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Commonwealth's Declared Policy:

"to preserve the wetlands and to prevent their despoliation and destruction. . ."

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Current Trends in Ecologic-Economic Valuation of Wetlands

Laura Mitchell and Laura Grignano

As the world's population increases, developmental pressures are inevitable. Wetlands are increasingly found at the center of today's land use disputes. Historically, management of wetlands was based upon the following notions: 1) all wetlands are created equal, implying that all wetlands perform the same functions and therefore have the same values, and 2) all wetlands should be preserved no matter what the cost. Over the past decade, however, this line of thinking has started to change. Increasing scientific research on defining different types and functions of wetlands along with rising developmental pressures have forced managers to reevaluate their thinking. Managers are learning that all wetlands are not created equal and that different types of wetlands perform specific functions, thereby demonstrating different values. Managers also now realize that evaluating a wetland as merely an isolated environment is of little value; it must be evaluated according to its position in the overall system.

While considerable research during the past two decades has been devoted to defining the functions of wetlands in the landscape, efforts to quantify the economic values of these functions have been relatively recent and remain rudimentary. Wetlands are generally nonhomogeneous, complex ecosystems subject to variation along a variety of physical, chemical, and geological parameters. As a result, the possible functions and values of each system are myriad, and efforts to estimate the total value of each wetland system require a combination of analyses.

The purposes of this report are 1) to outline some techniques employed in assigning economic value to wetlands; and 2) to discuss the application of economic valuation of natural resources and some of the problems associated with the process.

(continued)

The following overview of evaluation techniques is based on the premise that the specific functions of wetlands are known and defined to the best of the available scientific knowledge. At this time the following five functions of a wetland are widely accepted:

1) Primary Production-Outwelling

2) Water quality control

3) Storm Protection/Erosion Control

4) Habitat

5) Recreation (hunting, fishing, trapping)

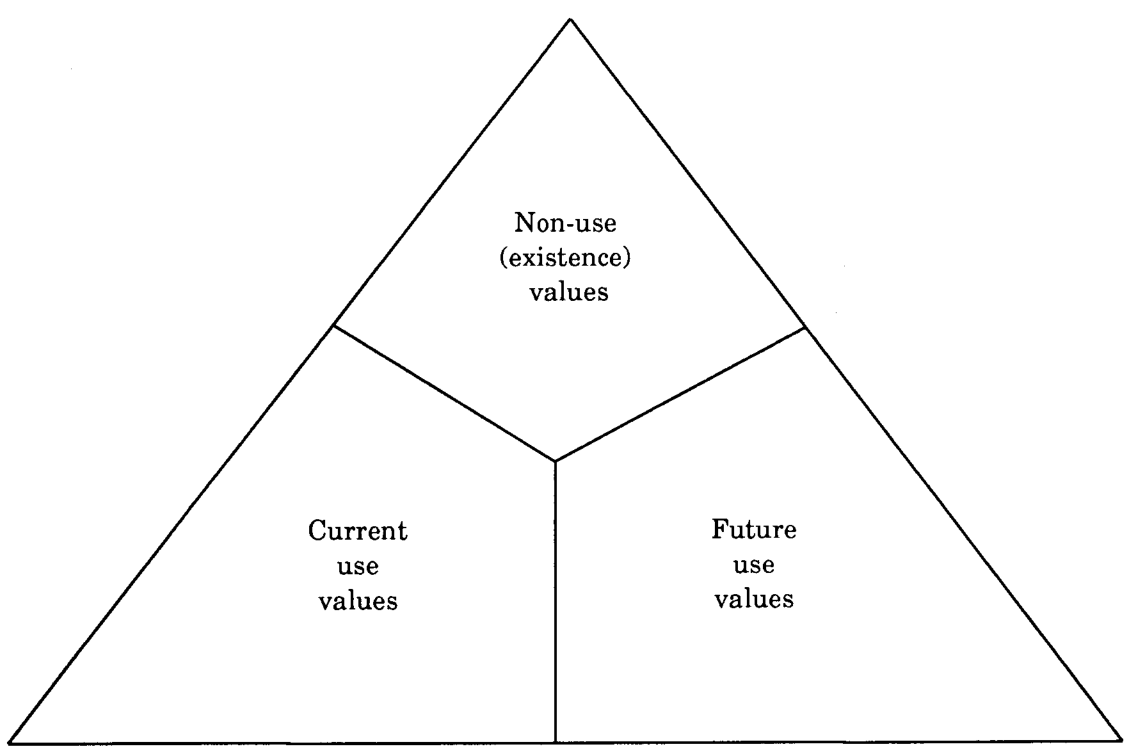
The importance of attaching a monetary value to the benefits provided by natural ecosystems, such as wetlands, is paramount when working in today's management process. Conversion of the benefits realized from a wetland system to monetary units permits the costs and benefits of both conservation and consumption to be weighed using a common denominator of value.

Valuation Techniques

While a host of potential functions exist for wetlands, the variety of techniques employed to quantify wetland values may be summarized as measurements of either **aggregate expenditures** or **aggregate benefits**. The first term refers to the total amount of market expenditures which take place in order to utilize one function of a wetland, such as fuel costs to reach the area. The second term refers to the **consumer's surplus**, or the willingness of the consumer to pay (WTP) to secure a benefit from the wetland beyond current market expenditures, such as funds for a protection program. **Total economic value** of the wetland is a combination of both of these factors: money moving through the market in order to utilize the resource and money paid out directly to insure the benefits of utilization.

This relatively simple scheme of measurement becomes more involved when three types of use categories are considered: non-use, current use, and future use (Fig. 1). Certain wet-

Figure 1. Total use of a natural system (modified from J. C. Bergstrom et al., 1990).



land benefits do not require physical use of the wetland at all, such as aesthetic or existence values. While wetlands have a current use, most wetland benefits continue as the system endures, leaving the potential for future returns. Computation of future values requires discounting, or reckoning the decreased worth of future use compared to current use. An important problem that plagues anyone trying to place an economic value on a natural resource is the discount rate. Our present economic system is built on the notion of maximizing relatively short-term profits. Marketed goods have a certain value today and their future value can be estimated using what economists term a discount rate. This concept includes the idea that after a certain point in the future, the good's value will begin to decline. Natural systems tend to work on a much longer time scale than do common marketed goods; therefore, they require a lower discount rate to properly estimate their value. The practice of assigning natural resources their own unique interest rate rarely happens. This failure often leads to grossly underestimating the system's true value. This paper will only address valuation of non-use and current use.

Non-Use Values

Non-use values, often called **existence values,** are by far the hardest to estimate. The existence value of a natural resource is the economic value people attach to the knowledge that a particular resource exists in nature (Bergstrom et al., 1990). To study this value, surveys are distributed to people in the area attempting to evaluate how much a person is willing to pay for this knowledge.

Use Values

Use values of wetlands can be grouped into three primary categories: recreation, productivity, and service functions. Recreation can include low-impact activities such as bird-watching and canoeing, or high-impact activities such as hunting. Flora and fauna contribute to harvestable wetland products such as timber, shellfish, and fur-bearing species. Certain wetland systems are valued for performance of a variety of services beneficial to man, such as

Definitions

Aggregate Expenditures: Total amount of market expenditures which take place in order to utilize one function of a resource.

Aggregate Benefits: Refers to the **consumer's surplus** or willingness of the consumer to pay to secure a benefit from a natural resource.

WTP: Willingness To Pay.

Total Economic Value: Combination of aggregate expenditures and aggregate benefits.

Existence Values: The economic value that people attach to the knowledge that a particular resource exits in nature.

Travel Cost Method (TCM): Valuation method which uses the average traveling expenses incurred in order to utilize a natural resource as an estimate of an area's value.

Contingent Valuation Method (CVM): Valuation method that is used to estimate consumer's surplus. CVM involves placing a dollar value on the worth of a protection plan for a given area.

Energy Analysis: Method looks at the total amount of energy captured by natural ecosystems as an estimate of their potential to do useful work for the economy.

Alternative Cost Approach: Valuation method that estimates the value of the particular benefit provided by the natural site by determining the cost of a man-made replacement, i.e. flood buffer.

reduction of flood peaks, and conversion or removal of inorganic nutrients (Kuenzler, 1988; Kleiss et al., 1989).

Both aggregate expenditures and consumer's surplus have been measured for recreation values of a variety of wetlands: freshwater marshes, saltwater marshes, and forested wetlands (Kreutzwiser, 1981; Costanza et al., 1989; Bergstrom, 1990). Bergstrom et al. (1990) estimated recreation expenditures through interviews conducted on expenditure categories. **Average variable costs** (such as boat rentals, park fees, cost of food, cost of bait) were calculated from a survey of persons using a wetland area, and then multiplied by the annual number of users per year. When no fees are charged, the **travel cost method** (TCM) has been employed, which uses the average travelling expenses incurred in order to utilize a wetland as an estimation of "visit" market prices. Everything from the price spent on recreational equipment to the price spent on food and gas is taken into consideration. The **contingent valuation method** (CVM) has been used to estimate consumer's surplus (Bergstrom et al., 1990). CVM involves a survey of responses to conditional circumstances—individuals are asked to place a dollar value on wetlands protection programs which maintain certain recreation levels (such as a certain catch/bag per day).

The TCM method of estimating expenses has proved a close estimation of expenditures only when users must travel a variety of distances to a wetland and when the wetland is the sole reason for travel. Only under these circumstances is travel cost a substantial portion of expenses incurred. The travel cost method works well if the wetland attracts persons from a wide range of distances; however, most wetlands are used by local residents and the travel cost method tends to underestimate the value of the resource. Also, persons who are willing to participate in such a survey presumably have a greater interest in the wetland than unwilling individuals, and results of the survey may overestimate the value of the wetland to the population using the resource.

The greatest problem associated with the CVM method of recreation valuation is that respondents may engage in "strategic responses"—individuals may overestimate WTP on purpose, in the hopes that this will ensure protection of the system, resulting in exaggerated benefits. In addition, there are obvious problems with the WTP methods. The simple fact that the population being sampled is not random severely biases the survey technique. The population using the resource already appreciates the area or else they would not be spending their time and money there. It would be erroneous to make the assumption that the general public feels the same way.

Productivity Valuation

The conversion of productivity of a wetland to monetary terms is more technical in nature than recreation estimates and generally does not employ WTP principles. Benefits may be measured directly as **products harvested per acre** of wetland. Costanza et al. (1989) reported the muskrat yield of brackish Louisiana marshes to be .98 pelts per acre, and .88 pelts per acre for nutria. Using the 1980-81 prices for eastern muskrat and nutria pelts, the 1980-81 pelt productivity alone was reported as $401 per acre. Expenditures are measured directly as capital and labor costs per acre or per quantity harvested.

A prominent problem associated with this technique is the fact that the relationship between acreage and production in a wetland may not be a linear one, causing underestimation of losses of productivity in altered wetlands. As the wetland decreases in size, its productivity may decrease by a larger margin than that estimated by its present productivity per acre. Additionally, a small consumption of or disturbance in the wetland, such as the drainage of two interior acres, may decrease productivity in more than the altered acres, because the whole wetland is affected by fragmentation. Finally, wetlands are not necessarily homogenous—certain portions of a wetland may be more productive than others.

Another method employed to estimate productivity of a wetland is **energy analysis** (Costanza et al., 1989). Estimation of the total biological productivity of a wetland versus the productivity of an adjacent water ecosystem is used as a measure of the total contributory value of the wetland. Primary productivity of the wetland is assumed to compose the basis for the food chain, supporting economically valuable species harvested in adjacent waters. Conversion from biomass estimates to consumer surplus estimates takes place by estimating the cost to society to replace the energy equivalent of the plant material in fossil fuel. Primary production in wetland systems is converted from biomass per acre to the heat equivalent of carbon fixed per unit time and then to the heat equivalent of fossil fuel. The present cost of the equivalent fossil fuel is then calculated (Costanza et al., 1989).

Unfortunately, this elegant method may overestimate the value of a wetland system if some of the production is not directly or indirectly useful to man. This technique assumes that the energy produced in the plant material is completely utilized by the adjacent aquatic systems. However, studies on nutrient cycling (Brinson, 1977) and carbon export (Haines and Montague, 1979) have demonstrated that a considerable amount of wetland productivity may be internally recycled, rather than exported.

It is questionable that fixed-carbon heat energy alone is an adequate food chain "currency." Wetlands may also contribute to the productivity of adjacent ecosystems indirectly by exporting nutrients, improving water quality, and providing habitat for early life stages of aquatic species.

Valuation of Other Benefits

Finally, wetlands may provide benefits by performing useful services in the landscape, such as removal of nutrients from runoff or retention of floodwaters and sediment loads. Dollar estimates of the values of these services are estimated using the **alternative cost approach**. The consumer WTP is also used in this method—estimation of the value of the particular service benefit is made by determining the cost of a man-made replacement. For example, the dollar value of a wetland's flood control benefits may be estimated by calculating the cost of engineered containment structures which would provide the same function. Value of nutrient retention may be estimated from the cost of installing tertiary sewage treatment facilities (Mitsch and Gosselink, 1987; Costanza et al., 1989; Turner and Brooke, 1990).

The accuracy of this approach depends upon the ability of an engineered structure or process to replace a natural one. There is a lack of consistently accepted methodologies in measuring how effective wetlands are in performing certain functions; therefore, it is difficult to estimate the comparative success of man-made substitutions. Additionally, it is often problematic to estimate the least-cost replacement for poorly understood functions, such as wetland ecosystem emissions of gaseous byproducts (Turner and Brooke, 1990).

Valuation as a Management Tool

Today's marketing systems are not structured to best manage natural resources; therefore, the collective management of these resources by government officials is essential in the allocation process. In addition to inherent problems associated with each of the valuation techniques outlined above, there are three primary reasons why the present economy fails to preserve natural ecosystems: incomplete cost-benefit analysis, lack of sufficient environmental education, and the common-property nature of resources. Today's economic system tends to favor the conversion of these resources to land uses which provide short-term, individual-oriented benefits.

The relatively short life-span of human beings causes us to omit long-term, accumulated costs associated with ecosystem loss in the analysis of natural resource use. **Cost-benefit analysis**, when used to make natural resource choices in a market economy, is inaccurate because only the short-term benefits of land or ecosystem consumption (development, harvest, conversion) are considered, while the decades of future returns from the conserved natural system (sustained production, recreation, aesthetics, environmental quality) are not considered.

Additionallly, the **lack of public awareness** of the full range of benefits provided by natural systems contributes to the continued demand for activities which consume these resources. For example, the global public has only recently begun to realize, through environmental education programs, the potential value of rain forests in maintaining the present climate of the earth. The inconclusive nature of technical information on many natural systems exacerbates the situation, making it difficult for individuals to realize the costs associated with ecosystem consumption.

Finally, the **common property nature** of the returns from natural ecosystems de-emphasizes the immediate impact of losses of these values. For example, a decline in outdoor recreational space in a locality does not completely affect an individual; the decrement is spread over the populace as remaining space gradually becomes more congested over a long period.

These three factors contribute to inefficient habitat and ecosystem consumption in market economies; therefore, regulatory mechanisms are put into place for the management of natural resources. It is through protective legislation and management programs that natural ecosystems such as wetlands will be conserved.

Economic, political, scientific, and socio-cultural forces influence natural resource policy. Government policies ultimately regulate allocation of resources; technical data provides information concerning resource function and quantity, and the customs and practices of a citizenry control the types of demands made upon a resource. However, the economic forces of supply and demand most profoundly decide the goals of a management program. Programs regulating natural resource use strive to allocate resources in a manner that will maximize the economic benefits to the affected locality or state.

Future Directions

In conclusion, the total economic value of conserved wetlands, as weighed by policy-makers, against the value of consumed wetlands, is still relatively uncertain and generally underestimated. The state of the science is new, and hopefully more accurate and valid techniques of measuring wetland values will be forthcoming. The inconclusive nature of technical information on many natural systems exacerbates the situation, making it difficult for individuals to realize the costs associated with ecosystem consumption.

In the meantime, researchers such as Costanza et al. (1989) suggest that to insure proper conservation of these resources, the "worst case" cost estimates of loss of wetlands should be accepted. Parties who benefit from the consumption of these resources must then assume the burden of proof that losses incurred with wetland destruction are in fact less than "worst case" scenarios.

An implementation of this policy could take place through the issuance of **assurance bonds**. State wetlands programs would charge parties responsible for wetlands destruction (drainage, access canal dredging, development) the worst-case cost of despoliation, $16,000 per acre, for example. Fees would go into assurance bonds to be returned to the responsible parties if, within a certain time-frame, independent studies proved the destruction costs to be less, or if the estimated acreage losses exceeded actual losses during the course of the project. Ideally, money from such bonds, never paid back, could create funds used to acquire state-owned wetlands, or to enhance existing systems. Such stringent wetlands protection in state policy does not currently exist. A system of this kind would require a major commitment from the scientific and managerial community to increase public education about the importance of wetlands as well as improved methods of wetlands valuation.

The field of environmental economics is relatively young, and many of the valuation techniques are in the experimental stages. The increased competition for land space and the resulting necessity to place monetary values on these parcels of land will most likely act as a catalyst for the advancement of the field.

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Wetlands Program Technical Report

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