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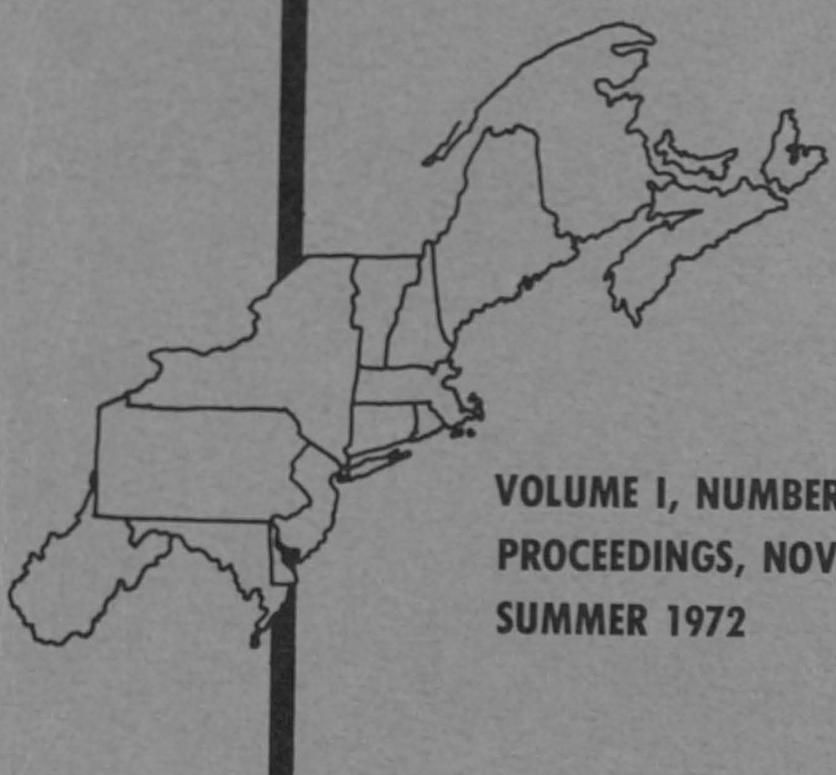

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# ECONOMIC CRITERIA FOR DECISIONS ON PRESERVATION AND USE OF INLAND WETLANDS IN MASSACHUSETTS*

Tirath R. Gupta
Research Assistant
Department of Agricultural and Food Economics
University of Massachusetts

## Introduction and Objectives

A long sustained belief that undeveloped natural resources constitute unproductive economic waste has recently been losing ground. Moreover, preserving a natural resource such as wetlands is not preserving something unproductive. On the contrary, the resource can often be considered as socially and economically productive in its undeveloped form. In other words, an unaltered natural resource has the potential of being productive in both material and non-material ways. In making a decision about preservation the relevant point is the social productivity of a resource in its preserved condition as compared to its social productivity in an altered condition.

Wetlands may be considered productive of habitats for wildlife with both commercial and aesthetic values, of visual cultural values, as buffers against floods, of materials possessing biological and educational values, and of water supply. The quantity and quality of these benefits will depend upon many factors, most important of which are the nature and location of a wetland itself. Contrarily, wetlands in their altered forms are capable of helping production of other economic goods and services such as food, other recreation, housing, commercial and industrial sites and transportation facilities for which the human race continues to strive under the banner of economic development.

In the context of these conflicting aspects of productivity, the necessity of choice among the social values of preserved versus altered use of wetlands exists. As a result of the growing concern for environmental quality, this controversy has become more apparent in recent times.

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What needs to be appreciated is that "there is no such thing as a free lunch". Society receives some benefits from the altered use(s) of a wetland or other natural resource and, thus, must agree to pay a price (opportunity cost) for preserving them. In the context of the goal of maximizing social welfare, this sacrifice of income or other returns should not be more than the benefits expected from keeping the resource in its natural state. The decision making task is to develop methods of valuing (1) the opportunity cost of retaining the wetlands, and (2) the benefits that the society is likely to derive from their use(s) in their natural form and to determine the general magnitude of these values. A comparison of these alternatives can show the state of net social welfare as it is likely to be affected through a decision to preserve or alter a wetland. Such a comparison will help in the implementation of the recent Massachusetts laws which prohibit alteration of wetlands by their owners without the permission of the State Department of Natural Resources.1/

Assumptions

In attempting to achieve this objective of valid comparisons, certain assumptions have been necessary.

Firstly, it is assumed that land is allocated to its most efficient use through the working of the land market. Secondly, like any other public good, the benefits from preserved wetlands may not be availed of in equal amounts by every member of the society, nor are the costs likely to be shared equally by all. This is the area of distribution of welfare and, thus, involves interpersonal comparisons of utility of a natural resource. No attempt is made to tread this area. In other words, it is assumed that the welfare indicator moves positively or negatively along with the direction of the aggregate difference between benefits and costs of preserving a wetland. Thirdly, it is assumed that any decision to preserve some wetlands, i.e. taking them out of the reach of the market forces, will not significantly affect the behavior of the macroeconomic variables such as investment, employment and prices.

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1/ See (a) Chapter 131, Section 40 of the General Laws. (b) Chapter 131, Section 40A of the General Laws. While the former law was restrictive, the latter is prohibitive in character. As an attempt to protect the "Inland Wetlands of the Commonwealth" it authorizes the Commissioner of Natural Resources with permission of the Board of Natural Resources to "adopt, amend or repeal orders regulating, restricting or prohibiting dredging, filling or removing or otherwise altering or polluting wetlands ... for the purpose of promoting the public safety, health and welfare, and protecting public and private property, wildlife, fisheries, water resources, flood plain areas and agriculture".

These assumptions have been necessitated by our inability to separate the effect of the interaction of the general institutional and the market forces and by our desire to come to some usable conclusions. It may, however, be added that wetlands over ten acres in extent constitute only six percent of the total land area of Massachusetts [3] and our valuation of benefits and costs, therefore, is not likely to be impaired by these assumptions.

Measurement of Opportunity Costs

This requires recognition of the fact that the sacrifice (of income) which a society makes by foregoing the use of a resource for a particular purpose which requires alteration of the resource is the cost to the society of preserving that resource. To be able to study this, productivity of wetlands in their altered uses has to be determined.

One way to get to this information is to locate wetlands of the past, i.e. those wetlands which have been drained and are being put to industrial/commercial/agricultural/residential uses and, then, determine the land productivity in these altered uses. This approach would involve extensive and intensive interviewing of owners to obtain data on costs, receipts and profits and would still leave room for doubts on the accuracy of the information obtained.

A second approach is to estimate the future productivity of filled in/drained wetlands in various developmental uses. Besides the problems encountered in the first approach, this method would also require projections of the economic variables into the future.

A third alternative, which is being used in this study, is to use the market price of wetlands as an indicator of their productivity in their altered uses. This approach recognizes that wetlands are bought and sold in terms of their income potential in an altered use because there is generally no income to the individual owner when they are preserved in their natural state. It is reasonable, for example, to say that:

$$\left.\begin{array}{l}\text{The annual productivity of a}\\ \text{wetland in its altered use}\end{array}\right\} \geq \left\{\begin{array}{l}\text{The interest the money paid for}\\ \text{it would earn per year if in-}\\ \text{vested elsewhere.}\end{array}\right.$$

So, if the market rate of interest is seven percent one can conclude that a wetland selling for $1,000 has a productivity in an altered use of at least $70 per year. The actual productivity, however, has to be more in order to cover returns to the developmental investment (filling in, etc.) as well as the purchase price.

Economists are well aware of the capacity of the market price to misrepresent a situation. There are some objects whose value in use may be different from their value in exchange. Adam Smith drew attention to this fallacy through the example of diamonds versus water.

The former, supposedly, have no value in use while they have a very high value in exchange and vice versa [4]. But, there appears to be no such fallacy in the case of wetlands. We know that to be able to command a value, an object must possess utility, scarcity, transferability and "futurity", i.e. "a basis for an expected future flow of returns or satisfaction to its user" [1]. The last characteristic is of special significance in the case of objects such as a stock or real property. The fact that wetlands possess all these qualities seems to call for no discussion. Moreover, the productivity of a piece of land is also some function of its location and the day-to-day observations reveal that the land prices are conditioned by this factor to a great extent. There is, therefore, enough justification to use the market prices of wetlands as the basis to estimate their discounted future productivity in an altered use to serve as a measure of the social opportunity cost of preserving them.

There are, however, some problems associated with this approach. Firstly, the market price can reflect only the minimum of opportunity cost of keeping a wetland unaltered. This is so because (1) of the differences in entrepreneurial ability to visualize current and/or future productivity of such land and (2) differences in subjective discounting of risk element. For such reasons, an individual purchaser may not have to pay as much as he would be willing to pay. There is, therefore, a possible purchasers' surplus inherent in the market value of land. This will tend to tilt the balance slightly in favor of preserving the wetlands.

Secondly, it may be argued that the estimates of opportunity costs of preserving wetlands must account for changes in the value of the marginal acre over time. For example, the social benefit of the marginal acre is likely to be much higher if there is only 1,000 acres of wetland as compared to nearly 310,000 acres currently estimated in Massachusetts [3]. The problem, however, does not appear to be a serious one for a number of reasons, such as (1) the market value for an altered use is not likely to be influenced by the total acreage of wetlands. On the contrary, it is based on its productivity in an altered use. (2) If the opportunity cost of preserving a wetland is expected to go up in the future, the social benefits may also be expected to move in the same direction and may even rise faster than the market value of land.

Even though the problem of changes in the value of the marginal acre over time is not a serious one, yet attempts are being made to overcome the same by: (1) limiting the period of analysis to 25-30 years whereby it can be assumed that the supply of wetlands would not change drastically and by (2) projecting the market prices of wetlands into the future.

It may be interesting to note that the price of wetland in Massachusetts has been found to vary from $300 to $70,000 per acre in expanding urban areas and down to a negligible value in rural and remote areas.

Two points that emerge from our field work spread over 14 towns of varying sizes throughout the state are: (1) the value of a wetland in both conservation and developmental usage is lowered when it does not have easy access and (2) the pressures for both retaining and altering wetlands increase with urbanization. A simple but important conclusion that follows is that the extent of the conflict of interests between developmental usage versus preservation of such lands will be different in different locations and tends to intensify with urbanization.

## Measurement of Benefits

Most, though not all, of the benefits that may emerge from preserving a wetland are intangible and their values cannot easily be expressed in terms of money. In other words, preserved wetlands constitute common property resources and the benefits from them will not be identified and priced by the established market mechanism. In searching for attempts made to place money values on such wetland benefits, one finds very little information. Two such estimates that have come to our notice vary from less than $20.00 [2] to more than $3,100.00 [5] per year/acre of swamplands. These estimates were found to be both incomplete and based on sentiments and/or misconceptions. Such studies may have value for academic or political purposes.

It may be repeated that one major objective in this study is to come up with generally applicable economic criteria for permit decisions for altering wetlands in Massachusetts. This necessitates a pragmatic attempt to identify and measure the benefits from preserving these lands. In such situations, the economist can do a satisfactory job only if help and advice is available from other technical disciplines. For this reason, we are cooperating with landscape architects, wildlife biologists and geologists. In the following pages no effort has been made to summarize or review what is already known to the economists by way of techniques of measurement of intangible benefits from public goods. On the contrary, the purpose is to discuss the working of the principle of division of labor amongst different disciplines in the context of our study. In the interest of brevity, our relationship with only one of the disciplines named above will be discussed in some detail. We choose landscape architecture for this purpose.2/

The landscape architects can contribute towards measurement of visual-cultural values of wetlands. The term visual-cultural is defined to encompass scenic, recreational and educational values. A wetland may be valuable for one or more of these purposes and they are often

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2/ The following sections on visual-cultural values draw heavily from the work of Walter L. Cudnohufsky, Julius Fabos and Richard C. Smardon of the Department of Landscape Architecture, University of Massachusetts, Amherst, Massachusetts.

intertwined, i.e. a wetland on a large stream may have a recreational value for canoeing, a scenic value for that seen while canoeing and educational value derived from the species of wildlife and plants that can be seen and identified while canoeing. To take a somewhat detailed look at one of these, as an illustration, let us choose scenic value.

Scenic beauty has psychological impacts which are reflected in social and economic benefits. All of these benefits, however, are not easily discernible. But there are certain observable characteristics such as a scenic wetland as seen from a bluff, cliff, mountain or hill with a panoramic view; a sequential scenic tour on a meandering river from wetland to wetland; a sequential scenic tour on a bicycle or hiking paths alongside a wetland; or views of wetlands as seen from an automobile moving along at 60 miles per hour which contribute to scenic values. Another kind of scenic value of a wetland is its role as a distinct landscape component and its contribution to the landscape diversity in the region.

Scenic value or visual quality is determined, according to our landscape architect friends, by visual diversity and contrast. In this study, contrast and diversity are being evaluated by rating certain resource variables on a scale of 5 to 1 with 5 being assigned to areas with the highest scenic value. Our next step is to arrive at "adjusted rating" points by ascribing a significance coefficient to each variable and multiplying the same with its initial rating. The significance coefficients are based on two criteria. First is the concept of immutability. A resource variable gets higher significance if it is less susceptible to physical change than a variable which is easier to change. The second criteria is the significance of the variable for different visual cultural values. A variable which has positive relevance for scenic, recreational and educational values gets the highest coefficient while a variable having relevance for only one of these values gets the lowest. The variables to be studied include landform contrast, wetland type diversity, landform type, wetland size, water body size. Table 1 explains the rating method for only the first two of these.

It is evident that in these two cases the scale varies directly with the degree of slope and the extent of the contrasting features surrounding a wetland. It may be noted that a variable has a constant significance coefficient while its rating changes from wetland to wetland.

In addition to the resource variables mentioned, certain cultural variables have been identified and are being scaled in a similar fashion. The cultural variables are essentially man's impact on the natural resource which can increase or decrease the social value of the resource. Prime examples in this category are location, presence and extent of visual and noise pollution. Location is important as it affects accessibility. If, for example, a wetland is within an inner ring of a metropolitan area, i.e. within 15 minutes of traveling time from such area, it gets a rating of 5 while a similar wetland located at a distance of

50 minutes of traveling time gets a rating of 2.. Visual and noise pollution have negative impact and so a scale of -1 to -5 is relevant. The scale varies directly with the increasing degree of pollutants such as extent of junked cars, dumped litter, traffic noise, raw sewage, etc. on or in the vicinity of a wetland. Expenses of restoration of a wetland, i.e. unhooking it from such pollutants, where possible and desirable, forms a part of the opportunity cost side of the equation.

Table 1
Example of Rating Procedure for Scenic Variables

| Resource Variables | Specification | Rating | Significance Coefficient | Adjusted Rating (3 X 4) |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |
| Landform contrast | Mountains, steep hills, rocky cliffs, slope > 10% | 5 | 3 | 15 |
| | Rolling highs, undulating land, sand bar or dunes, 8% < slope < 10% | 4 | 3 | 12 |
| | * | * | * | * |
| | * | * | * | * |
| | Flat land, slope < 5% | 1 | 3 | 3 |
| Land use contrast | Wooded or shrub swamp/ open land | 5 | 2 | 10 |
| | Deep or shallow fresh marsh/wooded land | 5 | 2 | 10 |
| | * | * | * | * |
| | * | * | * | * |
| | * | * | * | * |
| | Wooded swamp/wooded land | 1 | 2 | 2 |
| | Shallow or deep fresh marsh/open land | 1 | 2 | 2 |

Similar scaling is in progress at the hands of wildlife biologists. Some of the variables of interest to them include wetland type, wetland size, life form richness and water chemistry. We may explain the last two of these. Life form richness refers to the variety of vegetation present on a wetland. The greater this variety, the more diverse the habitat and the greater the number of wildlife species that can exist there. Water chemistry emphasizes the chemical nature of the water within the wetland. Hard or alkaline water, for example, produces a greater abundance of food plants and animals of high value for wildlife as compared to soft or acidic water. Similarly, our geologist friends are studying hydrologic characteristics of wetlands such as till and bedrock, outwash, alluvium. Outwash and alluvial wetlands are considered to be good sources of groundwater supply while those characterized by bedrock-till are not expected to contain much groundwater. Two further points need mention here. Firstly, while some variables will be common to each discipline, some others will be of interest to only one. Secondly, a variable which has a positive ranking in one use may have a negative value for another use. Location provides a good example. A large wetland situated on an urban fringe ranks high for its scenic and recreational values but its closeness to noise reduces its value as a bird sanctuary. Our preliminary studies, however, indicate that, as a whole, wetlands having high visual-cultural values also have high value for wildlife.

Once the scaling of resource and cultural variables relevant to each discipline, working in consultation with each other, has been done the "adjusted rating" points arrived at by each discipline are horizontally summed for each variable separately in the form:

$$X_i = \sum_{j=1}^{3} a_{ij} \qquad i = 1 \text{ ---- } n$$

where $a_{ij}$ denotes the score of the ith variable with jth discipline.

It appears relevant to mention at this point that after a study of topographic soils and surficial geology maps, the state has been classified into eight physiographic regions. With the scaling system, as described above, we are intensively studying a few wetlands in each of these regions. Attempts are being made to classify wetlands into certain categories, based on the total scores of our sample wetlands. The total score of a particular wetland will be determined in the form:

$$W_R = \sum_{i=1}^{n} X_{iR} \qquad R = 1 \text{ ---- } m$$

where:

$X_{iR}$ = points scored by ith variable on a wetland of Rth category

$W_R$ = total score of a wetland in Rth category

At our current stage of completion we cannot say how many categories we may come up with. Our attempts, however, are to keep the number at a minimum. When this point is reached, the job of physical measurements will stand completed. The "W" values arranged in a descending order will provide highest to lowest ranking of social values of wetlands. The economist, we believe, can use these values as ordinal measures of benefits from preserved wetlands.

## Comparison of Benefits and Costs

Next task would be to translate these ordinal measures into cardinal measures, i.e. to translate the physical values into annual dollar values of benefits so that a comparison with opportunity costs can be made. Since we are dealing with intangibles, no precise figure of benefits appears possible or plausible. "A multiple trial approach" will, therefore, be adhered to. Given the ranking of different categories of wetlands or the ranking of the wetland characteristics, we will assign relative values to the various kinds of benefits expected to flow from preserved wetlands. The base for establishing relative values is expected to emerge from our discussion with our teammates and with some people interested in the management and use of wetlands. The point that deserves emphasis is that a number of alternative values are being assigned to each kind of benefit and the results of the analysis observed. A computer program to facilitate this play with figures has been prepared.

As is apparent, we are using the Benefit-Cost technique whereby the present net worth of the time streams of benefits and costs will be calculated and compared. Analyses will be done for varying periods of time such as 30, 50 and 100 years. Some explanation is due at this point. Although the concept of "life" in years does not have much meaning in the case of land, yet any meaningful economic analysis has to have a time horizon. Thirty years is our most common number since it represents about a generation in the U.S. This indicates our belief that, in a dynamic society, preservation decisions may need to be re-studied every generation or so. We have chosen to work within a number of 100 years because the longer the time period the less precise or less dependable the results of the analysis.

Because of the problems such as choice of time, varying sizes/qualities of wetlands and the intangible nature of most preservation benefits, we do not propose to go in for a benefit-cost ratio. The main purpose of the analysis is to show gains or losses in social welfare with changes in opportunity cost values, benefit values, time horizon and discount rates. Our final product is expected to be in the form of, at least, ordinal values and cardinal values when possible of benefits and costs for different wetland categories. The decision makers, we hope, will be able to use this for issuing or denying permits for wetland alterations. Given an estimate of opportunity cost of preserving a wetland, we will also be able to show what the magnitude of benefits has

to be to achieve trade-off. This appears to be of particular interest to the decision makers since cost figure is easier to determine than the value of benefits.

It may be appropriate to conclude by emphasizing that wetlands in their preserved as well as altered forms have several potential uses and, thus, produce a multiple of economic values. Perhaps the main contribution of this study is its contrast with previous studies of wetlands which have a piecemeal approach with attempts to put a dollar value on each individual benefit. The approach here is to examine ways and means of evaluating all potential benefits and opportunity costs of preserving wetlands in order to come up with criteria for optimum decisions.

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