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An Economic Evaluation of Beach Erosion Management Alternatives

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Abstract *This paper examines the relative economic efficiency of three distinct beach erosion management policies — beach nourishment with shoreline armoring, beach nourishment without armoring, and shoreline retreat. The analysis focuses on (i) the recreational benefits of beaches, (ii) the property value effects of beach management, and (iii) the costs associated with the three management scenarios. Assuming the removal of shoreline armoring improves overall beach quality, beach nourishment with shoreline armoring is the least desirable of the three alternatives. The countervailing property losses under a retreat strategy are of the same order of magnitude as the foregone management costs when the beneficial effects of retreat — higher values of housing services for those houses not lost to erosion — are considered. The relative desirability of these alternative strategies depends upon the realized erosion rate and how management costs change over time.*

Key words Beach erosion, coastal management, hedonic prices, contingent choice.

JEL Classification Codes D12, D61, H43, Q21, Q24, Q26.

Introduction

By their nature, coastal areas, and in particular beaches, are unstable landforms. In response to changing ocean currents, sediment loads, wave action, and sea levels, most coastlines change their shape over time. East Coast U.S. beaches on barrier islands have tended to follow a shoreward erosion trend, but local areas can accrete as well as erode, and islands can also migrate northward or southward. The accumulation of real property development on these barrier islands over the past 50 years has created a demand to manage erosion processes through large-scale engineering

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projects. These projects, however, may impact the quality of coastal resources.

There are three basic strategies that have emerged to manage beach erosion. Shoreline armoring involves the construction of seawalls, rip-rap (rock piles), and other devices designed to prevent any shoreward movement of the coastline. There is ample evidence that armored beaches tend to be narrower and steeper, and therefore less desirable for recreation, than beaches that are not armored (Clayton *et al.* 1992; Leatherman 1988). Shoreline armoring has come under increased fire for its expense, negative aesthetic consequences, and environmental effects, such as habitat loss. However, this strategy is still utilized in many areas of the eastern U.S., including the study site reported here.

The second strategy is beach nourishment, the process of maintaining the coastline by pumping or trucking sand onto the beach to replace sand that has been lost to erosion. It does not have the negative aesthetic consequences of shoreline armoring, but it is an expensive process and is only a temporary solution to erosion problems in most cases (Pilkey and Dixon 1996; Pompe and Rinehart 1995b). In addition, there is concern that the dredging of offshore sand can aggravate the forces causing erosion. Armoring and nourishment have generally been the favored management schemes of coastal engineers in both their policy recommendations and in their academic literature.

The third management strategy is that of shoreline retreat. Many coastal geologists feel that erosion is an inevitable process that can be contained only locally and temporarily (Clayton *et al.* 1992; Pilkey and Dixon 1996). The policy of retreat is based on this proposition: Coastlines should be allowed to erode naturally without engineering intervention. The recommended policy response is to move or dismantle structures that will be lost to this erosive process in the short and medium run. In the long run, structures should be constructed at a sufficient distance from the beach so they will not be at risk over their expected lifetime. Allowing beaches to migrate, this argument goes, will maintain the flow of recreational and environmental services to the public at large with much lower public expenditures than any active management strategies.

There are three important considerations in making empirical judgments about the desirability of management alternatives on efficiency grounds. One is the effect on coastal property owners. Beachfront property, in particular, is at risk of total loss from erosion, and individuals who own such property risk losing significant wealth under a retreat strategy. A second category is the effect upon recreational beach users. Beachgoers generally prefer a beach devoid of seawalls and groins, both for aesthetic and safety reasons. In addition, wider beaches are generally preferred to narrower ones. The third is the cost of management, consisting of possible construction and maintenance expenditures on armoring, possibly including periodic expenditures on nourishment, or consisting of outright property losses associated with the retreat scenario. One might also emphasize environmental and habitat effects of management programs, though this is not something we chose to focus upon in the present paper.

This purpose of this paper is to make quantitative estimates of the costs and benefits of each of the erosion management strategies for Tybee Island, Georgia. Tybee is a typical East Coast barrier island, consisting of a similar geological makeup and subjected to weather conditions that are similar to other beaches in the eastern U.S. These estimates are then combined in a 25-year simulation of the three alternatives in order to provide evidence of the relative desirability of alternative beach management schemes in the eastern U.S.

The paper is organized as follows. We begin with a brief discussion of the study site. We then turn to the measurement of benefits and costs accruing to property owners through hedonic price regression analysis. The next section describes the measurement of recreational benefits through a stated preference survey, which is followed by estimates of management costs based on an examination of historical expenditures. We then describe the way that empirical results were adapted to fit the management scenarios. The results of the simulation are then presented and discussed. The final part of the paper draws a few central conclusions from the results.

The Study Site — Tybee Island

Tybee Island is located at the mouth of the Savannah River, about 19 miles east of the city of Savannah. It has a relatively small year-round population of less than 3,000 people (1998 estimate). It serves as an accessible beach recreation area for nearby communities, most notably the metropolitan area of Savannah (293,000 population in 2000), and is also a resort destination for visitors from Atlanta and other population centers.

Residential and commercial development of the island began in the late 1800s (Godley 1958). The historical erosion management practice has been a combination of shoreline armoring and nourishment. The first seawall was constructed on the southern part of the island in 1936, and substantial additions of groins and riprap have been made over the past 40 years. There have been five major beach renourishment operations since 1976, the most recent completed in 2000. While management has, for the most part, protected buildings and infrastructure, it has not fully protected the beach amenities that fuel this resort community's economy. Tourists expect that they will enjoy recreation on the beach, but the effects of erosion can cause long stretches of the beach to disappear at high tide. Disappointed tourists may take their business to other recreational destinations. We examine the incremental value of improved beaches for both tourists and coastal residents.

Hedonic Analysis of the Benefits of Erosion Protection to Property Owners

Beaches provide recreational and amenity values to coastal property owners, and they also influence the flood and erosion risk faced by these property owners. Historically, residential structures on or near beaches were built with salvaged or inexpensive materials in recognition of storm and erosion risks (Pilkey 1995). This has changed over the past several decades, as more people have spent substantial sums of money on property improvements close to the ocean.

It has been suggested that beach width and stability are important determinants of property value, affecting both recreational/amenity values and flood and erosion risk (Edwards and Gable 1991; Pompe and Rinehart 1995a). The relationship between property value, distance from the erosion reference feature (ERF — usually measured as the high-tide line), and the erosion rate is a complex one. Property owners value shorter distances from the ERF for recreational and amenity reasons, but they also value protection from storms and erosion risks, which is bolstered by greater beach width, more distance from the ERF, and a lower erosion rate.

Interpreting the results of a hedonic analysis of this relationship is made substantially more difficult by their dependence on homeowner's expectations of future coastal management actions. We interpret our results for Tybee Island as reflecting the residual risk of damage faced by property owners given the historical and existing programs. Our results are also conditioned on the availability of federal flood insurance, which most of the properties in the analysis are required to hold. We should note, however, there is uncertainty over whether sunny-day erosion losses (those not associated with a flooding event) would be covered under this program; there is a very plausible risk that they will not. If property owners are allowing for the risk of significant changes in erosion protection actions or insurance coverage, our interpretation is biased.

We employ a straightforward application of hedonic analysis, positing that housing price, P_i, is a function of structural characteristics, S_i (square feet, age, *etc.*), and environmental characteristics, Q_i (beach width, distance from the beach, erosion risk, and the presence of erosion control structures). Neighborhood variables not reflected in these environmental regressors were omitted based on a judgment that the community on Tybee was small and homogeneous enough to make them unimportant.

The data set consists of 318 properties on Tybee Island that were sold between 1990 and 1997, chosen at random from the county tax assessor database. We use this data set to make inferences about the value of beach resources for all properties on the island. Residential properties on Tybee were fully developed during the 1970s. New construction during 1990–97 was confined to a few redeveloped lots on the island's north side. We feel, therefore, that our sample is representative.

The variables representing environmental conditions reflect their condition in the spring of 1997. Thirty-two transects of beach and dune widths were measured along the beachfront portion of Tybee Island with an electronic range finder. From these measurements, another seven estimates were interpolated to provide adequate coverage over Tybee's beachfront. As such, the beach and dune width variables indicate coastal conditions within 200 feet of a property. Assuming a constant erosion rate across the island, it would be possible to infer what beach widths were in previous years. Nourishment operations in '93 and '95, however, make such a procedure unreliable. To the extent that beach conditions in previous years ('90 to '96) were significantly different from the spring of '97, the hedonic price of beach width could be biased.

Property distances from the shoreline were calculated using tax maps. There were no major storms during this period, and property distance from the shoreline did not change. Distance from the ERF was calculated as the sum of distance from the shoreline, the width of the dune field, and the width of the dry beach (above the high tide line — often zero if a seawall is present). Here, again, beach width is measured in the spring of 1997 and may not be representative of previous years. Erosion risks were defined qualitatively by each property's proximity to the north and south ends of the island (historically high risk areas [Clayton *et al.* 1992]) relative to all other areas (classified as 'not high risk').

The hedonic regression was estimated as a semi-logarithmic model with ordinary least squares. The model performed reasonably well, with 13 out of 17 variables significant at the 10% level and an R^2 of 0.67. The results are given in table 1. Beach width was highly significant, both statistically and economically. Evaluated at the means of the data, a one-meter increase in beach width implies an additional $233 in property value. Similarly, oceanfront and inlet-front status were highly significant and implied an increase in value of $34,068 for oceanfront homes and $87,620 for inlet-front homes. The variable measuring distance from the ERF was also highly significant, implying that each meter of additional distance reduced property value by $91. The erosion risk dummy was significant and implied that presence in the high-erosion zone reduced property value by $9,269.

Combining the results of the hedonic analysis with other costs and benefits requires the setting of a baseline estimate of the property benefits when the status quo beach management practices are in effect on Tybee Island. These estimates can then

Table 1
The Property Benefits of Beach Erosion Management; Parameter Estimates for the Hedonic Price Equation of Housing on Tybee Island

Variable	Definition	Parameter Estimate	Standard Error
Intercept	-	10.8943***	0.1197
BWIDTH	Low tide beach width at nearest shore (in meters)	0.0017***	0.0006
DIST	Distance from property to the high tide mark (in meters)	–0.0006***	0.0001
OCEAN	Dummy variable: 1 if oceanfront; 0 otherwise	0.2164***	0.0655
INLET	Dummy variable: 1 if inlet-front; 0 otherwise	0.4833***	0.0877
MARSH	Dummy variable: 1 if marsh-front; 0 otherwise	0.1362	0.0826
ERHAZ	Erosion zone: 1 if high erosion hazard; 0 otherwise	–0.0680*	0.0374
STRUC	Dummy variable: 1 if erosion structure visible at nearest shore; 0 otherwise	–0.0207	0.0471
AGE	Age of the home	–0.0016**	0.0007
MULTI	Dummy variable: 1 if multiple stories; 0 otherwise	0.0434	0.0361
BED	Number of bedrooms	0.0352*	0.0200
STONE	Dummy variable: 1 if stone or brick finish; 0 otherwise	0.0523	0.0385
GAR	Dummy variable: 1 if garage present; 0 otherwise	0.1555***	0.0445
FIREP	Dummy variable: 1 if fireplace present; 0 otherwise	0.0632*	0.0331
AC	Dummy variable: 1 if air-conditioning present; 0 otherwise	0.2020***	0.0464
APT	Dummy variable: 1 if apartment; 0 otherwise	–0.0804	0.0658
SQFT	Square footage of heated space	0.0001***	0.0000
TIME	Time trend variable: 0 – 7 for 1990–97	0.0403***	0.0067

Note: Dependent variable — natural log of selling price of the housing unit in 1996 dollars.
***significant @ $\alpha = 0.01$,**significant @ $\alpha = 0.05$, *significant @ $\alpha = 0.10$, $n = 318$, $R^2 = 0.6673$, F value = 35.394.

be compared with the estimated property benefits arising from different management scenarios. We scaled up the total estimates of value by computing the ratio of the total number of homes on the island to the number in our sample (2,795/318). Thus, we assumed that each property in our sample represented 8.79 identical homes. In order to relate the asset value of a house to the flow of services it represents, we adopted a real estate heuristic from the literature that 1% of the average property value per month is a reasonable rental rate (Kriesel, Randall, and Lichtkoppler 1993). This may introduce bias to the extent that it is inaccurate for our sample. The status quo value of housing services for the analysis was set by using the estimated equation to predict housing prices in the sample under the current beach conditions, scaling this up to represent the number of homes on the island, and taking the present discounted value of housing services over the next 25 years assuming no real appreciation of housing prices, no long-term net erosion, and a 4% discount rate. The resulting estimate is $906,016,772 in 1996 dollars.

In order to derive differential benefits estimates for changing levels of coastal amenities, the estimated *ex ante* hedonic equation was used to predict changes in the value of the housing stock. Bartik (1988) has shown that using the *ex ante* hedonic to predict *ex post* economic impacts of changing amenity levels produces an overestimate of true benefits when: (*i*) the housing rental schedule closely reflects supplier's costs, (*ii*) the change in the amenity is relatively large, (*iii*) increases in amenity levels decrease the marginal value of the amenity, and (*iv*) consumer relocation costs are relatively low. These conditions are likely met in the case of Tybee. Therefore, we assume our estimate of the impact of improved beach conditions on the value of the housing stock is an upper bound estimate of the true impact.[1]

Our alternative management scenarios involve increasing beach width and removing the bulk of shoreline armor (with the exception of the terminal groins) on Tybee Island. In one case, we assume that these beach conditions are maintained by drastically increasing the amount of beach nourishment. In the other, we assume that shoreline retreat maintains these conditions. To derive property benefits associated with the Nourishment Alternative, we estimated the value of houses in our sample assuming a 2.5-meter increase in the average beach width, and calculated the present discounted value of housing services over 25 years (employing the same assumptions as the status quo measure). The resulting measure is $908,143,449 in 1996 dollars, a $2,126,677 increase over the status quo. The property effects associated with the Shoreline Retreat Alternative are explained in a subsequent section. The differential property value effects of both alternatives can be found in the middle column of table 7.

Stated Preference Analysis of the Recreational Benefits to Beach Visitors

Beaches provide benefits to visitors who utilize them as a place for sunning, swimming, walking, fishing, and other sporting and leisure activities. The magnitude of these benefits depends, in part, on beach characteristics that are directly affected by erosion management choices, including beach width and the presence and nature of engineering structures, as well as the number of beach visitors attracted to the site (Silberman and Klock 1988). The recreational benefits of alternative management strategies relative to the status quo were measured through a contingent choice[2] (CC) survey of recreational beach users on Tybee Island during three seasons in 1998. To avoid double counting, Tybee Island residents were removed from this dataset.

The survey instrument for this research (which can be found in the Appendix) was designed around a map of Tybee Island that illustrates the types of beach conditions and depicts the location of beach types on Tybee under alternative management conditions. It begins with a short description of Tybee Island and its shoreline erosion phenomena, and then inquires about the frequency of beach visitation and experience with poor beach conditions that were erosion-related. The instrument then presents four color pictures of different beach conditions: widest beach (approx. 28 meters wide at high tide, 73 meters at low tide), wide beach (approx. 23 meters wide at high tide, 68 meters at low tide), narrow beach (approx. 9 meters wide at high tide, 55 meters at low tide), and narrowest beach (no beach at

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[1] On the other hand, if the Tybee housing market were a very small part of a larger market for coastal housing, then a localized change in beach conditions would not affect the equilibrium market relationship. The predicted value of the housing stock would precisely reflect the change in welfare, which would accrue to landlords in the form of increased rents. Most of the barrier islands in Georgia are undeveloped. There are only three developed substitute sites within Georgia. The closest, Saint Simon's Island, is 80 miles from Savannah. The South Carolina coast has a number of developed beaches, some of which are closer in proximity to Savannah (such as Hilton Head, 40 miles away). As such, Tybee is a significant portion of the coastal housing market in the southeastern U.S., and changes in amenity levels would likely have an impact on the equilibrium hedonic price function in the region.

[2] The only difference between a traditional referendum contingent valuation (CV) survey and contingent choice is that, in the latter, the respondent is presented with two (or more) distinct choices. Each choice is characterized by a set of beach conditions (the status quo versus an improvement) and an associated price. In a comparable CV survey, the respondent would be presented with a set of beach conditions and an associated price, each marginal to the status quo, and asked to make a *yes-or-no* decision on the proposed changes to status quo.

high tide, 45 meters at low tide). The facing page describes these beach conditions and discusses policies that can be used to maintain beach width.

The respondent is then presented with two color maps of the island: the status quo conditions and the improved conditions brought about by one alternative management plan. The contingent choice being made posits the status quo conditions against four alternatives (summarized in table 2), one of which was presented in any given survey. Alternative One depicts wider beaches (a one-meter increase in the average width) with shoreline armoring similar to the status quo. Alternative Two offers even wider beaches (a 2.5-meter increase in the average width) with minimal armoring (only the terminal groins, at the north and south ends of the island, remain). The third and fourth alternatives are graphically identical to the second, but contain a specification of the management strategy to be used to achieve the improvements. The third alternative specifies that a policy of increased beach nourishment be used to maintain wider beaches devoid of seawalls. The fourth alternative specifies that a policy of shoreline retreat be the management approach used to maintain the wider beaches. An existing payment vehicle — beach parking fees — was chosen for the survey. The facing page presents the primary valuation question:

> Considering the beach conditions and the price of using the beach, which would you prefer to see at Tybee Island? (circle one)
>
> a. Current Conditions (at $0.50/hour or $5/day or $50/year)
> b. Alternative Management (at $X/hour or $Y/day or $Z/year)

where *X*, *Y*, and *Z* vary among respondents. In order to prevent free riding of beach visitors that rent beach houses or hotel rooms, the survey clearly stated, "… parking fees would be extended to rental houses and hotels."

Potential participants were approached at the beach on Tybee Island and asked to participate in the survey. If they agreed, their name, address, and a brief survey of personal characteristics were recorded, and surveys were distributed with return envelopes. A follow-up postcard was sent to respondents' homes two weeks later, and a replacement survey was sent a month after initial contact if a response had not been received (Dillman 1978). The response rate for the survey was just under 50%, and the number of usable responses (1,612) was 48% of the surveys distributed. Because beach visitors have a choice between daily parking and an annual pass, two separate models were estimated (referred to as the 'day-tripper' and 'pass-holder'

Table 2
Management Scenarios for Recreational Benefits Survey

Scenario	Description
Status quo	Current levels of armoring and beach width*
Alternative 1	Wider beaches than status quo with similar shoreline armoring
Alternative 2	Wider beaches than Alternative 1 with greatly reduced shoreline armoring through unspecified policies
Alternative 3	Same as Alternative 2, but specified as achieved through beach nourishment
Alternative 4	Same as Alternative 2, but specified as achieved through shoreline retreat

* The status quo scenario assumes that nourishment is sufficient to prevent any long-term net beach erosion.

models, whose separation was justified by use of the Wald test for structural change)[3] and the results combined to make estimates for the beach visitor population.

Bell and Leeworthy (1990) use an 'on-site' cost model to estimate the benefits of Florida beaches. In their model, they distinguish between the conventional travel costs and those costs incurred at the recreational site, finding that the former are positively related to the demand for beach days, while the latter are inversely related. Our payment vehicle is an on-site cost that could have a similar inverse effect on the demand for beach days. While we felt that the payment vehicle was more believable than the more standard "voluntary contribution" mechanism, changing parking fees may induce substitution away from beach recreation (or induce recreation at other beaches). Moreover, we did not feel that we had sufficient data on travel costs to estimate a model following Bell and Leeworthy that would allow for changing visitation after the improvement. As such, our price increase measure is calculated as the prospective increase in parking fees, calculated at *current visitation rates*. We do not take into account how visitation changes after the improvement have occurred. This implies that our recreational benefit estimates are lower bounds to the true measure, because any adjustment in visitation will be strictly welfare increasing.

We only sketch the model underlying these estimates, which is a very conventional approach to analyzing dichotomous choice stated preference data. Individual utility depends on beach conditions associated with management actions, wealth, and a composite good (h). Letting b_0 represent status quo beach quality and management actions and b_1 represent proposed changes in beach quality (and in some cases management actions), respondents choose the alternative that gives them the highest utility. They will, therefore, choose the alternative management strategy if its indirect utility is higher than that associated with the status quo:

$$v(b_1, y - A, h; s) + \varepsilon_1 > v(b_0, y, h; s) + \varepsilon_0, \tag{1}$$

where y is the respondent's income, A is the incremental cost to the respondent of the proposed management alternative, h is a composite commodity, and s is a vector of observable characteristics (gender, age, history of visiting Tybee, *etc.*). The variables ε_0 and ε_1 are identically and independently distributed stochastic disturbance terms with zero means.

A logistic regression is used to estimate this model. The regression is specified as:

$$Prob\{alternative\ strategy\ chosen\} = [1 + e^{-v}]^{-1}, \tag{2}$$

where v represents the change in indirect utility relative to the choice representing status quo conditions (which is assumed to follow a logistic distribution) (Hanneman 1984). Eighty percent of the respondents were identified as 'day-trippers'. The estimation results for this portion of the data are presented in the first column of table 3. Ten of the 16 covariates were statistically significant at the 10% level. The estimated coefficients on NOURISH and RETREAT were *both* greater than that on WIDER. The only difference between these alternatives is that the two former specify the method of management, while the latter does not. Moreover, the specified management methods, beach nourishment and shoreline retreat, are very different in their approach. While one would expect that physical outcomes of beach management are important, this result suggests that management processes are as

[3] Wald statistic = 60.87 with 15 degrees of freedom. Conclusion: reject H_0, $\beta_{pass\text{-}holder}$ not equal to $\beta_{day\text{-}tripper}$.

Table 3
Discrete Choice Models for Beach Improvements on Tybee lsland

Variable	Definition	Day-tripper Model	Pass-holder Model
PRICEINC	The amount of the annual price increase	–0.0055***	–0.0049***
		(0.0009)	(0.0010)
INCOME	Annual household income (in thousands of dollars)	0.0069***	0.0082*
		(0.0022)	(0.0048)
WIDER	Dummy variable: 1 if Alternative 2 (wider beaches with minimal armoring); 0 otherwise	0.3214*	–0.2654
		(0.1715)	(0.3713)
NOURISH	Dummy variable: 1 if Nourishment Alternative; 0 otherwise	0.5662**	0.3046
		(0.2318)	(0.4617)
RETREAT	Dummy variable: 1 if Retreat Alternative; 0 otherwise	0.4266*	–0.4501
		(0.2313)	(0.4804)
BQUAL	Scale variable: 1–5, high to low satisfaction with current Tybee Island beach quality conditions	0.3921***	0.4491***
		(0.0709)	(0.1485)
SPRING	Dummy variable: 1 for Spring season; 0 otherwise	0.5452**	–1.2900**
		(0.2328)	(0.5059)
SUMMER	Dummy variable: 1 for Summer season; 0 otherwise	0.0740	–0.4745
		(0.2112)	(0.4182)
AGE	Age of the survey respondent	–0.0071	0.0184*
		(0.0051)	(0.0111)
MALE	Dummy variable: 1 for male; 0 otherwise	–0.1036	–0.1933
		(0.1358)	(0.2735)
PROGOV	Score variable: 2–10, low to high support for government intervention in land use activities	0.1277***	0.1059
		(0.0409)	(0.0882)
ENVIRO	Score variable: 3–15, low to high support for environmental protection	–0.0208	0.0316
		(0.0323)	(0.0675)
TRANSIT	Hourly transit time to the Island	–0.0076	0.0640
		(0.0113)	(0.0391)
HEDUC	Dummy variable: 1 indicating college degree; 0 otherwise	–0.0312	0.7531**
		(0.1407)	(0.3429)
LOCAL	Dummy variable: 1 if local resident (Savannah or Thunderbolt); 0 otherwise	–0.3973**	–1.1644***
		(0.1715)	(0.3262)
INTERCEPT	–	–1.9330***	–2.4457**
		(0.4995)	(1.1608)
N		1,229	313
Log-likelihood		–725.85	–168.51
LRTstat (w/15 df)		151.57	90.41
Prob: Predicted Prob		35.80%: 32.09%	42.81%: 39.86%

Notes: Dependent variable=1 for an affirmative response to beach improvements with associated fee increase, 0 otherwise.
***significant @ $\alpha = 0.01$, **significant @ $\alpha = 0.05$, *significant @ $\alpha = 0.10$ (Standard errors are in parentheses.)

well, and that beach visitors exhibit positive values for both of these distinct approaches. The model predicted a 32.1% affirmative response rate associated with the alternative strategies, which was close to the actual affirmative response rate of 35.8%.

The ‘pass-holder’ model included the remaining 20% of survey respondents, and the results are given in the second column of table 3. Eight of the sixteen covariates were statistically significant at the 10% level. Interestingly, none of the dummy variables identifying the alternative treatments were significant. A majority (53%) of the ‘pass-holders’ were local residents from nearby Thunderbolt and Savannah. (This is considerably higher than in the ‘day-tripper’ sample, 24%.) Local recreational users will be affected to a greater extent by changes in beach conditions, since their substitution possibilities are more limited, and there is much uncertainty about the long-term management of barrier islands, especially in light of the potential for sea level rise. As such, it is possible that there is no clear consensus among local people on the attractiveness of either management approach, and thus there is a good deal of noise in the parameter estimates. Also, the point estimate of one of the coefficients (WIDER) had an unexpected sign, which could reflect the belief of some local residents that wider beaches will bring more tourists, with associated congestion problems. The model predicted an affirmative response rate of 39.9%, which is reasonably close to the actual rate of 42.8%.

Due to the large number of ‘no’ responses in the data (roughly 2/3 for the ‘day-tripper’ model and over half for the ‘pass-holder’ model), we decided to use the mean measure of marginal WTP rather than the median. While these two should be equal for a symmetric distribution (as is the logistic), our point estimate of the median was negative (with a wide confidence interval) for one of the models (‘day-tripper’). The mean marginal WTP, however, can be estimated as the area under the fitted logistic regression curve, which is non-negative. The area under the logistic curve was calculated by numerical integration.

‘Day-tripper’ Welfare Measures

The integration procedure yielded a mean marginal WTP estimate of $97.65 (deflated to 1996 dollars) per ‘day-tripper’ household per year. Dividing by average visits per year (10.36 days), we arrive at a daily marginal WTP of $9.43 per household. These overall averages were calculated with all covariates set at their sample means. To derive differential welfare measures, we manipulate the sequence of dummy variables (WIDER, NOURISH, and RETREAT) to correspond with each of the alternatives, in turn. For example, the marginal WTP for Alternative One (the baseline for the logit model) was calculated by setting all three of the included dummy variables to ‘0’. This resulted in a daily marginal WTP of $7.43 per household. This is a monetary measure of what the average ‘day-tripper’ household is willing to give up (in terms of purchasing power) to attain the conditions identified in Alternative One relative to those in the status quo.

Likewise, the marginal WTP for Alternative Two was calculated by setting the WIDER dummy variable to ‘1’ and the other two to ‘0’. This resulted in a daily marginal WTP of $9.56 per household. Alternative Two was designed to elicit the value associated with the removal of a seawall on Tybee. There is strong evidence that such a scenario would lead to an increase in the quality of the beach. We cannot claim, however, that the removal of shoreline armoring and an improvement in beach conditions are perfectly correlated in all cases, and we do not know which change subjects were responding to. As such, we must interpret this result with caution. We conclude that this is weak evidence that the removal of shoreline armoring will enhance recreational benefits.

The ‘day-tripper’ daily marginal WTP measures for the Nourishment and Retreat alternatives were $11.39 and $10.35 per household per day, respectively. A primary objective of this research is to assess the relative efficiency of these two distinct methods. We find that recreational benefits are sensitive to the management regime when resultant beach conditions are identical, and these results are key in the analysis that follows. These differential welfare estimates will be used in conjunction with welfare estimates from the pass-holder model to analyze the overall recreational benefits of the various management alternatives under consideration.

'Pass-holder' Welfare Measures

The mean marginal WTP estimate for the 'pass-holder' sample is $176.09 (deflated to in 1996 dollars) per household per year. Dividing this by the average visits per year (46.71 days) produces a daily marginal WTP estimate of $3.77. We follow the same procedure as outlined above to estimate the welfare measure for Alternative One, which produces a daily marginal WTP estimate of $4.02 for the 'pass-holder' group. None of the other dummy variables were significantly different from zero, so we do not derive differential WTP measures for the other alternatives.

Aggregate Welfare Measures

We calculate weighted average welfare measures for each alternative assuming that the true proportion of daily users and pass holders is reflected in our sample. These figures are presented in column one of table 4. The estimated welfare measures were scaled up using Georgia Department of Transportation traffic count data (Deloney 1994). These data were generated from procedures that netted out regular commuter traffic from actual beach visitors. The resulting estimate of recreational trips to Tybee Island is 899,284 per year. Since our welfare estimates correspond to the household level, we make the conservative assumption that each car corresponds to one survey response. The annualized welfare estimates are presented in column two of table 4.

Table 4
The Recreational Benefits of Beaches; Weighted Averages of Marginal Willingness-To-Pay Estimates for the Valuation Alternatives

Alternative	Description	Daily* Mean Marginal WTP	Annual Mean Marginal WTP	PDV** of Recreational Benefits
1	Wider beaches with similar shoreline armoring	$6.75	$6,070,167	$94,828,634
2	Wider beaches with minimal shoreline armoring (No management policy specified)	$8.45	$7,598,950	$118,711,404
3	Wider beaches with minimal shoreline armoring (Beach nourishment specified as management policy)	$9.92	$8,821,697	$137,813,255
4	Wider beaches with minimal shoreline armoring (The adoption of a retreat policy specified for management)	$9.08	$8,074,698	$126,143,577

Notes: Averages have been deflated to 1996 dollars. Weighted averages assume the same proportion of 'day-trippers' and 'pass-holders' found in the sample: 4/5 and 1/5, respectively. The welfare measures assume no change in the number of recreational trips.
* Per vehicle day estimates are used because the contingent choice survey elicited WTP per household.
** Present discounted value of recreational benefits over 25 years assuming a 4% discount rate and a constant tourist population.

The weighted average daily marginal WTP for Alternative One (a one-meter increase in the average width with shoreline armoring similar to the status quo) is $6.75 (in 1996 dollars) per household. Scaling this number by the estimated beach user days provides an annual benefit estimate of $6,070,167 from wider beaches. Alternative Two (a 2.5-meter increase in the average beach width with minimal shoreline armoring) had a significant effect in the 'day-tripper' model. Taking this effect into account, daily marginal WTP increases by $1.70, corresponding with an annual welfare estimate of $7,598,950.

The only significant effects associated with specifying the management strategy (Alternatives Three and Four) were found in the 'day-tripper' model, where subjects exhibited an increased marginal WTP when either management strategy was specified. The marginal WTP for beach conditions maintained by nourishment were estimated to be about 10% higher than the same conditions maintained by a policy of shoreline retreat for the daily visitors. The weighted daily average marginal WTP for improved, nourished beaches was estimated at $9.92, while the weighted daily average marginal WTP to improved, natural beaches (maintained by retreat) was estimated at $9.08. These estimates correspond with annual recreational benefits of $8,821,697 and $8,074,698, respectively.

To estimate recreational benefits over the 25-year time horizon of our simulations, we made the conservative assumption that visitor days remain constant. The estimated valuation measures are assumed to remain constant, and future benefits are discounted at 4%. The resulting recreational benefit estimates are presented in the third column of table 4.

The Costs of Erosion Management

Structural engineering on Tybee Island began in 1882 and has had a constant presence since then. Table 5.A lists the major shoreline engineering structures erected and their accompanying costs. The present value of all erosion control structures amount to about $16.24 million (1996 dollars), which includes a rough estimate for structures built before the 1936 seawall (Pye 1998).

Table 5.B provides estimates of beach nourishment costs beginning in 1976 and running through to the renourishment undertaken by the Georgia Ports Authority in 1995. (At the time of this writing, another nourishment project had just been completed on which we did not have data.) The present value of beach nourishment costs since 1976 amounts to $16.62 million. Thus, the total costs of beach management on Tybee Island, including both structures and beach nourishment, amount to an estimated present cumulative value of $32.86 million.

In this analysis, the historical costs of beach management on Tybee Island serve as a guide to the projected future costs of the status quo management scenario. The average cost of beach management on Tybee over the past 35 years has been about $1 million per year (in 1996 dollars). This number is slightly higher than the Army Corps projected nourishment cost estimates of $972,000 per year (Delony 1994). The Corps estimates reflect initial nourishment costs of $5.5 million (projected from 1994 to occur in 1996) and three periodic renourishment costs at about $4.3 million every seven years (effectively, until around 2024). Included in these estimates are mobilization/demobilization costs and dredging costs, each with contingency cost buffers, as well as cultural resource investigation, planning, engineering, design, and construction management costs. We use the million-dollar yearly cost of status quo beach management as a benchmark.

In estimating the costs of erosion management using nourishment with minimal shoreline protective devices, we assumed that only the terminal groins at the ex-

Table 5
Historical Erosion Management Costs on Tybee Island, Georgia

A: Structural Engineering Projects

Year(s)	Type of Structure	Reach	Current Dollars	1996 Dollars
1882–1940	Various	Mostly near Ft. Screven	~$700#*	~$7,775#*
1936	Seawall	South end to Tilton Ave.	$93.5*	$1,046*
1965	Riprap	Tybee light to 7th St.	$301	$1,489
1971	Seawall/riprap	Repair 100 ft.	$65	$252
1975	Terminal groin	North end	$876	$2,596
1984	Riprap	South of 17th St.	$321.9	$488
1987	Terminal groin (& repairs)	South end	$607.4	$843
1995	Groin field	South end	$1,700	$1,746
TOTALS	—	—	$4,664.8	$16,235

B: Beach Nourishment Projects

Year	Reach	Volume (cu. yds.)	Linear Feet	Current Dollars	1996 Dollars	$/cu. Yard	$/Linear Foot
1976	North groin to 18th St.	2,300,000	18,480	$2,628	$7,298	$3.17	$0.39
1987	North and south ends	1,360,000	14,500	$1,989	$2,762	$2.03	$0.19
1993	North groin to 2nd St.	918,000	4,610	$3,780	$4,093	$4.46	$0.89
1995	North and south ends	344,000	7,100	$2,400	$2,465	$7.17	$0.35
TOT/AVG.		4,922	44,690	$10,797	$16,618	$3.14	$0.35

Note: All costs are in thousands of dollars.
These figures are rough estimates from a review of historical engineering operations at Fort Screven supplied by Pye (1998).
* Not used in subsequent analysis.

treme north and south ends of the island remained. (These are likely to be retained under any management scenario to help stabilize the beach template under the pressure of the long-shore current.) While the removal of seawalls, groins, and rip-rap should increase beach quality, beach nourishment would have to be increased drastically to maintain the *present location* of the shoreline, and overall costs are expected to be significantly higher than the status quo. We consider *ad hoc* cost increases of 50, 100, and 200% over the status quo.

The Retreat Simulation

Examining the costs and benefits of a retreat strategy was the most challenging and most interesting part of this analysis. Shoreline retreat differs from the other management strategies in that the composition and characteristics of the housing stock are directly affected in ways that vary over the course of the analysis. We focus on residential properties, which comprise the majority of buildings on Tybee Island.

We assume that once engineering structures were removed and nourishment projects ceased, the ocean shoreline of Tybee would begin to move landward at a regular rate. Unfortunately, unlike at many other east coast beaches, there has been so much intervention for so long that there is no way to make accurate estimates of a ‘natural’ erosion rate. In addition, erosion rates would vary at different parts of the island. We have chosen to use a variety of erosion rates based on maps of Tybee from the previous century and on erosion rates on similar barrier island beaches, and we have chosen to apply these uniformly along Tybee's shore. We examine six erosion rates, ranging from 1/3 meter to 2 meters per year.

Recall that we are using the rental rate as an approximation of use value associated with the housing stock, not changes in the value of capital. We assume that the use value of a house close to the beach stays high until the house becomes unusable, at which time all value is lost. As indicated above, using the *ex ante* hedonic equation to predict *ex post* effects will likely overshoot the true measure. Coastal property characteristics that are valued by homeowners include proximity to the beach (the inverse of distance), as well as quality of the beach. We value physical changes in the coastal environment accruing to homeowners under the assumption that estimated hedonic prices associated with these attributes remain constant. In addition, the value associated with frontage on the ocean is not lost, but rather transferred to other properties. These stylized facts partially compensate for the value of houses lost to erosion, but the hedonic prices of these attributes could change, which may damper this effect. Our approach abstracts from any structural change in the underlying hedonic relationship, which could be an important consideration.

Distance and beach width must be recalculated for every period in the erosion process and reevaluated in terms of its effect on the remaining housing stock. We assumed that a retreat process would generally maintain wide, high-quality beaches (Pilkey 1999), which increases the use value associated with housing. For consistency, beach widths in the retreat simulation were altered in accordance with the Retreat Alternative in the contingent choice survey. The distance of each house from the ERF is reduced annually by the erosion rate, which also increases the use value of housing. The effect of distance can be expected to become negligible at some significant distance from the beach, and in our sample there seemed to be no significant relationship beyond 460 meters from the ERF. Houses further than 460 meters were not modeled as increasing in value as their distance from the beach decreased.

In addition, there are two important discrete effects that must be addressed: houses that are lost to the erosion process, and houses that move from non-beachfront to beachfront status. To identify these properties, we examined every property within 100 meters of the dune line (slightly more than 10% of the sample). For each of these properties, two distances were measured on the county tax maps: the distance at which the property would be consumed by erosion, and the distance at which it became beachfront. If either of these distances were surpassed during the simulation, the status and resulting value of the house was adjusted. In the case of houses lost to erosion, the value of the housing services was permanently lost and a one-time charge of $14,000 (Parsons and Powell 1997) was assessed as the cost of dismantling and removal. In the case of a change to beachfront status, the value of the dummy variable for beachfront is changed from '0' to '1', and the house receives the increment in benefits predicted by the hedonic model for beachfront houses.

Under the assumptions governing this analysis, the effect of a retreat scenario on the value of housing services depends somewhat idiosyncratically on the erosion rate (see table 6). The stream of property benefits clearly decreases under a retreat scenario, but the degree of diminution is not monotonically related to the rate of erosion. At higher rates of erosion, beaches widen and proximity increases more quickly, which partially compensates for lost housing. As mentioned above, oceanfront status is never lost outright, but rather transferred to remaining properties. At an erosion rate of two meters per year, the estimated welfare loss for homeowners accruing from retreat over the 25-year simulation is around $32 million.

Table 6
Estimated Present Discounted Value of the Property Benefits Stream on Tybee Island Associated with Various Erosion Rates over 25 Years

Annual Erosion Rate (m/yr.)	Number of Houses Attaining Beachfront Status		Number of Houses Affected by Change in Distance		Total Number of Houses Unaffected		Number of Houses Remaining	Number of Houses Lost**	PDV* of Property Benefits Stream
0.0000	0	+	0	+	2,795	=	2,795	0	$906,016,772
0.3333	44	+	1,942	+	721	=	2,751	44	$901,235,009
0.6667	62	+	1,942	+	703	=	2,733	62	$897,175,450
1.0000	105	+	1,907	+	678	=	2,690	105	$876,382,791
1.3333	114	+	1,995	+	572	=	2,681	114	$893,141,262
1.6667	132	+	1,978	+	553	=	2,663	132	$891,844,446
2.0000	141	+	1,969	+	644	=	2,654	141	$873,984,638

Note: Values are in 1996 dollars.
* Present discounted value is calculated with a 4% discount rate.
** The property benefits stream includes dismantling costs of $14,000 for each house removed, incurred in the year that the loss occurred.

Net Benefits of the Alternative Management Approaches

We have outlined the analyses performed to produce estimates of benefits and costs for three categories — (*i*) housing benefits/costs, (*ii*) recreational benefits, and (*iii*) direct management costs — associated with the three management policies under consideration — (*i*) status quo involving armoring and nourishment, (*ii*) nourishment without armoring, and (*iii*) shoreline retreat. In table 7, all results are expressed relative to the status quo management strategy. It should be kept in mind that the recreational benefit estimates are a lower bound. The property effects associated with beach nourishment are an upper bound, while those associated with retreat are a lower bound, since the beneficial aspects of retreat partially offset property losses.

A fundamental result of our analysis is that the estimated recreational benefits from wider beaches with no visible seawall, groins, and rip-rap are very large compared to any of the estimated costs imposed by strategies that achieve these higher-quality beaches. Moreover, average household WTP of beach visitors is higher when the households are told how these improved beaches will be attained. Both the Nourishment and Retreat treatment variables were positive and significant in the 'day-tripper' model. (Neither treatment was statistically significant in the 'pass-holder' model.) The estimated recreational benefits are 17% higher for nourished beaches and 7% higher for beaches managed through retreat, both relative to the case where the management strategy is not specified. This result suggests that beach visitors are concerned about how beaches are managed, and would apparently like to have a say in the matter. Given the very different nature of these management approaches, we conjecture that a portion of our sample prefers the nourishment strategy, while another portion exhibits a preference for the retreat strategy. WTP could be diminished under the "unspecified" treatment due to household concerns about which approach would be taken. Under this interpretation, benefit estimates under the unspecific scenario represent pure recreational and aesthetic values of improved beaches reduced by the risk premium arising from uncertainty regarding which management regime will be implemented. The incremental values associated with the specific regimes reflect average preferences for these distinct approaches.

Table 7
Marginal Changes in the Present Discounted Value* of Welfare Measures for Beach Management Alternatives on Tybee Island over 25 Years

Alternative	Marginal Change in Recreational Benefits		Marginal Change in Property Benefits**		Marginal Change in Management Costs***		Marginal Change in Social Welfare
Nourishment w/o Armoring (50% cost increase)	$137,813,255	+	$2,126,677	–	$7,811,040	=	$132,128,892
Nourishment w/o Armoring (100% cost increase)	$137,813,255	+	$2,126,677	–	$15,622,080	=	$124,317,852
Nourishment w/o Armoring (200% cost increase)	$137,813,255	+	$2,126,677	–	$31,244,160	=	$108,695,772
Retreat (1/3 m/yr. erosion rate)	$126,143,577	+	(–)$4,781,763	–	(–)$15,622,080	=	$136,983,894
Retreat (2/3 m/yr. erosion rate)	$126,143,577	+	(–)$8,841,322	–	(–)$15,622,080	=	$132,924,335
Retreat (1 m/yr. erosion rate)	$126,143,577	+	(–)$29,633,981	–	(–)$15,622,080	=	$112,131,676
Retreat (1 1/3 m/yr. erosion rate)	$126,143,577	+	(–)$12,875,510	–	(–)$15,622,080	=	$128,890,147
Retreat (1 2/3 m/yr. erosion rate)	$126,143,577	+	(–)$14,172,326	–	(–)$15,622,080	=	$127,523,331
Retreat (2 m/yr. erosion rate)	$126,143,577	+	(–)$32,032,134	–	(–)$15,622,080	=	$109,733,523

* The present discounted values are calculated with a 4% discount rate.
** The stream of property benefits reflects a 2.5-meter increase in average beach width for all alternatives. The Retreat Alternative includes lost houses and changes in distances and beachfront status.
*** Management cost estimates for the Nourishment w/out Armoring Alternative reflect permanent cost increases of 50, 100, and 200% above the current level of $1 million per year, while the Retreat Alternative reflects cost savings of the PDV of $1 million per year over 25 years.

The sizable recreational benefits from both alternative regimes drive the overall resulting social welfare measures presented in table 7. The marginal change in social welfare across both regimes ranges from approximately $108 million to $136 million. The higher estimated net benefits of beach management on Tybee Island over 25 years are associated with the retreat strategy under modest erosion (1/3 – 2/3 meters per year). These scenarios exhibit high recreational benefits, management cost savings (in terms of foregone nourishment and armoring expenditures), and small net pecuniary effects on the property market.

If the realized erosion rate is greater than 2/3 meter per year and beach nourishment costs without shoreline armoring do not rise drastically (less than double the current costs), beach nourishment would be the preferred strategy over the time frame of this analysis. The estimated recreational benefits of beach nourishment are greater than those under shoreline retreat, and in this scenario the rising management costs are further justified by the forgone property damage. If beach nourishment costs rise drastically (triple), on the other hand, the optimal strategy again becomes shoreline retreat. This conclusion is similar to that obtained by Kyper and Sorenson (1985), though their analysis did not include recreational benefits. It should be noted, however, that the property benefits measure is an upper bound. In the beach nourishment scenario, this implies that the true effect could be less than $2,126,677; while in the retreat scenario, the true *negative* effect could be even greater in absolute value than what we have estimated. We also note that the recreational benefits are lower bounds. More research on both the recreational benefits and property effects of beach management is clearly warranted. Given the sensitivity of our results to the erosion rate and the rate of increase in management costs, these topics would also be fruitful areas of future research.

Conclusions

In this paper, we have compiled differential costs and benefits to evaluate the efficiency consequences of three relevant management strategies for Tybee Island beaches. We find that the potential benefits from maintaining wide beaches without shoreline armoring are substantial and make the status quo management strategy the least desirable of the three strategies examined. Our stated preference study of the recreational value of beaches indicated that a beach nourishment strategy provides for higher recreational benefits, while the recreational benefits of shoreline retreat are slightly lower. Both strategies, however, receive higher evaluations *for the same resulting general beach conditions* than when no management strategy is specified. This result suggests that people value information on the management of natural resources in a substantial way.

Our analysis suggests that the countervailing property losses under a retreat strategy are of the same order of magnitude as the foregone management costs when the beneficial effects of retreat — higher values of housing services for those houses not lost to erosion — are considered. However, property losses are highly dependent upon the rate of shoreline erosion. If unabated shoreline erosion proceeds at a high rate (two meters per year), property losses are estimated at roughly twice the value of management costs foregone. Our results also depend upon how management costs change over time. Under modest cost increases and relatively high erosion rates, beach nourishment is optimal. However, if costs rise dramatically, shoreline retreat is preferable over beach nourishment.

We interpret our results as indicating that there are good economic reasons for phasing out the current strategy for managing coastal erosion at Tybee Island. Our results also indicate that a retreat strategy should not be rejected out of hand because of the potential magnitude of losses to property owners. Assuming that the hedonic price function remains stable, we find that the countervailing effects of wider beaches and increasing proximity to the shoreline offset a large portion of the property losses. On the other hand, the value associated with these characteristics may change. Also, an abrupt change in management strategy could shock the property market, inducing larger welfare effects. Understanding the relationship between coastal management, recreational and property benefits, and the housing market is critical.

We would also like to see the results of similar analyses applied to different coastlines. Tybee is a somewhat typical East Coast barrier island, consisting of geological formations similar to that of other islands in the southeast and mid-Atlantic, and exposed to similar weather events (Clayton *et al.* 1992). The bathymetry and geographic setting of the Georgia coast, however, partially shelter it from the full brunt of hurricane and tropical storm forces. As such, erosive forces, and thus the costs associated with beach management, could be higher in other areas. Moreover, costs and benefits will be proportional to the levels of development and visitation on a given barrier island. Our analytical approach could be instructive in making decisions regarding beach and coastal management, but our specific results are probably not representative of the eastern U.S. in general.

This analysis has focused only on efficiency and not on the distributional consequences of the management alternatives. Retreat, in particular, would place significant burdens on a small, concentrated group of users. Our research indicates that exploring avenues of full or partial compensation, if that is what is required to make a transition to a policy of retreat, is worth the effort. Investigation of government-sponsored erosion insurance and other financing mechanisms could be a rewarding area of future research.

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Appendix: Contingent Choice Survey of Beach Users (This version corresponds with Alternative 1.)

Please read this page first

Georgia's Tybee Island

- is one of the state's 13 barrier islands, of which only Tybee, Sea, St. Simon's and Jekyll Islands have road access and have significant tourism.
- has been eroding at its north and south shore, but it has been gaining sand at its central shore.
- has a total of 2.9 miles of ocean front. Beginning in 1882, rock seawalls and groins have been constructed in an effort to control erosion and protect buildings. More recently, beach replenishment has been used to maintain the beach. 17 percent of the ocean front is currently covered with rocks and concrete.
- provides recreation for visitors and local residents, including sunbathing, walking, swimming, beach volleyball, *etc.*

Shore erosion is the disappearance of land into water. Some erosion is a natural consequence of the shifting nature of sand. Erosion is also caused by channel dredging and other human activities. When people try to prevent the loss of land to erosion, beach conditions usually change. Beaches become narrower and are often bordered by manmade structures like rock or concrete seawalls, rock groins, and jetties.

On Tybee Island there are stretches of ocean that have experienced a buildup of sand, and beachgoers are generally pleased with the resulting wide sandy beach. Along other parts of the shore there has been serious erosion. On these stretches, visitors have experienced narrow low-tide beaches, the disappearance of the beach at high tide, and large rock and concrete structures next to or in the ocean.

Future beach conditions on the island depend on the management choices made in reaction to erosion. Your participation in this study will provide information on how people value beaches and what erosion control strategies will be best for Tybee Island.

Beach Erosion and Outdoor Recreation

In recent years many public facilities, including parks, have been financed by user fees instead of tax revenue. User fees can pay for maintenance and for improvements such as better beach conditions. At Tybee Island, parking meters currently charge from \$0.50 to \$1/hour, or you can use the city parking lots for \$5.00/day, or you can buy an annual sticker for \$50.00 that lets you park at the meters or the lots.

At other beaches you have to pay more, especially the state park beaches in Florida and South Carolina, while other beaches are free. The quality of these beaches also varies.

The amount that people are willing to spend on parking fees (and other items like gasoline, food, *etc.*) in order to visit the beach is determined partly by the quality of the beach for recreation. We are interested in how beach width and erosion control structures affect the way you value Tybee Island beaches for recreation.

In the following pages, we would like for you to consider a management scenario for Tybee Island. Your evaluation will provide information which can help agencies to better manage our coastal public resources.

1. A. Over the last year, how many days did you visit Tybee Island: ___ days
   B. How many of these days involved an overnight stay: ___ days

2. Do you currently own a Tybee Island annual parking sticker? ___ Yes ___ No.

3 Of course, there are other beaches that you can visit besides Tybee Island. Over the last year, how many days did you visit other beaches? ___ days

4. How much personal experience have you had with poor beach conditions that were erosion-related? (Circle one number)

Have never seen it		Moderately aware of it		I have experienced it many times
1	2	3	4	5

[Note: Beach pictures have not been included in this abbreviated version of the survey.]

Erosion Management Techniques

The types of beach you can observe at Tybee Island are illustrated on the page at left. All of these pictures were taken during high tide when all beaches are at their narrowest. The beach will appear wider during other times of the day.

Please read and evaluate each management situation carefully. In each situation, we ask you to compare the outcomes of beach management alternatives. In short, beach management can result in two outcomes: (*a*) outcomes that generate **wide beaches**, and (*b*) outcomes that generate **narrow beaches**.

Wide beaches result from natural sand accumulation, or beach nourishment or a retreat policy. Beach nourishment is where sand is pumped or trucked to artificially widen the beach. The resulting beach has more recreational potential and it provides some storm protection to ocean front buildings. However, some critics argue that the borrowed sand may contain harmful substances, bad side effects might be suffered at the borrow site and the nourished beach may erode back to its original state very quickly.

A retreat policy is where a minimum distance between the water and buildings is specified, and no erosion control is permitted. If erosion reduces this distance then the building must either be moved back or demolished. However, while this policy may produce wider beaches it would also raise questions about how to compensate property owners.

Narrow beaches are usually found where the encroaching ocean has threatened buildings. On Tybee Island, rock seawalls are most commonly used to protect buildings and roads from erosion. The seawalls are pictured on the facing page.

Groins can also be used to protect property. They are like a seawall, but they jut out perpendicular from the shore. A groin can trap sand movement on the updrift side, thus widening that beach. However, the trapped sand is not available for replenishing the downdrift beach and sand loss might be accelerated.

[Note: Color-coded maps of Tybee Island have not been included in this abbreviated version of the survey.]

Suppose that within five years, an **alternative management plan** would change beach conditions as illustrated in the facing page. Here is a numerical summary of the beach conditions illustrated in the maps.

Summary of how beach conditions would change

	Current Conditions			Alternative Management		
Widest Beaches	76%	or	2.2 miles	76%	or	2.2 miles
Wide Beaches	7%	or	0.2 miles	7%	or	0.2 miles
Narrow Beaches	7%	or	0.2 miles	17%	or	0.5 miles
Narrowest Beaches	10%	or	0.3 miles	0%	or	0 miles
Total	100%		2.9 miles	100%		2.9 miles

User fees would have to be charged under either scenario. Parking meters would be upgraded to accept bills and pre-paid parking cards, and parking fees would be extended to rental houses and hotels. To maintain the **current conditions**, the current schedule of parking fees would be required: the parking meter fee of $0.50/hour, the city parking lot at $5.00/day or the annual pass costing $50.00.

The **alternative management** scenario would require an increase in the parking meter fee to *X* cents/hour, the city parking lot at $*Y*/day or the annual pass costing $*Z*. This money would be used for beach nourishment or for financing a retreat policy.

5. Considering the beach conditions and the price of using the beach, which would you prefer to see at Tybee Island? (circle one)
   a. **Current Conditions** (at $0.50/hour or $5/day or $50/year)
   b. **Alternative Management** (at $*X*/hour or $*Y*/day or $*Z*/year)

6. In either scenario, residents and frequent users would most likely buy an annual pass while occasional users would not. What option would you choose? (circle one)
   a. Parking meter fee
   b. City parking lot
   c. Annual pass

7. Suppose that the **alternative management plan** happens and beach conditions in the right-hand map result. At the new fees of $*X*/hour or $*Y*/day or $*Z*/year, how would you change the number of days you visit Tybee in a one-year period? (circle one)
   a. Visit Tybee the same number of days.
   b. Reduce the days you visit Tybee. How many fewer days? (fill in blank)
   c. Increase the days you visit Tybee. How many more days? (fill in blank)

8. What other beaches have you visited in the last 12 months? __________________
   ____

9. If Tybee beach conditions and prices changed to those in the **Alternative Management Plan** would you switch to (circle one):
   a. Visiting other beaches more often.
   b. Visiting other beaches less often.
   c. Doing some other type of recreational activity.
   d. Not applicable.

10. Please name the beach you would probably visit instead of Tybee Island: ________

11. How do you feel about the overall quality of the shore and beach conditions at Tybee Island? (Circle one)

Pleased	Satisfied	Neutral	Dissatisfied	Unhappy
1	2	3	4	5

12. Compared with Tybee Island, how do you feel about the overall quality of the shore and beach conditions at the other beaches you visited in the last 12 months? (Circle one)
    1. Not as good as Tybee
    2. About the same as Tybee
    3. Better than Tybee

The following questions ask for some important information about your household. Remember, your answers are completely confidential. This information is for statistical purposes only.

13. How many people usually visit Tybee with you? ______ number of people.

14. What is your annual household income?

___ Less than $15,000	___ $45,000 – $59,999	___ $90,000 – $104,999
___ $15,000 – $29,999	___ $60,000 – $74,999	___ $105,000 – $119,999
___ $30,000 – $44,999	___ $75,000 – $89,999	___ $120,000 or more

15. Did anyone in your household give up a chance to earn income to come on this trip? ___ yes ___ no

16. How many children live in your household? ___ children

17. Your age: ___ years

18. Your gender: ___ male ___ female

19. What level of schooling do you have? (Circle one number)
    1 = high school 2 = college 3 = advanced degree

The statements below summarize popular but divergent attitudes about coastal erosion policy. Please circle a number to indicate how you agree with each attitude.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
20. Buildings must be protected from the ocean.	1	2	3	4	5
21. The government should not tell people what they can do with their ocean front property.	1	2	3	4	5
22. There should be a ban on any more construction of erosion protection structures.	1	2	3	4	5
23. Government is not obligated to help people who want to build near the shore.	1	2	3	4	5
24. It is more important to make beaches pleasing to beach goers than to preserve coastal ecosystems in their natural state.	1	2	3	4	5