ESTIMATING THE ECONOMIC VALUE OF COASTAL WETLANDS: CONCEPTUAL ISSUES AND RESEARCH NEEDS

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October 1979

Sea Grant
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ALTERNATIVE MANAGEMENT STRATEGIES FOR VIRGINIA'S COASTAL WETLANDS

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PREFACE

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The results of the study are reported in a series of project papers under the general title: "Alternative Management Strategies for Virginia's Coastal Wetlands" with project paper titles as follows:

		Sea Grant Project #
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2.	Economic Implications of Environmental Legislation for Wetlands	VPI-SG-77-05
3.	Estimating the Economic Value of Natural Coastal Wetlands: A Cautionary Note	VPI-SG-77-06
4.	Existing Legal Framework for Management of Virginia Coastal Wetlands	VPI-SG-77-07
5.	The Development Value of Natural Coastal Wetlands: A Framework for Analysis of Residential Values	VPI-SG-77-08
6.	Economic Values Attributable to Virginia's Coastal Wetlands as Inputs in Oyster Production	VPI-SG-77-04
7.	The Economics of Wetlands Preservation in Virginia	VPI-SG-79-07
8.	Estimating the Economic Value of Coastal Wetlands: Conceptual Issues and Research Needs	VPI-SG-79-08
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ABSTRACT

ESTIMATING THE ECONOMIC VALUE OF COASTAL WETLANDS: CONCEPTUAL ISSUES AND RESEARCH NEEDS

Estimates of the economic value of coastal wetlands can better establish their social worth and provide an improved focus for debates over wetlands preservation. This has been recognized by many authors and several approaches to economic valuation now appear in the literature on wetlands. The most prominent techniques are the transference of net energy flows to monetary equivalents and the estimation of the market value of harvestable species and other direct user services derived from wetlands. The results reported are often based upon approaches which are conceptually flawed. However, valid estimates of wetlands economic values are difficult to obtain at this time due to a dearth of physical and biological data relevant for economic analysis. Cooperative research between physical and economic scientists can begin to provide the necessary information for sound economic analysis.

Nonetheless, in the near future we can only expect limited success in establishing the economic value of natural coastal wetlands. Until that time, wetlands use decisions must be made under conditions of scientific uncertainty. Therefore, procedures for decision making under uncertainty should be followed.

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INTRODUCTION

Marine wetlands may yield numerous valuable ecological services such as provision of fish and wildlife habitat and assimilation of waste. On the other hand, these same tracts of land may be developed as residential, commercial or industrial sites. In the past, the decision to develop wetlands areas has been made by private individuals acting in response to the price incentives present in the land market. Development of wetlands at the appropriate time and place meant that the owner was able to sell such sites at a positive return. However, the many ecological services of wetlands are not considered by either the buyer or seller in such a market transaction. Because property rights for these natural services are ill-defined, there are no markets where owners of wetlands can sell ecological services to willing buyers. As a result, the market price for wetlands will not reflect the value of these ecological services; so when wetlands are developed it will be with little or no recognition by the private buyers and sellers of the value of the nonmarket ecological services foregone.

In recognition of this market failure problem, public policies and programs to reduce the rate at which natural wetlands areas are developed for residential, commercial or industrial sites have been instituted during the last decade [Environmental Law Institute, 1979]. Each program prohibits alteration of natural areas unless all the benefits from alteration are judged to exceed all the costs. For example, the Virginia Wetlands Act states that a wetlands alteration should not be allowed unless "...the anticipated public and private benefits of the proposed activity exceeds the anticipated public and private detriment..." [Va. Code Ann.].

These program guidelines have stimulated interest in obtaining monetary measures of the value of natural wetlands services in order to better compare the benefits of preservation with the benefits of development. Unfortunately, many of the monetary value estimates currently available in the wetlands literature have been developed with conceptually invalid procedures. The main purpose of this paper is to illustrate some of the basic economic principles that must be understood and followed to obtain conceptually valid estimates of nonmarket values. The discussion will highlight the errors in many current studies as well as emphasizing where future cooperative research between economic and biological sciences is needed. Illustrative examples will be drawn from a three-year study conducted by the authors on the management of Virginia's coastal wetlands [Park and Batie, 1978]. While it is not possible to describe the full scope of economic science in a single manuscript, this paper will provide an introduction for noneconomists to the economic perspective on wetlands valuation and management.

We would also note that monetary measurement of wetlands values should not be the only decision information used in wetlands management programs. To the extent that multiple social objectives, such as equity and ecosystem diversity exist, there must be consideration of other measurements of benefits and costs in terms of those objectives [U.S. Water Resources Council, 1973]. We believe that nonmonetary measurements are essential for an informed decision process. We reject attempts to collapse benefits and costs into monetary measurements when such attempts violate basic principles of economic analysis.

PRICES AND ECONOMIC VALUE

The goal of an economic system, according to standard definition, is to facilitate the allocation of resources among competing uses. It can be demonstrated that an ideally functioning market system is one particular form of economic organization which will result in an allocation of resources that provides maximum satisfaction of revealed human wants within the constraints of resource availability, current technology and the prevailing distribution of income. The prices that eminate from such an ideally functioning market are not arbitrary, but rather they reflect the value of the resource in question to both buyers and sellers. Resource values can be measured by reference to those prices since an agreement on the subjective value of the resource must be reached or trade would not take place.

However, as the above discussion of ecological services of wetlands demonstrated, markets for many goods and services either fail to exist or do not operate according to theoretically ideal criteria. When this is the case, observed market prices may not reflect economic value. One author describes the problem as follows:

> ...there are many cases where exchanges occur without money passing hands; where exchanges occur but they are not freely entered into; where exchanges are so constrained by institutional rules that it would be dubious to infer that the terms were satisfactory; and where imperfections in the conditions of exchange would lead us to conclude that the price ratios do not reflect appropriate social judgements about values. Each of these cases give rise to deficiencies in the use of existing price data as the basis of evaluation of inputs or outputs [Margolis, 1969, p. 534].

As a result, an important economic research area is to develop "shadow prices" for the services of natural wetlands where no market or only limited market information exists. A shadow price should be the equivalent of the price which would have been generated by a market if such a market were able to function under theoretically ideal conditions.

ECONOMIC VALUES AND ENERGY ACCOUNTING

Properly estimated shadow prices for wetlands services do not result when a methodology based upon energy accounting is utilized. Perhaps the most widely known study of this type is one by Gosselink, Odum and Pope (GOP) which attempted to translate primary productivity of marshland as measured in calories into a dollar measure of value [Gosselink, et.al., 1974]. The fundamental premise of this methodology is that society's use of resources should maximize the net energy production of the total environment [Odum and Odum, 1972]. The argument concludes that "it is not human beings...that determine what is important; it is all the world's energy" [Odum and Odum, 1976, p. 50] and that "ultimately prices are determined by energy" [Odum and Odum, 1976, p. 52]. This statement reflects a belief that society should maximize net energy production rather than resource values based upon human uses. While this might be a relevant objective for resource allocation, it clearly is not the objective of the economic system.

Yet, although resource allocation which maximizes net energy is the energy accounting proponents' recommended ideal, they argue that a stronger basis for justifying the preservation of natural environments is obtained if the work of nature is calculated in terms of dollars rather than calories. This calculation is accomplished by multiplying calories of energy resulting from primary production of an acre of representative marsh by a dollar value per calorie. This dollar value is obtained by dividing the gross national product (GNP) by the national energy consumption index to calculate an average GNP produced per BTU of use in the United States. This conversion of energy to dollars has no valid scientific basis and should be rejected. This rejection is valid even if the calories of energy are weighed by quality factors as some proponents suggest [Lugo and Brinson, 1978]. A detailed discussion of this point is provided elsewhere [Shabman and Batie, 1978]. However, it should be recognized that the idea of linking factors of production, such as energy, to prices is not new to economics. Economists of the 19th Century studied and ultimately rejected the link between particular factors of production (land or labor) and market prices. In the energy theory of price determination, we see a resurrection of a similar value theory long ago discarded as a useful explanation for market exchange prices. Stated explicitly, one does not appraise fine art by comparing the energy content of the oil in a Rembrandt painting to the ink in a Picasso drawing. The difference in price between a Rembrandt and Picasso does not arise because oil paint contains more BTU's than ink [Peskin, 1976].

The promotion of the energy theory of value is unfortunate; GOP's coupling of energy analysis with dollar values that eminate from the market place does not provide decision makers with conceptually or empirically correct estimates of economic value. To imply that "prices are ultimately determined by energy" indicates a fundamental misunderstanding of the role and operation of economic systems. Of equal importance, the attempt to value calories as proposed diminishes the contribution that information from ecological systems analysis can make to resource decision making within a multiobjective decision framework. We only request that if analysts choose to do economic analysis, that they do it properly. If they choose to reject the methodology of economic science, we ask that they do so totally.

PITFALLS IN THE USE OF MARKET INFORMATION

Although no market prices for natural wetlands services exist, price and cost data for related goods and services may be used for shadow pricing. However, such data should be analyzed according to conceptually sound economic principles. The wetlands literature reports on several attempts to utilize market information, but in most instances, these results are derived from unsound procedures.

Derived Values

One approach to valuation is based upon the contribution of wetlands to provision of a product which is traded in the market. For example, since natural wetlands are productive of marine life a value estimate may be derived from the market price for seafood. A typical approach has been to divide the dockside value of the fish harvest by the total wetlands acres available to calculate a value per acre [Gosselink, et.al., 1974; Wass and Wright, 1969]. This ascribes the gross value of the catch to the wetlands. The reported logic of this calculation is that without the wetlands there would be no fishery. However, there are two basic errors in this approach.

First, the calculation implicitly assumes that any lost wetlands acreage will directly appear as reduced marketable fish harvest. However, if other factors, such as termperature and salinity, are limiting fish population, then destruction of wetlands may not affect fish catch. Also, by dividing total market value of the catch by total acres, the methodology implies that there is no difference between wetlands acres in their productive capability. Proper valuation should identify the values associated with incremental changes in the area of wetlands of differing biological productivity. For example, it would seem likely that loss of one acre of low productivity wetlands from an area where thousands of acres are available would result in a smaller loss in value than would destruction of a high productivity wetlands in an area where few wetlands acres exist. Of course, establishing these value differences will require quite detailed and sophisticated technical information linking wetlands quantity and quality to fish populations. This point is discussed further in the next section.

Second, allocating the total value of the catch to wetlands fails to recognize that the labor and capital resources employed in fish harvesting have a value in an alternative use. Therefore, the price paid to fishermen for their catch must (in the long run) be sufficient to pay a return to all the factors used in the harvest which is at least equal to their value in an alternative use. Thus, the value of the fish (and ultimately wetlands) is correctly calculated by taking the dockside value of the catch and allocating to labor and capital an amount equal to its value in an alternative use; then, the residual value is imputed to the fish [Batie and Wilson, 1978; Lynne, 1979]. This point should be an obvious one--fish don't harvest themselves. While it is a tautology that without fish there would be no fishery, it does not follow that without fish the resources employed in their capture could not be employed in an alternative enterprise.

Alternative Cost

The alternative cost procedure argues that the estimated value of wetlands in providing a service is equal to the cost of the next best alternative way of providing the same service. The proper use of alternative cost techniques should be governed by three considerations: (1) the alternative considered should provide the same services as the wetlands; (2) the alternative selected for the cost comparison should be the least-cost alternative; and (3) there should be substantial evidence that the service would be demanded by society if its price were equal to the cost of that least-cost alternative [Howe, 1971]. Most of the wetlands literature has failed to subject their estimate to any of these important tests [Gosselink, et.al., 1974; Westman, 1977].

The study by GOP, discussed above, illustrates these points quite well. GOP valued wetlands for waste assimilation by arguing that the waste degradation services of marsh areas can be replicated by tertiary treatment plants. They calculated the cost of such a plant and ascribed that cost as the waste assimilation value of wetlands.

The first problem with this approach is that the type and level of waste treatment services they used as the alternative would not be provided by all wetlands. To properly apply the approach, the type and level of waste assimilation provided by specific areas of wetlands must be determined. Such services will differ according to the characteristics of the wetlands and the amount of waste received by the wetlands area. Second, the alternative chosen may not be the least-cost waste treatment technology available. Perhaps a combination of land treatment, changes in production technologies and different waste treatment technology would be less expensive in particular areas.

A third serious flaw is the implicit assumption that the demand for tertiary waste treatment exists. The costs associated with the removal of each unit of additional waste can be characterized as sharply increasing, particularly for tertiary treatment [Kneese and Bower, 1973]. The implicit assumption is that these sharply increased costs provide additional natural values for which society would be willing to pay. This assertion must be carefully documented but it seldom is. The possible fallacy of this assumption can be stressed by reference to the following example. Assume that an acre of wetlands can produce a ton of marine worms per year. Further, assume that a ton of marine worms could be artificially propogated in a laboratory at a cost of $100,000. Could we then conclude that wetlands services which produce a ton of marine worms are worth $100,000 to society?

The answer is no, unless we can convincingly demonstrate that society would be willing to pay $100,000 per ton for marine worms.

TOWARD IMPROVED ECONOMIC VALUATION

Proper estimation of the economic values of wetlands requires basic information from the biological and physical sciences [Batie and Shabman, 1979; Midwest Research Institute, 1979]. This information should document the linkages between the existence of wetlands and particular services such as increased wildlife population density. While research of this general nature has been done, it is often not of sufficient detail or of proper design for use in economic valuation. We feel confident in making these statements after research on coastal wetlands management in Virginia. In the limited space available here, we can only summarize our general conclusions for some of the many services often attributed to coastal wetlands in the Chesapeake Bay.

Flood Control

Conceptually, wetlands could provide flood control in at least three ways. One is by the wetlands acting as a peat sponge. Alternatively, wetlands' vegetation could serve to reduce the velocity of flood water. Finally, coastal wetlands could provide flood control by acting as a reservoir, that is, by being a low lying area. The evidence that we have been able to collect for marine wetlands in the Chesapeake Bay suggests that these flood control services do not exist. First, coastal wetlands are subject to periodic innundation by tides, therefore, even where the composition of wetlands is a peat substrate, this peat would already be saturated with water and thus unable to act as a sponge. There is also little evidence to suggest that vegetation actually does reduce the velocity of flood water after the flooding has achieved a height that submerges the vegetation. Marine wetlands provide protection from coastal flooding to adjoining land parcels in the sense that any open area between housing and the ocean provides flood protection. However, it is not the wetlands in their natural state that provides that protection, since a filled wetlands would also protect neighboring parcels from flood damage as would a parking lot, an open field, or a forested area [Owens, Park and Batie, forthcoming].

Erosion Control

In our study of wetlands in the Chesapeake Bay, we were unable to find technical data that supported the assertion that wetlands provide erosion protection. Therefore, with the assistance of the Virginia Institute of Marine Science, we selected experimental case study areas and examined historical rates of erosion in areas identical to one another with the exception that some water frontage were wetlands and others were fastland. Our findings are that the Chesapeake Bay wetlands erode at the same rate as fastlands when subjected to similar winds, tides, currents and storms. Thus, the rate of erosion is the same whether the wetlands are filled or left in their natural state. In addition, our evidence suggests that wetlands exist more frequently in those areas with low erosion potential. This can explain the common observation that where wetlands exist there is often little erosion. However, this is not because wetlands provide superior erosion protection, but rather they exist where erosion forces are minimal [Owens, Park and Batie, forthcoming].

Oyster Population

Although oysters are well studied, the linkages between their availability for commercial harvest and wetlands is not well established.

While oysters do ingest primary production products, it is not known to what extent wetlands provide the main source, some of the source, or little of the source of this prime production. It is not even known if primary production is the limiting factor for oyster propagation and growth. Conceivably, oyster populations are not limited by food supply, but rather by predation, oxygen, temperature or light. Thus, we do not know if there is a critical acreage of wetlands necessary for oyster populations, below which oyster populations will decline. Also, differing wetlands qualities may or may not be significant [Batie and Wilson, 1979].

Wildfowl

Wildfowl are valuable to humans for hunting, viewing, and their contributions to the food web. Yet little is known concerning the relationship between wetlands and wildfowl populations. Walker reports that a great percentage of wetlands in the Chesapeake area and the Mid-Atlantic region generally is not heavily utilized by migrating birds. Furthermore, waterfowl appear to be "flexible in seeking out staging and feeding areas, and they adapt to change more easily than other organisms" [Walker, 1973, p. 81]. Indeed, on Virginia's Eastern Shore a popular area with the birds are dredge spoil banks.

Waste Assimilation

Tidal wetlands are reputed to provide a valuable ecological service in the form of water quality maintenance [Walker, 1973]. Wetlands' waste assimilative capacity may function in basically three ways. The first is that wetlands may serve as tertiary treatment system, when they are artificially loaded with sewage sludge. Although some research studies suggest wetlands have a significant capacity for assimilating nutrients [Valiela, Teal and Sass, 1973], the ability of wetlands to continue this service with high rates of loading for an extended period of time is questionable [Bender and Correll, 1974].

The second manner in which wetlands may improve water quality is in removing pollutants, in particular nutrients, from the estuary during natural tidal flushing of marsh. There is inconclusive evidence as to the extent of this service, although research suggests nutrients are changed from particulate to dissolved forms in some cases [Aurand and Daiber, 1973; Axelrad, Moore and Bender, 1976; Stevenson, et.al., 1976].

The third way in which wetlands may affect water quality is in relation to pollutant loading from nonpoint runoff. Wetlands apparently act as a trap for sediment, nutrients, and other materials attached to sediment particles [Boto and Patrick, Jr., 1978]. Unfortunately, no completed studies have attempted to quantify these processes, although research currently underway on the Rhode River watershed in Maryland is addressing this issue [Correll, 1979].

Wetlands Services

In viewing the broad range of services attributed to wetlands, Walker concluded:

> Thus far I have shown that the scientific justifications for coastal wetlands preservation are not quite as clear cut as they appear at first blush. The primary productivity of marshes is evident, but little can be said about the dependence of important specifics on marshes, or the response of the estuarine ecosystem to marsh destruction. Similarly, water quality seems to be improved by wetlands, but the dynamics of nutrient cycling is too poorly understood to predict the impact of wetlands on overall estuarine water quality. The erosion, sediment and flood control capacities of wetlands may only be modest, and are rather unpredictable [Walker, 1978, p. 90].

The point of this discussion is not to suggest that the ecological services of wetlands are nonexistent; however, there is a high degree of uncertainty about those services. As a result, improved estimation of the technical linkages between wetlands and natural services must exist before sound economic values can be estimated. This is because the estimation of shadow prices associated with the wetlands' contribution to ecological services requires knowledge of the physical production processes. Figure 1 illustrates this with respect to oyster populations. Resource management inputs such as fishermen, oyster dredges, and even the property rights associated with harvesting oyster rock combine with the biological and physical inputs, such as wetlands and salinity conditions. These inputs enter a production process which ultimately determines oyster populations and oyster harvests. The value of the harvest can then be utilized to derive a shadow price for the value of the wetlands' contribution only if the economic, biological and physical linkages are understood and are quantifiable.

POLICY AND RESEARCH: THE NEXT STEPS

The state of the art in wetlands valuation will lag behind the need to make wetlands management decisions for the foreseeable future. Given the current lack of full knowledge, we support adoption of management guidelines which stress wetlands preservation, unless the expected value of foregone development is "unacceptably" large. Of course, what is deemed unacceptable must be a broad social decision, but is one in which economic analysis can have the important role of better identifying the values of wetlands for development. If the value of wetlands development were clarified, public decisions to preserve wetlands, given the current uncertainty about natural wetlands values, could be more easily defended. Specifically,

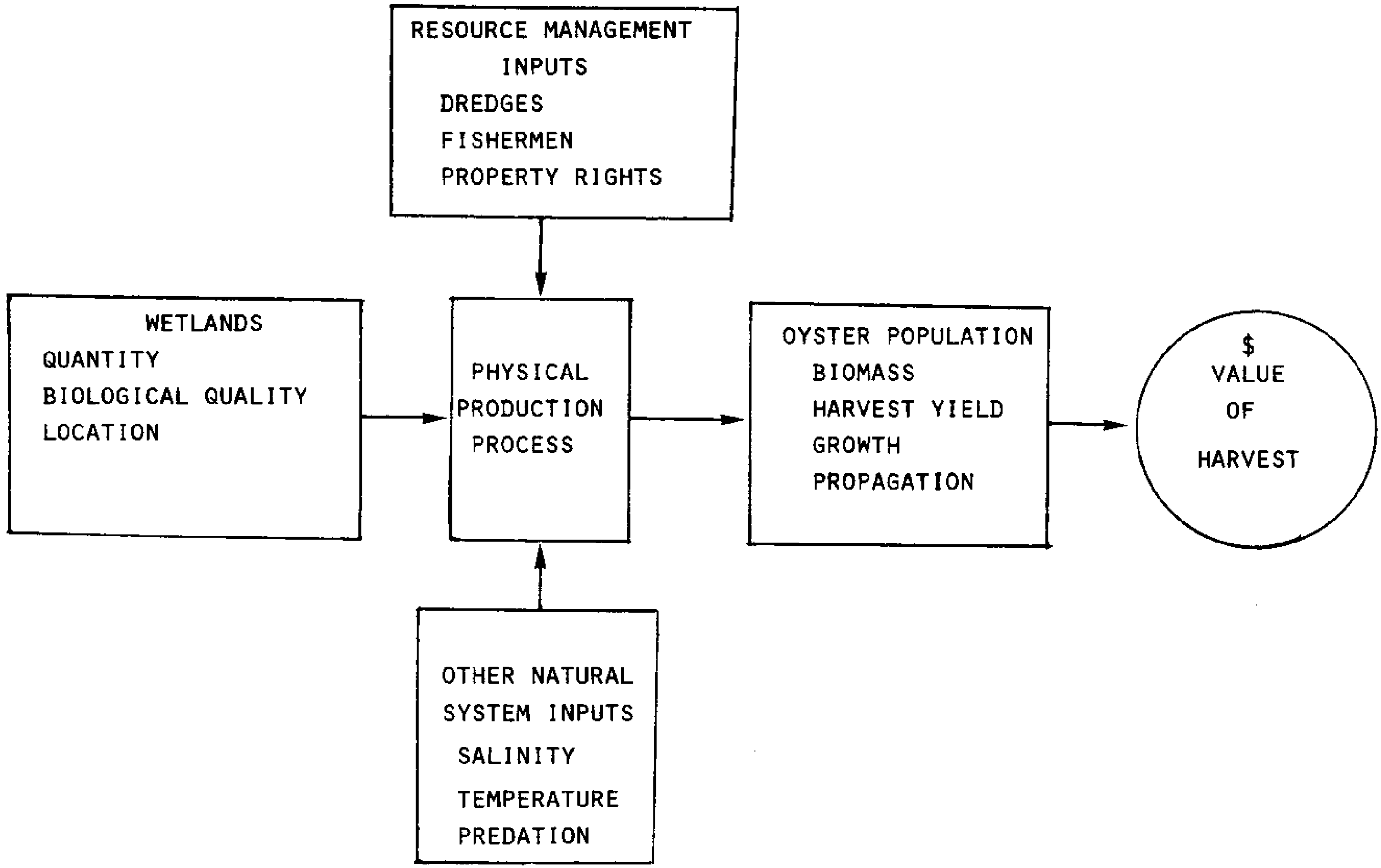

FIGURE 1 - VALUING THE CONTRIBUTION OF COASTAL WETLANDS TO OYSTER HARVESTS

lower development values make the argument for denial of a development permit more compelling [Shabman, et.al., forthcoming]. An important reason for concentrating on the estimation of development values is that land market information is available for estimating values. In fact, we have conducted such analyses of development values during the past three years. The procedures used are reported elsewhere [Shabman, et.al., forthcoming; Shabman and Bertelsen, 1979], and only the results are reported here for purposes of this discussion.

In Virginia Beach, Virginia, development values foregone by wetlands preservation (if development proposal is for residential lots) are not remarkably high. Development values varied according to location and type of development, but for illustrative purposes a three-fourths acre site with 150 feet of frontage on an open bay would have a development value of $14,000 [Shabman and Bertelsen, 1979]. Development value for water access through a private marina and for vacation home sites on wetlands in rural Accomack County, Virginia, were calculated for the situation when no fastland alternative site was available. Development values for a marina were $5.8 million per acre for five acres of wetlands. If a fastland alternative site was available, there were no positive returns to marina development in wetlands areas [Mabbs-Zeno and Batie, forthcoming]. Here, some allowance for wetlands development might be acceptable, especially since virtually the whole county shoreline is wetlands and few, if any, comparable fastland alternatives exist. However, the value of developing additional acres for marinas, will fall sharply as additional marinas are built. This decline of value with additional development is also true for the returns for second home development; these were estimated to be $40,000 per acre for one of the few Accomack recreational developments that utilized wetlands.

It will not be possible to conduct a detailed development value analysis for each wetlands allocation decision, however, these research results suggest some general guidelines that might be followed. First, due to the uncertainty of natural wetlands values, the development should move forward only upon the demonstration of "large" development values. In short, the burden of proof in the public decision process should be shifted from those who wish to preserve wetlands to those who wish to develop them. Second, the provision of water access to a large group of lot owners (or the general public) by development of small areas of wetlands may have a high social value, especially in areas where water access is limited. However, more intensive management of existing water access facilities should also be considered as a means of reducing the need for marsh development for water access. Third, the value of marsh filling for creation of waterfront lots (especially in areas with extensive waterfront) appears to have a relatively low value when compared with provision of water access.

In the meantime, the research community should continue to improve our understanding of the role of wetlands in the natural and economic systems. We believe that conceptually valid economic estimates of wetlands values are possible where physical wetlands linkages to wetlands services are established. However, since in most cases the technical linkages between wetlands and natural services are not well established, there should be additional research focused on alternative development values of wetlands. Such research has the attractive attributes of a high probability of successful completion and considerable utility in improving public decisions. Alternative development uses of wetlands worthy of investigation, in addition to the uses discussed in this paper, include: commercial uses, such as restaurants; industrial uses, such as manufacturing enterprises and ports; and recreational uses, such as public parks and beach access.

At the same time, research programs should be developed for ascertaining economic values of natural wetlands. To be fruitful this research should be conducted through cooperative efforts between the various disciplines. As the previous discussion of wetlands' contributions to oyster populations noted, there must be an appreciation of the nature of the production process which ultimately yields the wetlands services of interest. There is every reason to be optimistic that research projects that reflect such an appreciation will generate information of considerable utility for wetlands management.

FOOTNOTES

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