands can best be understood as part of an economic joint product. This jointness-in-products creates difficulties in measuring the economic importance of specific wetlands functions, and as a result the literature contains a limited number of empirical studies that isolate the hunting and fishing benefits associated with wetland integrity.

Abstracting from the technical measurement difficulties, there a number of general benefits that accrue to society from its interaction with any large-scale ecosystem such as coastal wetlands (Pearce and Turner 1990). Ecosystems supply both stock and flow resources that can be used as direct and indirect inputs to production and consumption activities, thereby generating productivity and growth in the overall economic system. While the resources can be either renewable or nonrenewable, goods and services provided by Louisiana's coastal wetlands (and their associated marine ecosystems) are generally considered renewable resources.[9] The provision of hunting and fishing resources via ecological support processes can be considered one of these renewable resources.

Wetlands are the most biologically productive ecosystems in the temperate regions, rivaling tropical rain forests (Mitsch and Gosselink 1993). Their biological productivity derives from an ability to recycle nutrients and energy, and provide habitat for living organisms.[10] Some fish and wildlife species spend their entire lives in wetlands and others using them intermittently for feeding or reproduction. Amphibians and reptiles also depend on wetlands, and are particularly sensitive to wetland degradation. In addition, over one-third of all bird species in North America rely on wetlands for migratory resting places, breeding or feeding grounds, or cover from predation (Kroodsma 1979). Many fur-bearing animals, such as muskrat, beaver, otter, mink, and raccoon prefer wetlands as their habitat, and wetland habitats are critical for the survival of a number of threatened and endangered species. The linkage of these biophysical functions with economic value comes from the net market and nonmarket value of the species. Market values are calculated by observing prices and relating them to estimates of production and harvesting costs, thereby allowing a relatively clear determination of the net economic value of the harvest attributable to wetlands. Linkages that are less clear are those involving nonmarket valuation, where estimating the relationship between habitat and nonconsumptive uses is extremely complicated because of biological, recreational, sociological, and economic considerations that interact in complex ways. In addition, wetlands policy is complicated by the fact that many wetland goods and services are public goods whose benefits accrue to society at large or to individuals other than the wetland owners. For example, a wetland may provide habitat for migratory birds that are targets of hunting, but fail to generate significant rent for its owner. As a result, many private wetland owners may find it more profitable to convert wetlands to alternative uses or abandon its maintenance altogether.

Once the conceptual benefits of an ecosystem are identified, economic values need to be assigned to these benefits. Having these assigned values allows policy makers to quantitatively assess the economic benefits that society might gain from marginal improvements in the integrity of the ecosystem. Value is associated with the amount that society (both current and future generations) would be willing to pay for the economic system characteristics (primarily the services and attributes) provided by the ecosystem if they were not provided free of charge. The greater the benefits derived from the services

[9] While significant nonrenewable mineral extraction, and the related economic activity, takes place in coastal Louisiana and the adjacent continental shelf, to a large extent its continued existence is not dependent on maintaining the integrity of the coastal wetlands. The extraction industry's cost structure may change if coastal wetlands are lost, but not likely to the extent that they would become economically infeasible. Navigation and port activities, however, are more likely to be negatively affected by the loss of coastal wetlands.

[10] And thus the joint-product link between hunting and fishing resources and the water quality services of wetlands.

provided by any particular ecosystem, the more that ecosystem is valued by society. In general, the value of these services tends to be positively related with the integrity of the ecosystem. Of course, any action taken to decrease the loss of Louisiana's coastal wetlands, and thus increase the welfare of society at large, comes with a cost. These costs must be weighed against the benefits to determine, from the criteria of welfare economics, whether action is warranted, and to what extent.

Valuation Methods

The total economic value of a wetland area is the sum of the amount of money that all people who benefit from the wetland area would be willing to pay to see it protected (Whitehead 1992). If this definition of wetland value is to be empirically viable, individuals that benefit must (1) realize that they benefit, (2) understand the full extent to which they benefit, and (3) be capable of placing a dollar value on the level of their benefits, either through reference to market-based prices or some alternative, nonmarket pricing system. Methods for valuing the stock of natural capital assets and service flows generated by wetlands have been extensively discussed in both the published and unpublished literature.[11] While philosophical debate has occurred over the ability to empirically measure the full range of benefits that flow from an environmental resource, economists generally agree that accurate measurement is possible if valuation studies are carefully conducted (U.S. Department of Commerce 1993). In fact, review of past nonmarket valuation studies suggests that previously perceived variability and unreliability in the estimated values does not actually exist, particularly if one controls for the varying characteristics of the resources being valued and the way in which the estimated values are presented (Carson et al. 1996). Thus, published value estimates might be useful in analyzing the economic impact of Louisiana's coastal wetlands as long as careful attention is given to the details of the study and the resources being valued.[12]

Four theoretically plausible valuation methods have been used in the neoclassical economic literature to place valid dollar values on wetland resources.[13] These methods are the net factor income (NFI) method, the contingent valuation method (CVM), the travel cost method (TCM), and the hedonic price method (HPM). A fifth set of methods found in the literature, but not theoretically valid under typical application, is the damage cost or replacement cost methods (DCM or RCM). All of these methods are briefly described below. In addition, the non-neoclassical literature, as well as the biological literature, often contains studies employing energy analysis methods (EAM), whereby the value of ecosystem assets are directly related to their energy processing abilities.[14] Shabman and Batie (1978) detailed the fundamental problems and economic fallacies imbedded in this approach,[15] and no further

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[11] For excellent early overviews, see Greenley et al. (1982) and Amacher et al. (1989). Scodari (1990) provides a thorough review of the advantages and disadvantages of various methods specifically within a wetland valuation context, while Whitehead (1992) contains a lucid, if somewhat terse, review of the methods and the theory behind them. More recent papers detailing established and newer methods include Feather et al. (1995), Apogee Research, Inc. (1996), Mahan (1997), Bockstael (1998) and Pendleton and Shonkwiler (2001). For comprehensive reviews of the theory and application of contingent valuation methods for nonmarket goods and services, see U.S. Department of Commerce (1993) and Bishop et al. (1998).

[12] This type of detailed examination was beyond the time constraints of this study, but it should be seriously considered for inclusion in future phases of a valuation project.

[13] The brief methods discussion borrows from Amacher et al. (1989), Whitehead (1992), and others.

[14] This approach, which first received widespread publicity and policy attention due to a study by Gosselink et al. (1974), is based on the Odum and Odum (1972) contention that society's use of resources should maximize the net energy production of the total environment (including its natural and developed components).

[15] The fundamental problem is that EAM fails to recognize the nature of the process by which economic values are determined, and makes an "illegitimate marriage" of the principles of systems ecology with economic theory (Shabman and Batie 1978). "This leads to estimates of marsh service value that are, at best, inaccurate. At worst,

discussion of its use is included in this report. The results from two studies employing EAM, however, are reported in Table 2 in order to completely characterize the wetland valuation literature.

The NFI method uses market prices to measure the additional profit earned by firms due to the contribution of the wetlands to production activities, and it generates use values. Thus, the NFI method is most appropriate when the wetland provides a service that leads to an increase in producer surplus, or the economic gains attained by the users of the resource, because it exploits the relationship between the value of the production activity and the wetland acreage. In the NFI method the physical relationship between wetland areas and the economic activity is empirically estimated from data on the production activity. It is then possible to identify the increase in producer surplus (economic gain) associated with the use of the wetland resource.[16] If the empirical estimates are obtained through statistical regression, then estimates of the marginal value product (MVP) of the wetland resource can be generated. In this context, the MVP provides a direct measure of the firm owner's willingness-to-pay to avoid wetland degradation.

Producer surplus generated by the use of a wetland can also be estimated using the RCM. This approach values the wetland=s service based on the price of the cheapest alternative way of obtaining that service. For example, the value of a natural wetland in the treatment of wastewater might be estimated using the cost of chemical, mechanical, or constructive alternatives. The use of RCMs needs to be governed by three considerations (Shabman and Batie 1978): (1) the alternative considered should provide the same services, (2) the alternative selected for cost comparison should be the least-cost alternative, and (3) there should be substantial evidence that the service would be demanded by society if it were provided by that least-cost alternative. Taken together, these condition differentiate RCM from the more general class of DCMs, where the entire value of a marketable good or service is tied to the preservation of a wetland resource, ignoring consumer and producer substitution possibilities. Even with restrictive application, the RCM can only be considered to yield an upper bound on the true WTP for the wetland service because the producer may not choose to actually use the alternative considered (Anderson and Rockel 1991).

The CVM is a survey approach that measures the total economic value of all wetland goods and services by directly asking individuals about their WTP. The CVM establishes a hypothetical market by providing information about wetland resources, specifying payment rules and vehicles, and posing valuation questions. Answers to these questions can be used to directly measure WTP, and CVM may be the only way to estimate many non-use values of environmental resources. But, in order for CVM to yield valid economic measures, study participants must be both willing and able to reveal their values. Other valuation approaches, such as TCM and HPM discussed below, depend on revealed preferences through market transactions and other behavior. Statements from economic actors about how they would act under hypothetical circumstances, as used in the CVM, are a very different measure and ultimately need to assessed for validity (Bishop et al. 1998). A panel of experts organized by the National Oceanic and Atmospheric Administration (NOAA) of the U.S. Department of Commerce, and co-chaired by Nobel laureate economists Kenneth Arrow and Robert Solow, concluded that (1) there is too much positive evidence to dismiss CVM and its usefulness in providing information about values, (2) CVM studies do not automatically generate value information, but are highly dependent on the content validity of the survey, and (3) CVM is an evolving market valuation technique (U.S. Department of Commerce 1993). In the words of the panel (p. 4610), "CV studies convey useful information. We think it is fair to describe such information as reliable by the standards that seem to be implicit in similar contexts, like

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these inaccurate estimates may capture the focus of policy debate, and hinder, rather than improve, the resource management process for coastal wetlands."

[16] In practice, it is often assumed that the demand for the good being produced by the user is perfectly elastic, and thus changing wetland services has no effect on consumer surplus.

market analysis for new and innovative products and the assessment of other damages normally allowed in court proceedings . . . . Thus, the Panel concludes that CV studies can produce estimates reliable enough to be a starting point of a judicial process of damage assessment, including lost passive-use values."

The TCM approach is often used to measure the recreational benefits of wetlands, but it is generally applicable to valuing any nonmarket wetland good or service that individuals are willing to travel to and use at the wetland site. The TCM method estimates the costs incurred traveling to visit and use the site, with the concept being that the travel and time costs are measures of implicit market prices. The estimated costs are then used to construct demand functions that use travel and time costs as independent variables.[17] Consumer surplus per recreation trip and year can then be approximated from the estimated demand curve. The application of TCM assumes that (1) users have identical utility functions for the activity, and thus will have identical demand functions, (2) users are indifferent between incurring costs as user fees or travel costs, (3) weak complimentarity holds in that changes at competing sites do not affect use at the site being valued, and (4) site use is not congested. Given these assumptions, TCMs cannot be used to value nonmarket goods and services that either do not require the user to visit the site or that are offsite products. Furthermore, TCM generally cannot account for multiple sites, visits to multiple sites on the same trip, or the impact of small resource changes on user perceptions and travel patterns.

The HPM has been used to measure the contribution of wetlands for flood control and the role of wetland aesthetics in housing and property prices. Thus, HPMs attempt to tie wetland service value directly to a market price (Freeman 1998). In a market at equilibrium, land values and land rents should be a function of land characteristics, including the proximity to and services provided by wetlands. The increment to the land or housing price arising from wetland services is a measure of the implicit price of that service. There are three key assumptions required to apply HPM to estimate the wetland contribution to land values. First, there must be data on a continuum of sites with varying wetland characteristics and acreage. Second, purchasers and sellers of wetland parcels are assumed to have access to the same information regarding the condition of the site and the nature and use of the wetland. Third, wetland purchasers (or purchasers of property near wetlands) are assumed to have identical preferences for wetland characteristics. The assumption of identical preferences makes estimation of demand curves possible when data does not exist about individual preferences.

The valuation method employed in any particular hunting and fishing service valuation study depends primarily on the ability to quantitatively discern the biophysical linkages between characteristics of a particular wetland area and the change in the quality and quantity of hunting and fishing resources. In cases where this relationship is well understood, NFI methods can be employed. In cases where the biophysical linkages are not well described, but the demanded hunting and fishing services can be defined, then RCM or CVM may be most appropriate even in light of their limitations. Given its nature, recreational hunting and fishing service values are often estimated using TCM approaches. No hunting and fishing service value studies were found that employed HPM approaches. Of course, the choice of a particular measurement method is important and can have implications for the estimated value of a wetland area. For example, in a meta-analysis of wetlands valuation studies, Woodward and Wui (2000) discovered that NFI methods tended to generate lower estimated values for wetlands than did RCM. This confirms the Anderson and Rockel (1991) observation that RCM should generate an upper bound on actual value.

[17] Other independent variables are also employed, including the theoretically requisite income and various potential demand shifters, depending on the situation being modeled.

Review of Estimated Values

Peer-reviewed literature estimates of the hunting and fishing service values generated by an acre of wetland are presented in Table 1. Four different categories of studies were identified; Louisiana specific studies, other U.S. studies, international studies, and studies that did not report their results on an area basis (primarily CVM based WTP studies). In addition, peer-reviewed literature estimates of total service values generated by an acre of wetland were arranged by the same four categories and are presented in Table 2. The overall service value estimates are potentially useful when evaluating a study, as individually disaggregated service values should (obviously) never exceed total service value. In fact, individually disaggregated service values, when summed across all service categories, also should not exceed total value. In any event, the total values are included in the report to help the reader gain a broader understanding of the information available in the valuation literature.

Reported estimates for the value of Louisiana wetlands in the provision of specific hunting and fishing services ranged from a low of $1.16/acre/year (blue crab) to a high of $18.78/acre/year (shrimp), with a mean and median value of $10.97/acre/year and $11.97/acre/year, respectively (Table 1).[18] The disparity in valuation can be linked primarily to differences in the markets for specific target species being investigated. The two existing studies that examined the role of Louisiana wetlands in aggregate commercial resource production estimated values of $20.90/acre/year for trapping and $43.85/acre/year for fishing. Given these aggregated service values, the values reported for individual target species appear plausible (and visa versa).[19]

Studies conducted for wetlands in other regions of the U.S. reported specific hunting and fishing service values that ranged from $1.05/acre/year (blue crab in Florida) to $663.74/acre/year (oyster at Northumberland, Virginia), with a mean and median value of $152.28/acre/year and $8.73/acre/year, respectively (Table 1). While some of the individual estimates fell within the range of values reported for Louisiana, a number of them were substantially higher. In particular, wetland valuation through ecological support of Chesapeake Bay oyster production was generally one order of magnitude higher than the value estimated for Louisiana wetlands, although the Virginia values ranged across two orders of magnitude. A meta-analysis of the role of wetlands in commercial fishing estimated its value at $1,025.03/acre/year. The value of wetlands in the U.S. recreational hunting and fishing industry fell between these extremes, ranging from a low of $8.63/acre/year (muskrat trapping) to $871.39/acre/year for estuarine-dependent fish species, with a mean and median value of $204.02/acre/year and $112.17/acre/year, respectively.

A limited number of international studies reported commercial and recreational hunting and fishing service values between $16.76/acre/year and $120.84/acre/year, with a mean and median value of $54.21/acre/year and $25.03/acre/year, respectively. Considering only coastal zone wetlands across all study categories, the value of wetlands to single-target hunting and fishing (oysters, menhaden, etc.) ranged from $1.05/acre/year to $663.74/acre/year, with a mean and median of $113.95/acre/year and $10.03/acre/year, respectively. Considering only coastal zone wetlands across all study categories, the value of wetlands to aggregate hunting or fishing (both commercial and recreational) ranged from $16.76/acre/year to $1,025.03/acre/year, with a mean and median of $233.37/acre/year and $106.54/acre/year, respectively.

18 All values in year 2000 dollars.

19 It should be emphasized that all of the reported Louisiana valuation studies were conducted by one set of authors in a very specific time period. The importance of this information to understanding the value of water quality services derived from Louisiana wetlands is not clear, although it is always preferable to have multiple, independent studies on which to base inferences.

For comparison purposes, reported estimates of willingness-to-pay (WTP) values for wetland hunting and fishing services ranged from a low of $83.99 to $616.46, with a mean and median of $303.67 and $207.79, respectively (Table 1). Variability among the WTP estimates was essentially similar to those generated by the other valuation methods, and they yielded similar valuation levels.

Table 1. Published estimates of hunting and fishing service values provided by wetlands, 1978-2001.

Study	Location	Site Type	Site Use	Site Size (acres)	Valuation Method	Discount Rate (%)	Time Horizon (years)	Base Year	NPV Estimate (base yr $)	Annualized Value/Acre (base yr $)	Annualized Value/Acre (yr 2000 $)[a]
					Louisiana Specific Studies						
Costanza and Farber 1987	Terrebonne Parish, Louisiana	Coastal Louisiana	Commercial blue crab fishery	-----	Secondarily calculated marginal value product	-----	-----	1983	-----	0.67	1.16
Costanza and Farber 1987	Terrebonne Parish, Louisiana	Coastal Louisiana	Commercial menhaden fishery	-----	Secondarily calculated marginal value product	-----	-----	1983	-----	5.80	10.03
Costanza and Farber 1987	Terrebonne Parish, Louisiana	Coastal Louisiana	Commercial oyster fishery	-----	Secondarily calculated marginal value product	-----	-----	1983	-----	8.04	13.90
Costanza and Farber 1987	Terrebonne Parish, Louisiana	Coastal Louisiana	Commercial shrimp fishery	-----	Secondarily calculated marginal value product	-----	-----	1983	-----	10.86	18.78
Costanza and Farber 1987, Costanza et al. 1989	Terrebonne Parish, Louisiana	Coastal Louisiana	Commercial trapping	-----	Secondarily calculated marginal value product	-----	-----	1983	-----	12.09	20.90
Costanza et al. 1989	Louisiana	Coastal wetlands	Commercial fishing,	-----	Production function, marginal value product	8.0 , 3.0	Infinite	1983	317, 846	25.36	43.85
					Additional U.S. Studies						
Lynne et al. 1981	Florida Gulf Coast	Coastal wetlands	Commercial blue crab fishing	-----	Estimated production function, marginal value product	10.0	Infinite	1974	3	0.30	1.05
Batie and Wilson 1978	Accomack, Virginia	Coastal wetlands	Oyster production	-----	Estimated production function, marginal value product	10.0	Infinite	1969	11	1.13	5.30
Batie and Wilson 1978	James City, Virginia	Coastal wetlands	Oyster production	-----	Estimated production function, marginal value product	10.0	Infinite	1969	16	1.64	7.70

Table 1. Published estimates of hunting and fishing service values provided by wetlands, 1978-2001 – continued.

Study	Location	Site Type	Site Use	Site Size (acres)	Valuation Method	Discount Rate (%)	Time Horizon (years)	Base Year	NPV Estimate (base yr $)	Annualized Value/Acre (base yr $)	Annualized Value/Acre (yr 2000 $)[a]
---------- **Additional U.S. Studies** ----------											
van Vuuren and Roy 1993	Lake St. Clair, Michigan & Canada	Freshwater wetlands	Trapping	49.4 diked	Travel cost	4.0	50	1985	286	5.39	8.63
Batie and Wilson 1978	York, Virginia	Coastal wetlands	Oyster production	-----	Estimated production function, marginal value product	10.0	Infinite	1969	19	1.88	8.82
van Vuuren and Roy 1993	Lake St. Clair, Michigan & Canada	Freshwater wetlands	Public hunting	49.4 diked	Travel cost	4.0	50	1985	567	10.68	17.09
Batie and Wilson 1978	Virginia Beach, Virginia	Coastal wetlands	Oyster production	-----	Estimated production function, marginal value product	10.0	Infinite	1969	42	4.24	19.89
van Vuuren and Roy 1993	Lake St. Clair, Michigan & Canada	Freshwater wetlands	Public hunting	741 undiked	Travel cost	4.0	50	1985	1,094	20.61	32.98
van Vuuren and Roy 1993	Lake St. Clair, Michigan & Canada	Freshwater wetlands	Angling	741 undiked	Travel cost	4.0	50	1985	2,488	46.87	75.01
Woodward and Wui 2001	-----	Mixed	Bird hunting	-----	Econometric meta-analysis of 39 studies yielding per acre values; excludes WTP where per acre value was not generated	-----	-----	1990	-----	70 90% C.I. of 25 - 197	92.23
Bell 1997	Florida west coast	Estuarine saltwater marsh	Recreational fishing for estuarine dependent species	-----	Estimated production function linked with angler demand function to calculate consumer surplus	8.125	Infinite	1984	981[b]	79.71	132.11

Table 1. Published estimates of hunting and fishing service values provided by wetlands, 1978-2001 – continued.

Study	Location	Site Type	Site Use	Site Size (acres)	Valuation Method	Discount Rate (%)	Time Horizon (years)	Base Year	NPV Estimate (base yr $)	Annualized Value/Acre (base yr $)	Annualized Value/Acre (yr 2000 $)[a]
Additional U.S. Studies											
van Vuuren and Roy 1993	Lake St. Clair, Michigan & Canada	Freshwater wetlands	Hunting clubs	370.7 diked	Travel cost	4.0	50	1985	5,174	97.47	155.99
van Vuuren and Roy 1993	Lake St. Clair, Michigan & Canada	Freshwater wetlands	Hunting clubs	49.4 diked	Travel cost	4.0	50	1985	6,115	115.20	184.36
Woodward and Wui 2001	-----	Mixed	Recreational fishing	-----	Econometric meta-analysis of 39 studies yielding per acre values; excludes WTP where per acre value was not generated	-----	-----	1990	-----	357 90% C.I. of 95 - 1,342	470.36
Batie and Wilson 1978	Westmoreland Virginia	Coastal wetlands	Oyster production	-----	Estimated production function, marginal value product	10.0	Infinite	1969	1,072	107.22	503.09
Batie and Wilson 1978	Northumber-land, Virginia	Coastal wetlands	Oyster production	-----	Estimated production function, marginal value product	10.0	Infinite	1969	1,414	141.46	663.74
Bell 1997	Florida east coast	Estuarine saltwater marsh	Recreational fishing for estuarine dependent species	-----	Estimated production function linked with angler demand function to calculate consumer surplus	8.125	Infinite	1984	6,471[b]	525.77	871.39
Woodward and Wui 2001	-----	Mixed	Commercial fishing	-----	Econometric meta-analysis of 39 studies yielding per acre values; excludes WTP where per acre value was not generated	-----	-----	1990	-----	778 90% C.I. of 108 - 5,618	1,025.03

Table 1. Published estimates of hunting and fishing service values provided by wetlands, 1978-2001 – continued.

Study	Location	Site Type	Site Use	Site Size (acres)	Valuation Method	Discount Rate (%)	Time Horizon (years)	Base Year	NPV Estimate (base yr $)	Annualized Value/Acre (base yr $)	Annualized Value/Acre (yr 2000 $)[a]
International Studies											
Kosz et al. 1992	Vienna National Park	Danube floodplain contained in Park	Recreational hunting	-----	Prices paid for permits	-----	-----	1991		14.57 ecu	16.76[c]
Sathirathai and Barbier 2001	Thailand	Mangrove wetland	Offshore fishery, all species	988	Production function	-----	-----	1993	n.a	21[d]	25.03
Costanza et al. 1997	World wide	Coastal wetlands	Food production	815 m world wide	Mixed aggregation of various studies; little detail given concerning specific studies	-----	-----	1994	-----	104	120.84
Studies Where Value Not Reported on an Area Basis											
Cooper and Loomis 1991	San Joaquin Valley, California	Seven freshwater wildlife reserves	Recreational waterfowl hunting	-----	Travel cost model	-----	-----	1987	-----	55.41[e g]	83.99[g]
Farber 1988	Terrebonne Parish wetlands	Coastal	Recreational hunting and fishing combined	650,000	Travel cost model, direct WTP, demand function derived consumer surplus	-----	-----	1984	-----	103-323[g] per household, depending on method and assumptions	170.71-535.33[g]
Creel and Loomis 1992	San Joaquin Valley, California	Freshwater recreational areas	Recreational fishing only	-----	Linked site selection and trip count models	-----	-----	1988	-----	131.50[f g]	191.41[g]
Creel and Loomis 1992	San Joaquin Valley, California	Freshwater recreational areas	Recreational hunting only	-----	Linked site selection and trip count models	-----	-----	1988	-----	154.00[f g]	224.17[g]

Table 1. Published estimates of hunting and fishing service values provided by wetlands, 1978-2001 – continued.

Study	Location	Site Type	Site Use	Site Size (acres)	Valuation Method	Discount Rate (%)	Time Horizon (years)	Base Year	NPV Estimate (base yr $)	Annualized Value/Acre (base yr $)	Annualized Value/Acre (yr 2000 $)[a]
---------- **Studies Where Value Not Reported on an Area Basis** ----------											
Creel and Loomis 1992	San Joaquin Valley, California	Freshwater recreational areas	Recreational hunting and fishing combined	-----	Linked site selection and trip count models	-----	-----	1988	-----	423.50 [f g]	616.46 [g]

[a] Study values inflated to common year 2000 values using the Bureau of Labor Statistics (BLS) CPI Inflation Calculator, which bases yearly adjustments on the average consumer price index by year.
[b] East-west difference due to different WTP estimates and marsh abundance levels.
[c] Inflated to year 2000 using the BLS CPI Inflation Calculator and converted to U.S. dollars using the ratio 1.10 ecu/$1.00 U.S.
[d] Under the assumption of a unitary demand elasticity.
[e] Consumer surplus per hunter day.
[f] Mean of two differently specified models.
[g] Value is not reported on a per acre per year basis. In most cases, the value represents household willingness-to-pay for the service where the service/wetland quantity relationship is not defined.

Table 2. Published estimates of total service values provided by wetlands, 1975-2001.

Study	Location	Site Type	Site Use	Site Size (acres)	Valuation Method	Discount Rate (%)	Time Horizon (years)	Base Year	NPV Estimate (base yr $)	Annualized Value/Acre (base yr $)	Annualized Value/Acre (yr 2000 $)[a]
					Louisiana Specific Studies						
Costanza and Farber 1987	Terrebonne Parish, Louisiana	Coastal Louisiana	Summation of commercial fishing, trapping, recreation, and storm protection	650,000	Simple summation of mixed method estimates of individual services	8.0	Infinite	1983	586.73	46.94	81.16
Costanza et al. 1989	Louisiana	Coastal wetlands	Commercial fishing, trapping, recreation, and storm protection	-----	Production function, revenue accounting, travel cost, and WTP contingent valuation	8.0 , 3.0	Infinite	1983	2,429 - 8,977	194.32[b]	335.96
Costanza and Farber 1987, Costanza et al. 1989	Terrebonne Parish, Louisiana	Fresh coastal wetlands	All services	650,000	Energy analysis based gross primary productivity conversion, net value lost when converting wetland to open water	8.0	Infinite	1983	6,400	512.00	885.20
Costanza and Farber 1987	Terrebonne Parish, Louisiana	Saltwater coastal wetlands	All services	650,000	Energy analysis based gross primary productivity conversion, net value lost when converting wetland to open water	8.0	Infinite	1983	6,700	536.00	926.70
Costanza and Farber 1987	Terrebonne Parish, Louisiana	Brackish coastal wetlands	All services	650,000	Energy analysis based gross primary productivity conversion, net value lost when converting wetland to open water	8.0	Infinite	1983	10,602	848.16	1,466.40

Table 2. Published estimates of total service values provided by wetlands, 1975-2001 -- continued.											
Study	**Location**	**Site Type**	**Site Use**	**Site Size (acres)**	**Valuation Method**	**Discount Rate (%)**	**Time Horizon (years)**	**Base Year**	**NPV Estimate (base yr $)**	**Annualized Value/Acre (base yr $)**	**Annualized Value/Acre (yr 2000 $)[a]**
					Additional U.S. Studies						
van Vuuren and Roy 1993	Lake St. Clair, Michigan & Canada	Freshwater wetlands	Public and club hunting, angling, trapping	741 undiked	Travel cost	4.0	50	1985	4,435	83.55	133.71
Gupta and Foster 1975	Massachusetts	LLNN Wetland	Benefits of wildlife, visual/cultural, water supply, and flood control	-----	Average state acquisition price scaled by habitat score (wildlife) or quality (visual cultural), 1971 ACE study of Charles River (flood control), 1970 USGS study (supply)	7.0	30	1972	500	40	165
van Vuuren and Roy 1993	Lake St. Clair, Michigan & Canada	Freshwater wetlands	Public and club hunting, angling, trapping	370.7 diked	Travel cost	4.0	50	1985	6,027	113.54	181.71
van Vuuren and Roy 1993	Lake St. Clair, Michigan & Canada	Freshwater wetlands	Public and club hunting, angling, trapping	49.4 diked	Travel cost	4.0	50	1985	6,968	131.27	210.08
Roberts and Leitch 1997	Mud Lake, MN-SD	Fresh wetland	All services	-----	Cost savings, residual return to water utilities, contingent valuation	-----	-----	1995	-----	375	423.72
Gupta and Foster 1975	Massachusetts	HLNN Wetland	Benefits of wildlife, visual/cultural, water supply, and flood control	-----	Average state acquisition price scaled by habitat score (wildlife) or quality (visual cultural), 1971 ACE study of Charles River (flood control), 1970 USGS study (supply)	7.0	30	1972	1,400	113	466
Gupta and Foster 1975	Massachusetts	LLNH Wetland	Benefits of wildlife, visual/cultural, water supply, and flood control	-----	Average state acquisition price scaled by habitat score (wildlife) or quality (visual cultural), 1971 ACE study of Charles River (flood control), 1970 USGS study (supply)	7.0	30	1972	1,700	137	564

Table 2. Published estimates of total service values provided by wetlands, 1975-2001 -- continued.

Study	Location	Site Type	Site Use	Site Size (acres)	Valuation Method	Discount Rate (%)	Time Horizon (years)	Base Year	NPV Estimate (base yr $)	Annualized Value/Acre (base yr $)	Annualized Value/Acre (yr 2000 $)[a]
Additional U.S. Studies											
Gupta and Foster 1975	Massachusetts	MMNM Wetland	Benefits of wildlife, visual/cultural, water supply, and flood control	-----	Average state acquisition price scaled by habitat score (wildlife) or quality (visual cultural), 1971 ACE study of Charles River (flood control), 1970 USGS study (supply)	7.0	30	1972	3,000	242	997
Gupta and Foster 1975	Massachusetts	LHNL Wetland	Benefits of wildlife, visual/cultural, water supply, and flood control	-----	Average state acquisition price scaled by habitat score (wildlife) or quality (visual cultural), 1971 ACE study of Charles River (flood control), 1970 USGS study (supply)	7.0	30	1972	4,100	330	1,359
Gupta and Foster 1975	Massachusetts	HHNH Wetland	Benefits of wildlife, visual/cultural, water supply, and flood control	-----	Average state acquisition price scaled by habitat score (wildlife) or quality (visual cultural), 1971 ACE study of Charles River (flood control), 1970 USGS study (supply)	7.0	30	1972	6,000	484	1,994
Gupta and Foster 1975	Massachusetts	LLLL Wetland	Benefits of wildlife, visual/cultural, water supply, and flood control	-----	Average state acquisition price scaled by habitat score (wildlife) or quality (visual cultural), 1971 ACE study of Charles River (flood control), 1970 USGS study (supply)	7.0	30	1972	6,400	519	2,138
Gupta and Foster 1975	Massachusetts	HHLH Wetland	Benefits of wildlife, visual/cultural, water supply, and flood control	-----	Average state acquisition price scaled by habitat score (wildlife) or quality (visual cultural), 1971 ACE study of Charles River (flood control), 1970 USGS study (supply)	7.0	30	1972	11,700	943	3,885
Gupta and Foster 1975	Massachusetts	HHMH Wetland	Benefits of wildlife, visual/cultural, water supply, and flood control	-----	Average state acquisition price scaled by habitat score (wildlife) or quality (visual cultural), 1971 ACE study of Charles River (flood control), 1970 USGS study (supply)	7.0	30	1972	26,000	2,095	12,750

Table 2. Published estimates of total service values provided by wetlands, 1975-2001 -- continued.

Study	Location	Site Type	Site Use	Site Size (acres)	Valuation Method	Discount Rate (%)	Time Horizon (years)	Base Year	NPV Estimate (base yr $)	Annualized Value/Acre (base yr $)	Annualized Value/Acre (yr 2000 $)[a]
Additional U.S. Studies											
Gupta and Foster 1975	Massachusetts	LLHL Wetland	Benefits of wildlife, visual/cultural, water supply, and flood control	-----	Average state acquisition price scaled by habitat score (wildlife) or quality (visual cultural), 1971 ACE study of Charles River (flood control), 1970 USGS study (supply)	7.0	30	1972	40,700	3,280	13,512
International Studies											
Gupta and Foster 1975	Massachusetts	HHHH Wetland	Benefits of wildlife, visual/cultural, water supply, and flood control	-----	Average state acquisition price scaled by habitat score (wildlife) or quality (visual cultural), 1971 ACE study of Charles River (flood control), 1970 USGS study (supply)	7.0	30	1972	46,000	3,707	15,271
Thibodeau and Ostro 1981	Charles River Basin	Costal wetlands	All services	8,535	Simple summation of mixed method estimates of individual services	6	Infinite	1978	171,772	10,306.32	27,220
Gren et al. 1995	Danube floodplain	Mixed	All ecosystem services	4.3 m	Summation of individual service estimates	5.0 and 2.0 percent	infinite	1991	3,027 ecu to 7568 ecu per acre	151.35 ecu	174.13[c]
Costanza et al. 1997	World wide	Coastal wetlands	All services and products	815 m world wide	Mixed aggregation of various studies; little detail given concerning specific studies	-----	-----	1994	-----	5,983	6,952
Sathirathai and Barbier 2001	Thailand	Mangrove wetland	Direct and indirect use (timber, fishing, coastline protection)	988	various	-----	-----	1993	-----	1,553[d]	1,851

Table 2. Published estimates of total service values provided by wetlands, 1975-2001 -- continued.

Study	Location	Site Type	Site Use	Site Size (acres)	Valuation Method	Discount Rate (%)	Time Horizon (years)	Base Year	NPV Estimate (base yr $)	Annualized Value/Acre (base yr $)	Annualized Value/Acre (yr 2000 $)[a]
	------- **Studies Where Value Not Reported on an Area Basis** -------										
Mullarkey and Bishop 1999	Northwest Wisconsin	Fresh wetland	Total value under high certainty	110	WTP mail survey; respondent certainty and scope test included	-----	-----	1995	-----	20.77 [e]	23.47 [e]
Mullarkey and Bishop 1999	Northwest Wisconsin	Fresh wetland	Total value under low certainty	110	WTP mail survey; respondent certainty and scope test included	-----	-----	1995	-----	57.83 [e]	65.34 [e]
Pate and Loomis 1997	San Joaquin Valley, CA	General wetlands	Generalized to all uses	90,000	WTP mail survey of Oregon residents	-----	-----	1989	-----	67.80 [e]	94.15 [e]
Loomis et al. 2000	Nebraska	Platte River	Wastewater dilution, water purification, erosion control, habitat, and recreation	300,000	WTP mail survey	-----	-----	1998	-----	252 [e]	100.79 [e]
Stevens et al. 1995	New England	General wetlands	Recreation, rare species, food production, flood protection, water supply and pollution control	-----	WTP contingent valuation mail survey	-----	-----	1993	-----	114.29 [e]	136.20 [e]
Pate and Loomis 1997	San Joaquin Valley, CA	General wetlands	Generalized to all uses	90,000	WTP mail survey of Washington residents	-----	-----	1989	-----	99.75 [e]	138.52 [e]
Pate and Loomis 1997	San Joaquin Valley, CA	General wetlands	Generalized to all uses	90,000	WTP mail survey of Nevada residents	-----	-----	1989	-----	196.01 [e]	272.20 [e]
Pate and Loomis 1997	San Joaquin Valley, CA	General wetlands	Generalized to all uses	90,000	WTP mail survey California residents outside the San Joaquin Valley	-----	-----	1989	-----	210.77 [e]	292.70 [e]

Table 2. Published estimates of total service values provided by wetlands, 1975-2001 -- continued.

Study	Location	Site Type	Site Use	Site Size (acres)	Valuation Method	Discount Rate (%)	Time Horizon (years)	Base Year	NPV Estimate (base yr $)	Annualized Value/Acre (base yr $)	Annualized Value/Acre (yr 2000 $)[a]
	---------- **Studies Where Value Not Reported on an Area Basis** ----------										
Pate and Loomis 1997	San Joaquin Valley, CA	General wetlands	Generalized to all uses	90,000	WTP mail survey of San Joaquin Valley residents	-----	-----	1989	-----	215.55 [e]	299.34 [e]

[a] Study values inflated to common year 2000 values using the Bureau of Labor Statistics (BLS) CPI Inflation Calculator, which bases yearly adjustments on the average consumer price index by year.
[b] Storm protection accounted for 79 percent ($153.20/acre/yr) of the total value.
[c] Inflated to year 2000 using the BLS CPI Inflation Calculator and converted to U.S. dollars using the ratio 1.10 ecu/$1.00 U.S.
[d] Value is strongly influenced by estimates for coastline protection, which account for 96% of the total.
[e] Value is not reported on a per acre per year basis. In most cases, the value represents household willingness-to-pay for the service where the service/wetland quantity relationship is not defined.

Literature Cited

Amacher, G.S., R.J. Brazee, J.W. Bulkley and R.A. Moll. 1989. *Application of Wetland Valuation Techniques: Examples from Great Lakes Coastal Wetlands.* Report No. 88-G1569-02, School of Natural Resources, The University of Michigan and the Institute of Water Research, Michigan State University.

Anderson, R. and M. Rockel. 1991. *Economic Valuation of Wetlands.* Discussion Paper #065, American Petroleum Institute, Washington, D.C.

Apogee Research, Inc. 1996. *Monetary Measurement of Environmental Goods and Services: Framework and Summary of Techniques for Corps Planners.* IWR Report 96-R-24, U.S. Army Corps of Engineers Institute for Water Resources, Alexandria, Virginia.

Batie, S.S. and J.R. Wilson. 1978. "Economic Values Attributable to Virginia's Coastal Wetlands as Inputs in Oyster Production." *Southern Journal of Agricultural Economics* 10(1):111-118.

Bell, F.W. 1997. "The Economic Valuation of Saltwater Marsh Supporting Marine Recreational Fishing in the Southeastern United States." *Ecological Economics* 21:243-254.

Bishop, R.C., P.A. Champ and D.J. Mullarkey. 1998. "Contingent Valuation." In D.W. Bromley (ed.), *The Handbook of Environmental Economics.* Cambridge, Massachusetts: Blackwell Publishers Ltd.

Bockstael, N.W. 1998. "Travel Cost Models." In D.W. Bromley (ed.), *The Handbook of Environmental Economics.* Cambridge, Massachusetts: Blackwell Publishers Ltd.

Carson, R., N. Flores, K. Martin and J. Wright. 1996. "Contingent Valuation and Revealed Preference Methodologies: Comparing Estimates for Quasi-Public Goods." *Land Economics* 72:80-99.

Cooper, J. and J. Loomis. 1991. "Economic Value of Wildlife Resources in the San Joaquin Valley: Hunting and Viewing Values." In A. Dinar and D. Zilberman (eds.), *The Economics and management of Water and Drainage in Agriculture.* Boston, Massachusetts: Kluwer Academic Publishers, pp. 447-462.

Costanza, R. and S. Farber. 1987. "The Economic Value of Wetlands Systems." *Journal of Environmental Management* 24:41-51.

Costanza, R., S.C. Farber and J. Maxwell. 1989. "Valuation and Management of Wetland Ecosystems." *Ecological Economics* 1:335-361.

Costanza, R., R. d'Arge, R. de Groot, S. Farber, M. Grasso, B. Hannon, K. Limburg, S. Naeem, R.V. O'neill, J. Paruelo, R.G. Raskin, P. Sutton and M. van den Belt. 1997. "The Value of the World's Ecosystem Services and Natural Capital." *Nature* 387:253-260.

Creel, M. and J. Loomis. 1992. "Recreation Value of Water to Wetlands in the San Joaquin Valley: Linked Multinomial Logit and Count Data Trip Frequency Models." *Water Resources Research* 28(10):2597-2606.

Farber, S. 1988. “The Value of Coastal Wetlands for Recreation: An Application of Travel Cost and Contingent Valuation Methodologies.” *Journal of Environmental Management* 26:299-312.

Feather, T.D., C.S. Russell, K.W. Harrington and D.T. Capan. 1995. *Review of Monetary and Nonmonetary Valuation of Environmental Investments.* IWR Report 95-R-2, U.S. Army Corps of Engineers Institute for Water Resources, Alexandria, Virginia.

Freeman, A.M. 1998. "Hedonic Pricing Methods." In D.W. Bromley (ed.), *The Handbook of Environmental Economics.* Cambridge, Massachusetts: Blackwell Publishers Ltd.

Gosselink, J.G. E.P. Odum and R.M. Pope. 1974. *The Value of the Tidal Marsh*. Publ. LSU-SG-74-03, Center for Wetland Resources, Louisiana State University, Baton Rouge, Louisiana.

Greenley, D.A., R.G. Walsh and R.A. Young. 1982. *Economic Benefits of Improved Water Quality: Public Perceptions of Option and Preservation Values.* Boulder, Colorado: Westview Press.

Gren, I-M., K-H. Groth and M. Sylven. 1995. "Economic Values of Danube Floodplains." *Journal of Environmental Management* 45:333-345.

Gupta, T.R. and J.H. Foster. 1975. "Economic Criteria for Freshwater Wetland Policy in Massachusetts." *American Journal of Agricultural Economics* 57:40-45.

Heimlich, R.E., K.D. Wiebe, R. Claassen, D. Gadsby and R.M. House. 1998. *Wetlands and Agriculture: Private Interests and Public Benefits*. Agricultural Economic Report No. 765, Resource Economics Division, Economic Research Service, U.S. Department of Agriculture, Washington, D.C. 94 p.

Keithly, W.R. and J.M. Ward. 2001. "An Economic Perspective of Hypoxia in the Northern Gulf of Mexico." In N.N. Rabalais and R.E. Turner (eds.), *Coastal Hypoxia: Consequences for Living Resources and Ecosystems*. Washington, DC: Coastal and Estuarine Studies 58, American Geophysical Union.

Kosz, M., B. Brezina and T. Madreiter. 1992. "Kosten-Nuzen Analyse Ausgewahlter Varianten Eines Nationalparks Danau-Auen." Institute fur Finanzwissenschaft and Infrastrukturpolitik der Technischen Universitat Wien, Austria.

Kroodsma, D.E. 1979. "Habitat Values for Nongame Wetland Birds." In P.E. Greeson, J.R. Clark and J.E. Clark (eds.), *Wetland Functions and Values -- The State of Our Understanding*. Minneapolis, Minnesota: American Water Resources Association.

Loomis, J., P. Kent, L. Strange, K. Fausch and A. Covich. 2000. "Measuring the Total Economic Value of Restoring Ecosystem Services in an Impaired River Basin: Results from a Contingent Valuation Survey." *Ecological Economics* 33:103-117.

Lynne, G.D., P. Conroy and F.J. Prochaska. 1981. "Economic Valuation of Marsh Areas for Marine Production Processes." *Journal of Environmental Economics and Management* 8:175-186.

Mahan, B.L. 1997. *Valuing Urban Wetlands: A Property Pricing Approach.* IWR Report 97-R-1, U.S. Army Corps of Engineers Institute for Water Resources, Alexandria, Virginia.

Mitsch, W. J. and J.G. Gosselink. 1993. *Wetlands, 2nd Edition*. New York: Van Nostrand Reinhold.

Mullarkey, D.J. and R.C. Bishop. 1999. *Sensitivity to Scope: Evidence from a CVM Study of Wetlands*. Mimeo. Presented at the American Agricultural Economics Association meetings, Nashville, TN.

Odum, E.P. and H.T. Odum. 1972. "Natural Areas as Necessary Components of Man's Total Environment." *Transactions of the North American Wildlife and Natural Resources Conference.* pp. 178-189.

Pate, J. and J. Loomis. 1997. "The Effect of Distance on Willingness to Pay Values: A Case Study of Wetlands and Salmon in California." *Ecological Economics* 20:199-207.

Pearce, D.W. and R.K. Turner. 1990. *Economics of Natural Resources and the Environment.* Baltimore, Maryland: John Hopkins University Press.

Pendleton, L.H. and J.S. Shonkwiler. 2001. "Valuing Bundled Attributes: A Latent Characteristics Approach." *Land Economics* 77(1):118-129.

Roberts, L.A. and J.A. Leitch. 1997. *Economic Valuation of Some Wetland Outputs of Mud Lake, Minnesota-South Dakota.* Agricultural Economics Report No. 381, Department of Agricultural Economics, North Dakota State University, October.

Sathirathai, S. and E.B. Barbier. 2001. "Valuing Mangrove Conservation in Southern Thailand." *Contemporary Economic Policy* 19(2):109-122.

Scodari, P.F. 1990. *Wetlands Protection: The Role of Economics*. Environmental Law Institute, Washington, D.C. 89 pp.

Shabman, L.A. and S.S. Batie. 1978. "Economic Value of Natural Coastal Wetlands: A Critique." *Coastal Zone Management Journal* 4(3):231-247.

Stevens, T.H., S. Benin and J.S. Larson. 1995. "Public Attitudes and Economic Values for Wetland Preservation in New England." *Wetlands* 15(3):226-231.

Thibodeau, F.R. and B.D. Ostro. 1981. "An Economic Analysis of Wetland Protection." *Journal of Environmental Management* 12:19-30.

U.S. Department of Commerce, National Oceanic and Atmospheric Administration. 1993. "Natural Resource Damage Assessments Under the Oil Pollution Act of 1990." *Federal Register* 58(10):4601-4614.

van Vuuren, W. and P. Roy. 1993. "Private and Social Returns from Wetland Preservation Versus Those From Wetland Conversion to Agriculture." *Ecological Economics* 8:289-305.

Whitehead, J.C. 1992. "Economic Valuation of Wetland Resources: A Review of the Value Estimates." *Journal of Environmental Systems* 22(2):151-161.

Woodward, R.T. and Y.S. Wui. 2001. "The Economic Value of Wetland Services: A Meta-Analysis." *Journal of Ecological Economics* 37(2):257-270.