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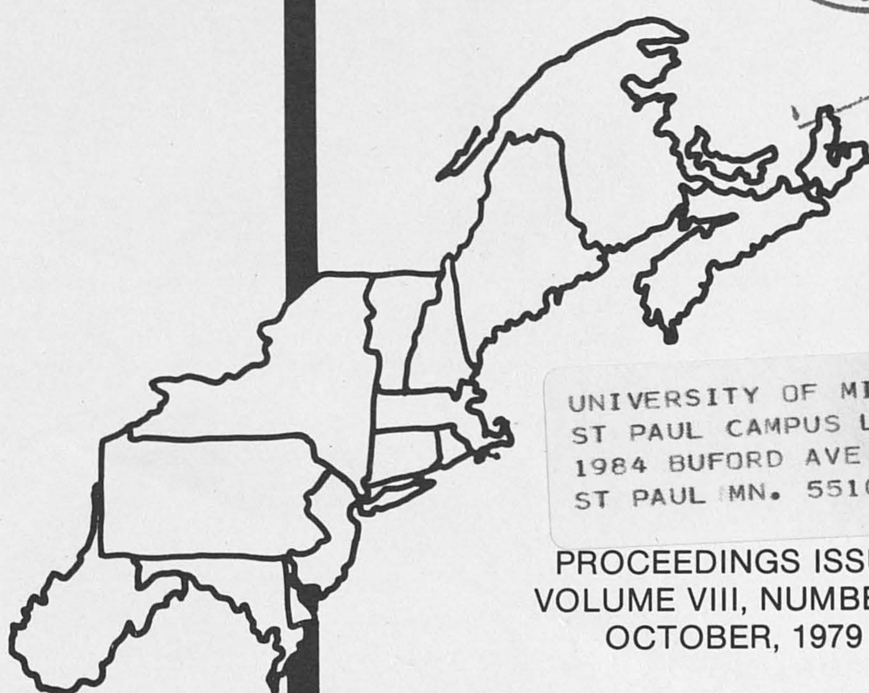

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THE ECONOMICS OF WETLANDS PRESERVATION IN VIRGINIA

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Virginia and other northeastern coastal states have adopted legislation in an effort to diminish the rate at which coastal wetlands are being "reclaimed" for development as residential, commercial, or industrial sites.[1] In all these states, the arguments for public protection of natural wetlands were based upon a growing, but still incomplete, body of scientific evidence linking wetlands to any array of non-market ecological services such as waste assimilation and provision of fish and wildlife habitat.

Virginia's law requires that a permit for wetlands alteration be obtained from a local government wetlands board before any development can proceed. The local boards receive technical advice and permit review from state agencies. In addition, the federal government is involved in wetlands permitting through authority granted to the Corps of Engineers under Section 404 of PL 92-500 [Federal Register]. At all levels of government, agencies making permit decisions are mandated to balance the benefits of preservation with the benefits of development before allowing wetlands alterations. For example, the Virginia law states that a permit should be granted if "...the public and private benefit of the proposed activity exceeds the public and private detriment..." [Virginia Wetlands Act].

Although statistics on actual wetland acres altered before and after the Virginia Wetlands Act are not reliable, it does appear that the practical result of this balancing process has been oriented toward wetlands preservation. For example, only 48 permits for alterations of coastal wetlands throughout the whole state were granted during 1976-77, with the average permit allowing alteration of considerably less than ½ acre. By contrast, there are over 160,000 acres of wetlands in the state. In fact, a survey of wetlands board members confirms this apparent emphasis on wetlands preservation [Mabbs-Zeno and Batie, 1979b]. Wetlands boards tend to believe that the values of natural wetlands are usually in excess of values in development, even for wetlands areas as small as a few square

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feet. For example, one wetlands board has an operating rule of denying all development permits that will destroy more than 100 square feet of coastal marsh, as well as critically examining proposals which would affect less marsh area. As part of the survey, wetlands board members were asked to rank each of a listed set of nine goals that could possibly guide their board's decisions. The ranking was on a scale of 1 to 10 where 10 indicated the goal was "most important" in influencing permit decisions. The results demonstrated that the surveyed board members (65% response) stressed preservation. The goal "preservation of wetlands," for instance, received a mean ranking score of 9.7 with a standard deviation of only .11. Conversely, and despite the fact that the Virginia Wetlands Act states that boards should "accommodate necessary economic development in a manner consistent with wetland preservation" [Virginia Wetlands Act], the goal of "accommodation of necessary development" ranked low in importance with a 5.7 mean score and a standard deviation of 3.28. Given the current Virginia wetlands permitting program, the objectives of the following discussion are: (1) to assess a possible economic justification for the apparent preservation orientation of the wetlands boards; (2) to suggest how estimates of development values for coastal wetlands can be used in the wetlands premitting process.

On the Ecosystem Services of Wetlands

Ecologists differentiate between services to man which arise from ecosystem structure and from ecosystem function [Westman]. The structure of an ecosystem includes the species contained therein and their arrangement with the abiotic aspects of the system. Services potentially derived from wetlands ecosystem structure include the direct harvest of marketable products such as fish and shellfish and the contribution of the ecosystem to recreation and aesthetic enjoyment. The functions of ecosystems stem from the way the components of the system interact to provide "life-support" services such as waste assimilation, cycling of nutrients, and balancing of carbon dioxide and oxygen gases in the air.

The extent of functional services that may be provided by any particular area of coastal wetlands is a matter of scientific uncertainty at this time, with the evidence being limited and inconclusive. For example, it is taken as an article of faith among many proponents of wetlands preservation that all coastal marsh areas will assimilate pollutants [Logo and Brinson], yet recent comprehensive reviews of the research literature by Correll and Walker conclude that the research results to date do not uniformly support this contention [Correll, Walker]. Even if some coastal marsh areas should be conclusively shown by future research to provide this functional service, so too may other parts of the ecosystem. In addition, technology (e.g., advanced waste treatment) may also be shown to provide this service, thereby mitigating the need to preserve wetlands in order to obtain this function. Furthermore, all marsh areas are not likely to be equally productive in providing functional services. In short, the basis for estimating the marginal product of a given area of marsh acreage in providing larger ecosystem functions, needs to be more firmly established. The most that can be said at this time about functional services of wetlands is that these services may exist for some wetlands areas and that these services may be of high "life-support" value within the larger ecosystem.

The existence and extent of the structural services of wetlands, such as providing breeding grounds and food source for havestable species, may be more easily established through the research process. For example, the contribution of wetlands to increasing the yield of oysters appears to be of some significance [Batie and Wilson, Manzi, et. al., Meade and Tihansky]. Yet, while sturctural services are more readily identified and studied than are functional services, the contribution of preserved marsh to structural services also stands upon a narrow, and as yet undeveloped, scientific base [Haines, 1977, 1976, Correll].

Indeed, in reviewing the broad range of structural and functional services attributed to marsh, 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 specifies on marshes, nor 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, p. 90].

The point of this discussion is <u>not</u> to suggest that either the structural or functional services of wetlands are non-existent. Rather, it is to argue that there is a high degree of uncertainty about those services. On the other hand, the rapidly expanding research effort focused upon coastal wetlands can, over time, be expected to clarify the nature and extent of wetlands services [Larson, et. al.].

On the Irreversibility of Wetlands Alteration

Justifications for preserving wetlands for their natural services rest upon a partially developed scientific base. However, given this scientific uncertainty a persuasive argument for preservation is that wetlands represent a natural system which, once destroyed, cannot be replaced by man. This argument suggests that until we become more certain of natural wetland services society should, on both efficiency and intergenerational equity grounds, attempt to avoid irreversible weltand development decisons.

However, the argument of total irreversibility may be overstated. First, as noted above, substitute inputs may be found for producing some of the services of wetlands. For example, while wetlands appear to contribute to oyster harvest in the Chesapeake Bay, there is a range of output over which changes in harvest technology and property rights for oyster grounds can substitute for lost marsh acreage [Batie and Wilson]. Second, altered natual wetlands may be replaced by direct construction of new wetlands. In fact, there are several cases where such marsh building acitivity has been successfully accomplished [Garbish (undated), Garbish (1978), Woodhouse, et. al., Knutson].

However, with our current state of knowledge about wetlands, it is not certain that a comparable flow of functional or structural services can be provided by man-made marsh or by substituting other inputs for wetlands acreage. Furthermore, the costs of building new wetlands or of finding and employing wetlands substitutes may be high. As such, while there is promise for "scientific management" to help replace services lost from developing wetlands, the likely success and costs of these actions remain speculative at this time.

A Generalized View of the Permit Process

Until the scientific uncertainty about the existence and scope of natural wetlands services and the possibility of reversing wetlands alterations is eliminated, society will make wetlands permitting decisions with whatever limited knowledge is available. The following discussion suggests one possible justification for the current preservation oriented permitting process and indicates how the limited available economic information on the value of developed wetlands may be used in that process.

A two stage decision process is envisioned for resolving whether the development of an incremental unit of wetlands acreage should be permitted, in this case by a local wetlands board. Society (through the wetlands board) may either grant the permit (strategy S_1) or deny the permit (strategy S_2). In the first stage of the decision process the board assesses whether the marginal benefits in development (d) equal or exceed the marginal value in preservation (p), as those preservation values are currently understood. Thus, p will most likely reflect the more readily established structural service values of wetlands. If $p > d$, then the permit would be denied even though development values may be positive.

If $d > p$, the permit is not immediately granted, but rather the second stage of the decision process is begun where more uncertain functional service values of wetlands are considered. Although it is not now clear whether any particular wetlands area provides functional services, if the area does, if it is important in the total ecosystem, and if development is irreversible, then the destruction of wetlands may have a long term negative effect on the "life-support" capability of the biosphere. It is this area of uncertainty which is dealt with in stage 2.

One can view such decision-making under uncertainty in a systematic manner by utilizing a simple gaming framework where the permit decision is depicted as a two person game of "society" against "nature".[2] The only uncertainty to society in this game is that nature's strategy is unknown, and may result in functional services of the wetlands area, such as maintaining the atmospheric balance of gases, proving to be of significant value to the total ecosystem. Given this situation, society might choose to adopt a minimax decision strategy, i.e., minimizing the maximum loss that could be imposed on present or future generations by society's choice between strategy S_1 and S_2. Following Bishop [1978] this stage is the adoption of a "safe minimum standard" criterion suggested by Ciriacy-Wantrup [1968].

Table 1 depicts a hypothetical game for the wetlands permitting process with society's strategies depicted as rows S_1 and S_2. Nature's strategy is depicted as two possible states that may hold in the future. In state 1, the value of future services of wetlands conforms to current knowledge. In state 2, wetlands prove to be of unexpectedly high value by providing basic "life-support" services by their functioning.

Table 1

Loss Matrix for Society's Wetlands Management Strategies

Strategy of Society	State of Nature 1	State of Nature 2	Maximum Losses
S_1 (Grant the Permit)	$-x$[a]	$y-x$[b]	$y-x$
S_2 (Deny the Permit)	x	$x-y$	x

[a] x = expected marginal value in development (d) - the expected marginal value in preservation, as those values are currently understood (p).

[b] y = marginal value of functional "life-support" services of wetlands.

Each cell in the matrix describes a social payoff. In cell S_1-1, a development permit is issued if the expected marginal value for development (d) exceeds the marginal value of preservation (p). The difference, d-p, is set equal to x. Since this is a loss matrix, the gain of x in cell S_1-1 is depicted as a negative vlue. In cell S_1-2, nature's strategy results in wetlands functioning being a key part of the larger ecosystem with a resulting value equal to y. If development were allowed, y would be lost. This loss would be offset by the gains from development with the net payoff equal to y-x. In cell S_2-2m x is foregone, but that loss is reduced by the size of y. The maximum loss column is the basis for making the decision using a minimax decision strategy. As long as y exceeds 2x for the acreage in question, a preservation policy (deny the permit) should be pursued. If the reverse is true, the development strategy is appropriate. Thus, in the second stage it may be desirable to deny the permit even when the first stage of the decision process did not reach that conclusion.

However, a basic problem in using these general decision stages for wetlands management is that the values y and p are not known, nor for that matter is much known about d. Thus, since the strategy of nature is not known and the structural and functional values of preserved wetlands are presently not quantifiable, it is impossible to state unequivocably that either p or y is greater than, equal to, or less than d; hence, there is no clear basis for choice in either stage. In addition, a second problem to consider is whether or not the minimax strategy is conservative in the extreme. As Bishop notes, "Obviously, to live is to take chances. If the costs of avoiding uncertainty became unacceptably large, we accept the chance of large losses rather than blindly pursuing a minimax approach, and policies ...should reflect this" [Bishop, p. 13].

Nevertheless, given the current lack of full knowledge, the two stage decision process may, at this time, be most desirable. This two stage approach to decision-making would argue for preservation, strategy 2, unless its expected social cost is "unacceptably" large. Of course, what is deemed an unacceptable cost in this uncertain situation must be a broad social decision, but is one in which economists do have a role. "...[T]he role of the economist is to help public decision-makers become aware of the nature of the economic issues..., to evaluate the social costs of choosing a safe minimum standard (preservation strategy), and to help the decision-maker view these costs in perspective" [Bishop, p. 14]. In the context of wetlands permitting, if society better understood the value of wetlands development (d), there would be an enhancement of the ability to proceed logically in either stage of the decision process. That is, lower values of d make the argument for denial of the permit more compelling in either stage 1 or stage 2. Economists can make a major contribution to wetlands management, given the uncertainty about natural wetlands services by providing a conceptually correct estimation of d. One reason for concentrating on the estimation of development value foregone (social costs of preservation) is because the quantification of the benefits of preservation requires knowledge of the linkages between the existence of natural wetlands and the provision of services such as fish harvest. As noted earlier, the biological and physical sciences are still in the earlier stages of this "production function" estimation. In contrast, information is available with which to estimate the value of wetlands development.

Development Values of Wetlands: Two Case Examples

Two of the major pressures for development of Virginia's wetlands have been for residential home development in the urbanizing coastal areas and for water access (marinas) and recreation home development in the more rural areas of the state. Two recently completed studies can provide insight into the nature and magnitude of the economic value of these types of wetlands development. In both studies, a hedonic price equation was estimated which regressed land sale prices on a set of explanatory variables representing individual land parcel characteristics, including measures of water access and waterfront location created from filled wetlands. The estimated coefficients on the explanatory variables were used to assess the contribution of each parcel characteristic to transfer price. The proper interpretation of these coefficients is that they are the marginal willingness to pay for the various land parcel characteristics such as waterfront location.[3] Thus, the economic benefits from "marginal" increases in the number of land parcels with waterfront locaton and/or water access made available in the land market by wetlands development were estimated using the hedonic price equation's coefficients.[4] The results of each of these studies are briefly summarized below.[5]

Shabman and Bertelsen [1979] estimated the gross willingness to pay development benefits that would be derived from filling an additional small acreage of wetlands for residential home sites in a middle income area of Virginia Beach. The resulting lots would front upon either an open body of water or a man-made channel created from the dredge and fill operations. Virginia Beach is an area of extensive shoreline, much of the shoreline having been developed from wetlands filling. Also, it is a large urban area with many alternative choices for permanent home sites. As such, the estimates shown in Table 3 are for a small increment in the number of waterfront lots within that market area. Table 2 shows the results for two typical configurations of waterfront lot characteristics.

Table 2

Development Value for Filling of Wetland for Residential Home

Development:	Virginia Beach, Virginia	
	Lot Fronts on Open Water[a]	Lot Fronts on Man-Made Channel[a]
Value Per Lot	$14,000[b]	$6,500[b]
Value Per Acre	$19,000[b]	$8,600[b]

[a]Both lots are 3/4 acre in size with a 150 foot water frontage.

[b]Values are gross benefit estimates. These should be reduced by development costs such as dredging and filling if net development benefits are to be calculated.

Mabbs-Zeno and Batie [1979a] estimated the benefits of wetlands filling for a large scale (4,877 lots) recreational home subdivision named Captain's Cove, which is located in rural Accomack County, Virginia. The large size of the subdivision enabled the researchers to measure the marginal value of marsh alteration for two types of recreational lot demands; (1) the alteration of marsh to develop marina facilities for inland recreational lots and (2) filling marsh to provide recreational lots directly fronting open water or canals. Development cost data and a hedonic price equation of parcel sales within Captain's Cover were used to estimate the development value net of development costs of marsh destruction under two separate conditons: (1) if no fastland (non-wetland) site alternative which will provide similar water access services is considered for development, and (2) if a fastland site is considered. Information on the lot owners primary residences suggests that parcels in Captain's Cove were sold in competition with recreational home sites from the New Jersey shore to eastern North Carolina. As such, both types of lots in Captain's Cove were treated as a marginal increment to the stock of lots available in this large recreational home market.

Table 3 displays the results of the Captain's Cove Study. Five acres of marsh was initially destroyed to construct a marina and common recreation area. This marina provided water access to 3700 interior lots subdivided from adjacent fastland. The marina added a total value to this land of $29,000,000. This is an average $7,837 increase in value for each interior lot over the value of the land in its next best use, which was presumed to be agriculture. These calculated values are based upon the condition that no alternative fastland location exists which can provide water access without marsh destruction. When this condition holds, there are very high values associated with filling wetlands to provide water access via a marina to the large number of interior lots. Marginal values of $5,800,000 are attributed to each acre dredged for the marina. Subsequent destruction beyond the initial five acres was utilized to create lots fronting on open-water or man-made canals. However, the marginal returns to wetlands destruction beyond five acres for recreational home site development on the water are minor by comparison,[6] as shown in column 2 of Table 3.

However, if a fastland alternative location that provides water access is available without necessitating wetlands alteration, and is used as the next best alternative for comparison, net returns to destroying wetlands and Captain's Cove become positive only if large areas of marsh are developed.[7] This is because limited shoreline and marina development at a fastland site is lower cost than development in wetlands. Still, if enough wetlands acres are destroyed, the total returns to development over the fastland site alternative become positive since a large number of lots with direct waterfront location can be created on channelized marsh.

Conclusions

The general decision strategy discussed earlier provides a conceptual framework for analyzing wetlands permitting decisons, but its implementation is restricted by the existing state of knowledge on natural wetlands values. Still, the strategy does stress the importance to decison-making of having estimates of development values for wetlands. Indeed, with the results of the two case studies presented here, both case specific and more general statements about the current permit process can be made.

In Virginia Beach, the opportunity costs of preservation (if development proposal is for residential lots) are not remarkably high, especially, when it is realized that the estimates are gross benefits which would be reduced in magnitude by development costs. Another factor to consider is that between 1949 and 1971, one-third of the wetlands in Virginia Beach (1,100 acres) were developed. Marginal value arguments would suggest that this extensive development activity may have driven down the marginal value of additional development, but raised the marginal value of wetlands in their natural state.

In Accomack County, the marginal and total net values for marsh

Table 3

Net Wetland Development Value for a Large Recreational Subdivision: Accomack County, Virginia

Number of Wetland Acres Developed	Present Value of Net Benefits for Wetland Development[a] ($000's)			
	No Fastland Alternative		Fastland Alternative Considered	
	Total Value (1)	Marginal Value[b] (2)	Total Value[c] (3)	Marginal Value[b] (4)
5 (marina)	29,000	5,800/acre	-600	-120/acre
14	30,000	111/acre	400	111/acre
83	33,000	43/acre	3,400	43/acre
136	35,000	37/acre	5,400	37/acre

[a]Estimates are returns net of development costs. The results shown in columns (1) and (3) are rounded to two significant digits for ease of exposition. This causes some minor differences between the results reported here and in the original paper [Mabbs-Zeno and Batie, 1979a].

[b]Calculated as the change in total value with respect to a change in the number of wetland acres developed. The results are reported on a per acre basis.

[c]Values in this column are equal to column 1 minus the total value of an alternative fastland location, which equals 29,6000,000. This hypothetical fastland site has the same number of interior lots and a marina, but has fewer lots located on open water and none on canals.

alteration to provide waterfront recreational lots in a large subdivision are higher than in Virginia Beach, whether or not a fastland site exists. The most interesting result is that providing water access by constructing a marina, which takes relatively few wetlands acres, provides values of $5,800,000 per acre filled, if no fastland alternative is considered. In addition, unlike Virginia Beach, wetlands acreage has increased in Accomack since 1949 due to natural forces. Here, some allowance for wetland development might be acceptable, especially since virtually the whole county shoreline is wetlands and few, if any comparable fastland alternatives exist.

None of the above is to argue that in general the opportunity costs of wetlands preservation are or are not "unacceptable." The basis for stressing preservation as wetlands boards are presently doing may still be strong, given uncertainty about wetlands values. However, while arguments for the conservative permitting policy of the Virginia wetlands boards may be made, it is also true that the boards may now be making preservation oriented decisions without an understanding of the opportunity costs of foregone development of these decisions.[8] While it will not be possible to conduct a detailed opportunity cost analysis for each permit decision, the research reported here does suggest some general guidelines that might be followed in the permit process. First, due to the uncertainty of preservation values, the burden of proof for granting the permit should be placed upon the demonstration of "large" development values. 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. Under these conditions, it may be reasonable to allow development given the uncertainty of preservation values and the possibility that new marsh can be built or substitutes for marsh acreage found. 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 marginal value when compared with provision of water access.

These conclusions rest upon a limited empirical base and future research should focus on expanding this base. Research focused on alternative development values of wetlands appear to have the attractive attributes of a high probability of successful completion and considerable utility in improving public decisions with respect to wetlands. Alternative development uses of wetlands worthy of investigation, in addition to the residential 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 natural values. This research, to be fruitful, should concentrate on two dimensions. First, research to estimate production functions which relate wetlands to natural services will require close coordination of economists and natural sciences if the research is to result in sound economic analysis of values emanating from natural processes. Secondly, such research must focus on decision-making under conditions of risk and uncertainty.

FOOTNOTES

[1]In this paper the terms marsh and wetlands will be used interchangeably. Virginia's law applies to the state's saltwater coastal wetlands. Other states' laws may apply to both coastal and inland wetlands. [U.S. Department of Interior].

[2]The motivation for using a simple gaming framework to address this issue stems from Bishop's recent article [1978].

[3]In its general form the hedonic price equation is:

$$P = W, X_1 \ldots X$$

where:

P = transfer price of the land parcel
W = a measure of the characteristic of waterfront location or access
X = other lot characteristics hypothesized to contribute to P.

Marginal willingness to pay for W, $\frac{dp}{dw}$, can be found for any parcel, n, given the characteristics of n.
For a discussion, see Freeman (1975), Freeman (1974), Harrison and Rubinfeld.

[4]These studies measure the contribution of wetlands developed to the value of the land parcels affected, when compared to the next best alternative site. In one case study, the next best alternative site was an inland lot; in the other case study, the next best alternative site was fastland acreage bordering open water.

[5]The value estimates provided below are not directly comparable between studies. Of most importance is that one estimate is net of development costs while the other is not. However, the presentation of the results is only meant to indicate the orders of magnitude involved. Furthermore, the numbers are based upon case study results and cannot be generalized beyond the conditons which bounded each case. Readers interested in the procedural details are directed to the original papers.

[6]One anonymous reviewer of this paper expressed concern that the estimates of development value in both case studies did not take into account certain public service costs (e.g., sewer) and certain cost associated with the natural hazards of coastal storms. In the Captain's Cove study public service costs were included as part of the development costs. In the Virginia Beach case these costs were included in that the wetlands values were derived by comparing developed wetlands sites to a fastland alternative when there was no difference in public service costs between the two types of sites.

Hazard costs are reflected in a reduced transfer price to the extent that these costs are recognized by the land purchasers. However, to the extent that disaster costs are externalized to other members of society through disaster aid programs, transfer prices may overstate the true value in development. Isolating these effects would be difficult and was not done in the studies reported here. However, given the values of the homes in question, the probablistic nature of the natural hazard events and the upper limits to disaster aid and flood insurance coverage, it is unlikely that the values reported for waterfront lots would fall dramatically by inclusion of these external costs. Furthermore, given the long history of waterfront construction in Virginia Beach it seems likely that some purchasers are aware of coastal hazards. This may not be true of Captain's Cove. However, it is worth noting that the highest values for wetland destruction in Captain's Cove came from marina development which would be least susceptible to extensive storm damage.

[7]For this case the alternative considered was a "similar" development in a "nearby" area. In this sense, the alternative was a perfect physical substitute for Captain's Cove. Alternative marsh developments that destroyed less marsh, or development a long distance from the Captain's Cove site where fastland may be available, were not considered to be substitute sites.

[8]As discussed above, this conservative permitting policy can be justified in the context of the minimax framework, given the scientific uncertainty about wetlands values. However, it is worth noting that as information is obtained on wetlands values and on the possibility of reversing wetlands alterations or substituting for wetlands services, a minimax decision strategy is less appropriate. With more complete information, a deterministic benefit-cost analysis of wetlands alterations would be possible.

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