III. Wetland Functions: Physical Values and Economic Values

Public recognition of the value of wetlands has risen rapidly over the past 25 years. Today, scientists and environmental interest groups recognize how many different species and functions depend on wetlands and strive to increase public awareness of their importance in the natural order and to society. However, this increased recognition has not resulted in economic value that individual landowners can capture in the marketplace. Many now-recognized wetland benefits are nonmarketed goods, such as water quality and wildlife preservation. Although these wetland services are important to society, they have often been undervalued relative to converting wetlands to other land uses. Economists have developed nonmarket valuation techniques to estimate these values. However, variations in methods, physical properties of the wetlands, position of the wetland in the landscape, and socioeconomic context contribute to large variations in estimated wetland values.

Functions, Services, and Economic Values

There are bioeconomic linkages among wetland functions, services generated by those functions, and socially valued outcomes (fig. 2). A wetland performs a biologic, hydrologic, or geologic function that produces a good or supports an ecological service. Some wetlands perform many such functions, but some may perform only one or none. Many of the services provided are joint products, provided simultaneously in varying degrees by the same wetland function, based on the quality and characteristics of the wetland. For example, sediment and nutrient trapping in wetlands also makes the wetland a valuable habitat for fish nurseries and is associated with flood peak retention. Human populations value the flow of goods and services natural wetlands produce, some of which are traded in markets. Many other goods and services are not marketed, but economists have developed techniques for estimating the economic values of the nonmarket goods and services that account for complex bioeconomic linkages. In general, marketed goods and services provide mainly private benefits, while nonmarketed goods and services provide mainly public benefits.

An example of a marketed good that produces mostly separable, exclusive, private benefits is tree growth. The wetland may be a physical medium for tree growth that supports a service, such as commercial tree harvest. That service has an economic value, in this case the net value of the timber. Foresters can model and value linkages between site characteristics and tree growth, determining the types of trees that will grow on a site and the associated board-feet of timber that can be produced. Next, the good or service must be valued in economic terms. Forest economists use market valuation techniques that consider commercial prices of timber, transportation costs, production costs, and other factors to estimate the net economic value of the timber produced.

Another example is commercial fishing. Here, the linkages are less clear, particularly the relationship between fish habitat and commercial fish harvest. A wetland area functions as a nursery ground for young fish, and as a medium for further growth. The tonnage of fish and shellfish that can be harvested in an estuary, or offshore from the estuary, is related to this wetland habitat function. The economic value linkage is the relationship of the commercial fish harvest to the net value of the commercial fish species. That is, once the portion of the tonnage harvested related to the wetland is known, an economist can combine dock prices with estimates of production and harvesting costs to estimate the net economic value of the harvest attributable to wetlands.

Finally, the linkages that are least clear are those involving nonmarket valuation. For example, the wetland function could be wildlife habitat that provides a service of improving the recreational waterfowl experience for hunters. Estimating the relationship between wildlife habitat and waterfowl hunting quality is extremely complicated because of the many links between physical functions, services provided, and economic values served. The economic valuation linkage is the relationship between recreational waterfowl hunting and the net economic value of the hunting experience. Nonmarket valuation techniques can be used to establish the linkage between the service provided and the contribution of wetlands to that value. The relationships between habitat, waterfowl populations, hunting quality, and economic values involve biological, recreational, sociological, and economic considerations that interact in very complex ways.

Nonmarket Wetland Values

Although some values derived from wetlands can be determined using market transactions, or using

Figure 2
Wetland bioeconomic linkages

	Private values		Mixed values	Public values		
Wetland	**Forestry**	**Fisheries**	**Recreation**	**Flood control**	**Water quality**	**Endangered species**
Function	Tree growth medium	Fish habitat	Wildlife habitat	Flood retention	Water filtration	Wildlife habitat
Service	Commercial timber harvest	Commercial fish harvest	Recreational waterfowl harvest	Reduced flood flows/peaks	Cleaner water	Biodiversity
Economic value	Net economic value of timber	Net economic value of commercial catch	Net economic value of hunting experience	Net economic value of reduced damages	Net economic value of reduced damages	Net option and existence values

Source: Adapted from Bergstrom and Brazee (1991).

income attributable to each factor of production used to produce marketable commodities (for example, Lynne, and others, 1981), most economic values associated with wetland benefits must be estimated using nonmarket techniques. Eliciting use values with nonmarket techniques involves either revealed preference approaches, such as travel cost or hedonic methods, or expressed preference approaches, such as contingent valuation and conjoint analysis (Scodari, 1997; Anderson and Rockel, 1991; Braden and Kolstad, 1991; Freeman, 1979). Values of people who do not use wetlands reflect the importance of the continued existence of the resource, or the option of using the resource in the future. Travel cost methods are used for recreation sites where it is assumed that the cost of traveling to the site and foregoing income from working to use it are revealed measures of the value users place on the resource (Clawson and Knetsch, 1966). Hedonic methods decompose the observed values of goods, such as housing, into various attributes, including environmental amenities that might influence price (Farber, 1987). Contingent valuation directly elicits values through surveys, and can be used for both use and nonuse values (Bergstrom, and others, 1990; Loomis, and others, 1990). Finally, ecological functions provided by wetlands can be valued using replacement or avoided cost methods that price the service provided in terms of equivalent manmade services (for example, nutrient filtering), or in terms of avoided damages (for example, from flooding or hurricanes) (Folke, 1991).

Many authors have constructed classification schemes for wetland functions and values (NRC, 1995; Anderson and Rockel, 1991; Novitski, and others, 1996; Scodari, 1997; Leitch and Ekstrom, 1989; Leitch and Ludwig, 1995). Although these authors generally agree on the broad categories of functions and services, they do not agree on details or what to call specific functions and services. Not surprisingly, physical scientists characterize wetlands based on physical and biological functions, while economists make characterizations based on human uses and valuation of wetland resources. Available economic studies of wetland valuation from the United States and abroad are collected and organized in table 1 (see Appendix I for compilation details). Although the values vary greatly, even within a category, some generalizations about nonmarket wetland values are possible.

Agricultural vs. Nonagricultural Wetlands

Typical wetlands in agricultural landscapes have generally not been studied for economic values. Coastal marshes and wetlands in urbanizing areas have received more attention by economists. Perhaps this is because the functions and values associated with

Table 1—Economic values of wetland functions

Wetland function valued	Number of studies	Median	Mean	Range of means
	Number	- - - - - - - - - -Dollars per acre-	- - - - - - - - - -	
Marketed goods:				
Fish and shellfish support	8	702	6,132	7-43,928
Fur-bearing animals	2	na	137	13-261
Nonmarketed goods:				
General-nonusers	12	32,903	83,159	115-347,548
General-users	6	623	2,512	105-9,859
Fishing-users	7	362	6,571	95-28,845
Hunting-users	11	1,031	1,019	18-3,101
Recreation-users	8	244	1,139	91-4,287
Ecological functions:	17	2,428	32,149	1-200,994
Amenity and cultural	4	448	2,722	83-9,910

na = not available.
Sources: See Appendix I.

coastal wetlands are more obvious because these wetlands are near large populations or may have been perceived as more threatened, despite higher absolute rates of agricultural wetland conversion.

Marketed Goods

Values for marketed goods from wetlands, generally including fish and shellfish and fur-bearing animals, are lower than values for nonmarketed goods from wetlands. If the values of marketed goods were large relative to nonmarketed goods, wetland owners might be able to capture more of the value of services provided by the wetlands directly from anglers and others who benefit from them.

The values of marketed goods that might be produced by draining or filling a wetland are not considered in this section. These values are the opportunity costs of keeping the wetland as a wetland (we estimate opportunity costs of agricultural conversion in response to a proposed policy change in Chapter VI). The case of timber harvesting is an ambiguous one because harvesting timber, particularly from old-growth bottomland hardwood stands, may be tantamount to destroying the wetland, even though the trees are theoretically a renewable resource that can regenerate. Much of the acreage of wetlands listed as converted to "other" uses between 1974 and 1982 was forested wetlands that had been drained and harvested, but not put to an identifiable use at the end of the inventory period. This land may have been intended for agricultural use, but was not used for agricultural production at the end of the inventory period.

User and Nonuser Values

Values per acre elicited from people who do not use the wetland directly are generally higher than values elicited from wetland users. This apparent paradox is because the willingness to pay for wetland preservation by nonusers is actually lower per person than for users, but the number of nonusers willing to respond with a value is much greater than the number of wetland users. Evidence from some studies shows that willingness to pay declines with distance from the subject wetland (Hanley and Craig, 1991). This finding is complicated by certain nationally or internationally known wetlands (Florida's Everglades or Virginia's Great Dismal Swamp) that may have nonuse values for persons thousands of miles away. Another complication with nonuse valuation is that respondents may consciously or unconsciously be valuing wetlands generally, rather than any specific subject wetland.

Nonuse value estimates may be good relative measures of public support for environmental amenities, but may be suspect as absolute measures of benefits. In particular, nonuse values for relatively abundant, generic wetlands, versus a specific, clearly defined wetland subject to a development proposal, may not be useful. Comparisons between nonuse values and market values may also not be appropriate. Finally, the hypothetical nature of survey techniques to obtain nonuse values makes differentiation between "willingness to pay" and "ability to pay" difficult (Freeman, 1979; Anderson and Rockel, 1991; Barbier, and others, 1997).

Variations in Wetlands and Context

The range in values shown, even within specific functional categories, arises partly from the range in wetland characteristics that are almost unique from wetland to wetland, and, more importantly, from the social and economic context within which the valuation studies were conducted. It is easy to understand that coastal marshes, riparian wetlands, and prairie pothole wetlands may elicit different values based on variation in the functions and services they provide. What is more difficult to recognize is that the number of people living in the surrounding area and their wetland use, education, age, income, and other characteristics, and the range of alternative wetland and nonwetland opportunities available may contribute more to differences in valuation than the wetland characteristics themselves. That is, identical wetlands, providing identical functions and services, may be less valued in remote, isolated areas surrounded by other similar wetlands than in densely populated areas with few remaining wetlands.

Ecological Functions

Values of ecological services based on replacement costs of artificially supplied alternatives can be large. However, wetlands may not actually be used to provide such services, particularly water supply, and the artificial substitutes may seldom actually be built. In reality, areas undergoing wetland conversion often forego the services once provided by natural wetlands, risking increased flood damages and enduring periodic water shortages and reduced water quality.

Heterogeneity and Cumulative Impact

Economic valuation techniques attempt to estimate the marginal value of small losses or gains of wetlands. Valuation methods are based on the assumption that increments of wetland acres are identical, uniform substitutes for one another, and that a continuous, smoothly shaped supply function of wetland acres (or services) underlies the valuation problem. However, even within a given wetland complex, differences in hydrologic and landscape position mean that some wetland acres are more critical in providing functions and services than others. Conversion of these key wetlands can result in discontinuous changes that drastically affect the functions and services provided by the remaining wetlands. Threshold effects create other complications in which incremental conversion of wetlands causes no discernable diminution of services until a threshold is reached, dropping function and service flows to near zero. Examples include effects on flood storage and nutrient filtering dependent on discharge stage and minimum habitat size, shape, and connectedness requirements for fish and wildlife species.

Benefits Transfer

Policy analysts and decisionmakers are interested in using existing valuation studies to conduct cost/benefit analyses using benefits transfer methods (Scodari, 1990). Benefits transfer refers to the practice of using values estimated for an alternative policy context or site as a basis for estimating a value for the policy context or site in question (Barbier, and others, 1997, p. 43; Brookshire and Neill, 1992). Benefits transfer studies are often the only recourse where data are poor or funds are not sufficient for a full-scale valuation study. A number of problems with benefits transfer methods are discussed in the literature (Krupnick, 1993; WRR, 1992). This compilation of values indicates several limitations on possibilities for benefits transfer. First, wetland values in the interior of the United States and in agricultural areas generally are largely missing from the literature. Second, other than for users of fish and wildlife habitat services, most other functional categories are poorly represented. Third, there may be little opportunity to adjust wetland valuation estimates for differences in landscape and socioeconomic context. Finally, the geographic scope over which benefit estimates can be extrapolated is unclear, despite its critical role in determining the total and per acre level of benefits, particularly from nonusers.

The array of values displayed in table 1 is impressive and clearly indicates that wetlands are valued resources. However, it is not possible to estimate the full social value of the U.S. stock of wetlands based on the sparse and fragmentary data in this compilation. A much more comprehensive, consistent, and systematic effort will be needed to produce valuation estimates that could form the basis of a realistic benefits transfer scheme. A similar assessment was reached by Paul Scodari, who concluded that "Even the very best of the wetland value estimates produced to date do not shed much light on the welfare implications of wetland conversions beyond the specific wetland areas studied" (Scodari, 1997, p. 76). Although greater use of economics could improve estimates of private benefits subject to wetland regulation in specific cases (Barbier, and others, 1997), it is unlikely that economic valuation estimates could be deployed rapidly enough and with sufficient sensitivity to usefully inform cost/benefit considerations for any but the largest wetland conversion proposals (Holtman, and others, 1996; Shabman and Batie, 1987). By contrast, as we do below, it is possible to estimate, albeit crudely, the market value of the stock of remaining U.S. wetlands in their highest and best alternative use, an estimate with considerable policy interest in its own right.