The Economic Effects of a Five Year Nourishment Program for the Ocean Beaches of Delaware, Updated

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CHAPTER 1: INTRODUCTION AND SUMMARY

This research effort was conducted for Delaware's Department of Natural Resources and Environmental Control (DNREC) to provide the State with updated information on the economics effects that are associated with shoreline management. In DNREC's ongoing efforts, the State has devoted resources for the maintenance of Delaware's shoreline since 1988. In order to again examine the accountability of the resources utilized in shoreline management, the State funded this update of results previously provided in 1998.[1] Users should be aware that the results produced herein used some of the ratios from the prior study, to apportion 2002 conditions. In some cases, different sources of data were used to value parameters. In all cases, the methods used herein are described for each calculation.

To define the economic value of shoreline management, economic benefits and economic activities are estimated for two scenarios: the baseline scenario is a continuation from 2003 onward of the State-wide management efforts underway since 1988 and quantified in 1996 and 2002. In the without shoreline management scenario, the shoreline is allowed to diminish according to the long term annual erosion rate for the five years from 2003 forward. Economic benefits of shoreline management that would be lost to the State/local economies in the absence of pro-active shoreline maintenance. Economic benefits of nourishment are dollars that would be lost to the national and State/local economies include losses in recreational values, measured as consumer's surplus and losses in property values. Losses in economic activity as described herein represent losses that would be transferred to other areas as Delaware beaches become less desirable. If fewer tourists visit the beaches, restaurant, lodging, retail trade and other services in the State will drop. However, since visitors who do not come to Delaware beaches will spend these dollars elsewhere, the loss in revenues is referred to as a decline in economic activity (that will be offset by an increase in economic activity elsewhere). The differences in the levels of economic benefits and activity five years hence with and without shoreline management are the economic impacts of shoreline management.

ECONOMIC BENEFITS AND CHANGES IN ECONOMIC ACTIVITY

The economic benefits of beach nourishment to the State and local economies can be thought of as the avoidance of economic losses that would occur without proactive shoreline management. Two primary categories of economic benefits were estimated and correlated with shoreline nourishment: the **consumer's surplus** for the recreation value of the beach visits (the enjoyment for the visit and the willingness to pay for continued shoreline management for future enjoyment) and the impact on **housing prices** related to shoreline management. The loss in consumer's surplus associated

[1] "The Economic Effects of a Five Year Nourishment Program for the Ocean Beaches of Delaware," DNREC, Work Order No. 873726, March 1998.

with beach width is measured by the loss in the consumer's surplus for visitors who may cease to visit Delaware if the beach size is reduced. The loss is quantified as visitors are "squeezed out" as the beach becomes narrower and beach congestion is held constant. A set of behavioral assumptions define the timing of the loss as visitors react to the narrower beaches.

The loss in property value is measured as the decrease in the value of the housing stock associated with an eroding shoreline. Long term erosion is real in the without management scenario and the decrease in housing values is assumed to start immediately as the market learns that the shoreline can be expected to retreat notably. As part of this study, a hedonic model was used to test the sensitivity of the market to shoreline management. In the earlier study, the findings indicated that there was a statistically significant positive impact on price as measured by the quality of the nearby beach, where quality was measured by beach width. The current effort demonstrated that the State's 15 years of shoreline management has removed the impact of beach width on housing prices. The results point to a steadily declining concern of buyers to the current width of the beach, in other words, the market is confident that the State's efforts, including those that have resulted in securing three approved federal projects, will continue to be successful. To estimate the impact of the absence of State's management efforts, the prior model results were used, even though the indications are that those results may understate the full impact of the State's shoreline management strategy.

Other losses to the State and local economies associated with an absence of proactive shoreline management include revenues lost from tourists who chose not to return to Delaware beaches because of crowding. The loss in tourism in turn reduces business profits, results in few jobs and decreases state and local revenues linked to tourist spending. Though the reduction in property values would, in most U.S. regions, result in a reduction in property tax receipts, the algorithm used to levy property taxes in Delaware is not sensitive to market fluctuations in price. Note that losses in tourism revenues, taxes and local wages are economic transfers, in many cases to other states, as the monies previously spent on vacations in Delaware will be spent elsewhere.

SUMMARY OF FINDINGS

The findings of this study are based on estimated based on the difference in economic benefits and activities with and without shoreline management activities. The value of these activities with proactive shoreline management is shown in Exhibit 1-1.

EXHIBIT 1-1	
BASELINE INFORMATION, DELAWARE OCEAN BEACHES	
POPULATION	
RESIDENT BEACH POPULATION:	38,558
DELAWARE & MARYLAND RESIDENTS, WITHIN DAY-USE DISTANCE	179,734
DELAWARE POPULATION (2000)	783,600
SUSSEX COUNTY	156,638
KENT COUNTY	126,697
NEW CASTLE COUNTY	599,265
HOUSING	
HOUSING UNITS	16,967
PROPERTY VALUE	$6,908,703,630
TOURISM (ANNUAL)	
VISITORS (excludes day visitors travelling less than 50 miles)	4,766,724
VISITOR EXPENDITURES AT THE BEACH	$665,174,528
CONSUMER'S SURPLUS, BEACH VISITORS	$409,044,756
EROSION (ANNUAL)	
AVERAGE ANNUAL EROSION RATE	2-4 feet
ON-GOING SHORELINE MAINTENANCE*	300,000 cubic yards
NET LONG-TERM EROSION	0

* Based on historical average

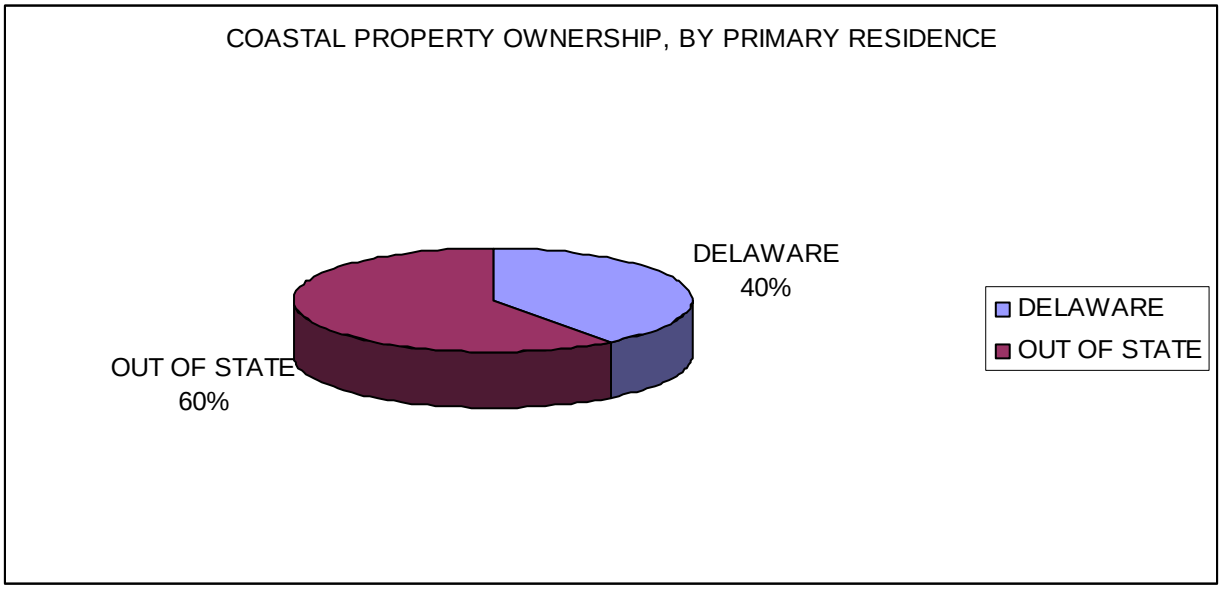
The estimated five year losses without a proactive State shoreline management policy are shown in Exhibit 1-2.

EXHIBIT 1-2
FIVE YEAR ECONOMIC LOSSES WITHOUT NOURISHMENT

POPULATION	TOTALS
NO ESTIMATED REDUCTION	0
HOUSING	
HOUSING UNITS (No estimated reduction)	0
LOSS IN PROPERTY VALUE TO EXISTING HOUSING STOCK	$109,740,639
TOURISM	
REDUCTION IN VISITORS (excludes day visitors travelling less than 50 miles)	271,476
REDUCTION IN VISITOR EXPENDITURES AT THE BEACH	$90,550,820
REDUCTION IN CONSUMER'S SURPLUS, BEACH VISITORS	$23,292,198
REDUCTION IN LOCAL BUSINESS PROFITS	$5,858,849
JOBS AND WAGES & SALARIES	
REDUCTION IN THE NUMBER OF JOBS	1,549
REDUCTION IN WAGES AND SALARIES	$24,746,245
STATE GOVERNMENT	
REDUCTION IN PERSONAL INCOME TAX RECEIPTS	$1,121,005
REDUCTION IN OCCUPANCY TAX RECEIPTS	$874,156
REDUCTION IN CORPORATE INCOME TAX RECEIPTS	$509,720
REDUCTION IN GROSS RECEIPTS TAX	$533,991
LOCAL GOVERNMENT	
REDUCTION IN PARKING RECEIPTS	$246,796
EROSION	
AVERAGE ANNUAL EROSION RATE	2-4 Feet
ON-GOING SHORELINE MAINTENANCE	NONE
NET LONG-TERM EROSION	8-16 Feet

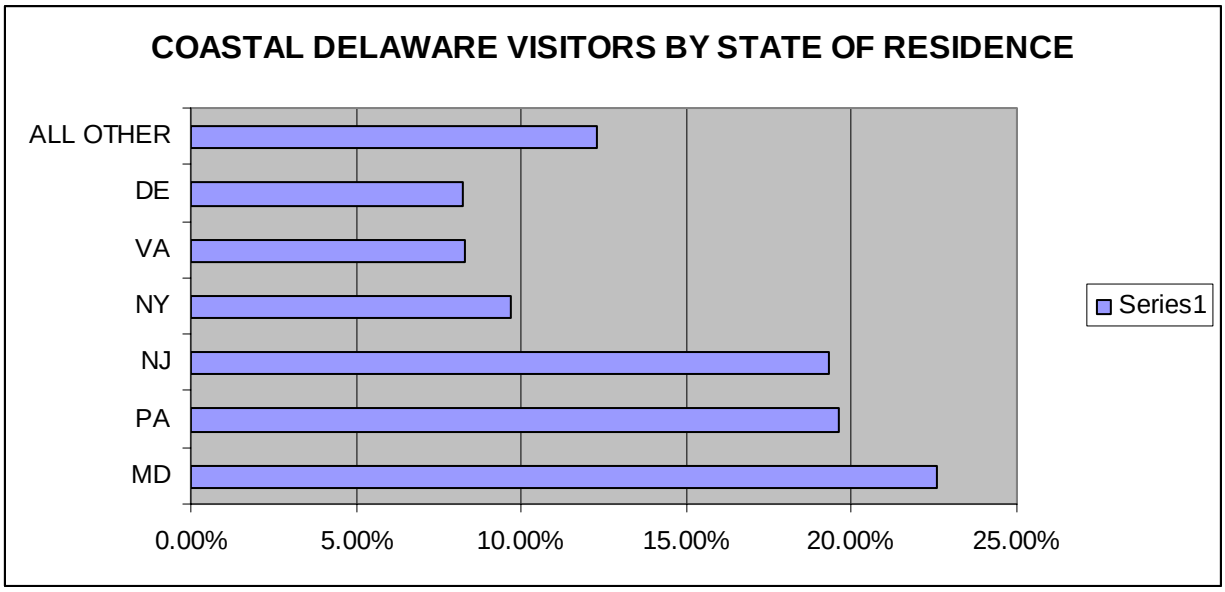
To put the benefits into perspective, the research effort included an analysis of the incidence of beneficiaries. Property values and wages accrue to the individuals. Most of the property and work force in the coastal region do not reside in the State of Delaware. Exhibit 1-3 offers a breakdown of property owners. Of those owners, less than 1% are from outside of the U.S. In other words, most of the benefits related to the success of Delaware's shoreline management efforts relative to property values and wages accrue to residents of states other than Delaware.

Exhibit 1-3: Coastal Property Ownership, by Primary Residence



Likewise, most of the visitors to Delaware's beaches come from outside of the state. Exhibit 1-4 shows the state of origin of visitors to the Delaware shoreline.

Exhibit 1-4: Coastal Delaware Visitors by State of Residence



The consumer's surplus associated with maintaining a quality coastal environment accrues to those who visit the coastal region. Delaware residents make up less than 10% of those who visit the Delaware coastal area.

CHAPTER 2: THE RESEARCH FRAMEWORK

This study updates a 1998 effort (based on 1996 data) wherein the research team demonstrated, through the use of a hedonic model and other tools, the value of Delaware's nourishment program over a five year period[2]. The current effort is based on 2002 data.

Between 1996 and 2002, significant changes were taking place in Delaware's shoreline management plan. With three approved Federal projects, the State's efforts were directed toward securing the Federal funding share for two of the large-scale nourishment projects, Rehoboth and Dewey projects. Total project costs were @$170 million.

As the Rehoboth project went into construction, there was additional push by the Administration through the Office of Management and Budget (OMB) to move the federal government out of shore protection projects. The policy has moved to a position of 'no new projects' and the process for securing funding for approved projects is problematic. The ramifications of the push to move the federal government out of the shoreline management business is far reaching. Today's reality is that funding for the Bethany/South Bethany project is in peril. Moreover, the OMB's attempts to get the federal government out of shoreline nourishment can be expected to endanger future federal contributions to renourishment, which could impact both the Rehoboth and Dewey projects and the Ocean City MD project, all of which are part of the littoral system that impacts Delaware's shoreline.

SHORELINE CONDITION

In keeping with the earlier study, Exhibit 2-1 describes the shoreline in terms of seven reaches and 24 subreaches to denote shoreline erosion rates in combination with economic and political boundaries. The current shoreline position is defined by digitized aerial photography from 2002. Unlike the earlier project, the costs of nourishment since 1996 are not considered. Largely, the State's efforts focused on moving forward the Federal protection projects, rather than 'pumping sand on the beach'. Aside from Hurricane Isabel in 2001, the tropical seasons did not inflict much damage to the Delaware shore and Isabel damages were limited.

In the previous study, a positive correlation was revealed between the condition of the beach, with condition defined as narrowest 24-hour width of dry beach, and housing prices. The width of dry beach was measured using an erosion reference feature (ERF), defined as the ocean edge of the vegetation line or the base of the dune where a dune is present and vegetation is lacking. In some

[2] "The Economic Effects of a Five Year Nourishment Program for the Ocean Beaches of Delaware," Final Report, 1998; prepared by Jack Faucett Associates in cooperation with Linda K. Lent and Christopher Jones.

cases the ERF goes through structures, where the structures were built on what was previously the dune line. In a few cases the ERF is landward of the houses, meaning the houses were built seaward of what was previously the dune line or that erosion following construction resulted in the houses being seaward of today's dune. Appendix B provides the measurements by station that characterize the shoreline. A constant congestion framework was used to anticipate the

Exhibit 2-1: Shoreline Recession Rates Used in Economic Analyses

Reach	Length (ft)	Sub-Reach	Length (ft)	Long-Term Shoreline Recession Rate (ft/yr)
1. Fenwick Island	20,900	Unincorporated Fenwick	1,900	4.0
		Incorporated Fenwick	4,000	4.0
		Fenwick Island St. Park	3,600	4.0
		Fenwick Acres	600	4.0
		Uninc. Sussex County	2,800	4.0
		Fenwick Island St. Park	6,600	4.0
		York Beach	1,400	4.0
2. South Bethany	6,000	South Bethany	3,600	4.0
		South Bethany, N	500	4.0
		Middlesex	1,900	4.0
3. Sea Colony Unit	2,300	Sea Colony	2,300	4.0
4. Bethany Beach	5,100	Bethany Beach	5,100	4.0
5. North Bethany	22,500	Uninc. Sussex County	16,200	3.0
		Delaware Seashore St. Pk	6,300	2.0
Indian River Inlet				
6. Dewey Beach	36,100	Delaware Seashore St. Pk	26,900	2.0
		Indian/N Indian Beach	2,500	2.5
		Dewey Beach	5,700	2.0
		Silver Lake	1,000	1.5
7. Rehoboth Unit	11,500	Rehoboth (S. residential)	2,400	1.5
		Rehoboth (commerical)	3,800	2.0
		Rehoboth (Surf Ave)	1,900	2.5
		Henlopen Acres	1,300	3.5
		North Shores	2,100	4.0

expected reaction of beach users to a reduction of shoreline width. These economic responses, as calculated from the 2002 shoreline condition, enable estimates of the likely consequences if the State of Delaware ceased its ongoing shoreline management program.

ECONOMIC BENEFITS

The economic benefit categories used to measure the value of Delaware's shoreline management, as well as the geographic distribution of those values, include:

- The change in the expected number of visitors to the Delaware shoreline without a management program
- The loss of consumers' surplus associated with the loss of visitors
- The contribution of the condition of the shoreline to land value
- The reduction in economic activity associated with a reduction in visitors
- The geographic incidence of impacted property owners and visitors.

Behavioral Assumptions: Reduction in the Number of Beach Visitors and Associated Loss in Consumer's Surplus

The economic value of a beach visit is measured by consumer's surplus, i.e., the value of a beach visit over and above the cost of undertaking that visit. As developed in the prior study, a constant congestion framework was used to simulate the impact of eroding beaches on visitor decisions. As the beach narrows, visitors will first attempt to mitigate crowding by spreading out beach use over areas which may be less crowded and selecting vacation days that are less popular. It is assumed that changes in on-site behavior can mitigate the erosion evidenced in years one and two of the five year cycle. In years three through five, the decrease in consumer's surplus is measured according to the number of visitors who are crowded off the beach, assuming beach congestion is held constant. The consumer's surplus in this study is measured according to the amount visitors indicate they are willing to pay for a day at the beach and the amount visitors state they are willing to contribute annually to an ongoing beach maintenance program that will maintain the beach for future generations. More information on these calculations is provided in Chapter 3.

Impact of Shoreline Condition on Property Values

The hedonic model used in this application is designed to define the correlation of housing prices to the condition of the beach. Housing prices were represented by properties sold in the area for

the period, 1997 – 2002. Previously, the model had demonstrated a statistical correlation between beach width (the proxy for beach condition) and property value.

The relationship of beach width to property value is a function of a number of variables. The shoreline management program was initiated in 1988 in recognition of the fact that the eroding shoreline was undermining the economic health of the region. In the face of shrinking beaches, the tourism population was shifting from the traditional family units to unrelated young adults. Decision makers recognized a spiraling descent, with rental markets

lagging and a depression in purchase prices of single family homes along with reduced receipts in hotels, restaurants and other tourism expenditures. Property owners on the oceanfront faced the additional threat of imminent damage from minor coastal storm events.

The deteriorated condition of the beach in combination with the diminished amount visitors spent created an economic slump. With the initiation of the State's shoreline management program in 1988, the shoreline economy began to recover. Housing prices began to improve as did the expenditures of visiting tourists, in keeping with other shoreline areas. As the State put sand on the beach and also initiated efforts to secure federal nourishment projects, the economy recovered. Ten years after the onset of the State's shoreline management efforts, the earlier economic study was undertaken. The 1996 results demonstrated that areas with relatively narrower beach were transacting for prices lower than housing prices near wider beaches.

This study was undertaken during the period where not only was the State managing the shoreline and keeping sand in place for tourism, the State was also successful in securing approval for widespread federal nourishment protection. The federal protection would not only keep sand on the beach for the tourism industry, these projects would protect the infrastructure from damages in severe hurricane events. With the expectation of these projects in combination with the ongoing State policy of keeping sand on the beach, it was expected that at some point the condition of the beach would cease to impact housing prices and tourism activity. A hedonic model was constructed to test where the housing market stood in this process.

The findings, detailed in Appendix A, indicate that the perceived goal[3] of the State's nourishment project was achieved. The condition of the beach was no longer a significant concern in purchase decisions. The model demonstrated no significant correlation between beach width and property values.

These findings sent the research team back to the drawing board. The findings indicated that the interaction of housing prices with shoreline condition had moved along a curve. While statistical data are not available, the appearances are that prior to the State's initiation of a shoreline

[3] As the Federal projects were approved but not in place, the model reflects the expectation rather than actual condition of the shoreline.

management program in 1988, housing prices were very sensitive to the condition of the nearby beach area. Ten years into the program, at the time of the earlier study, housing prices were still significantly impacted by the condition of nearby shoreline areas. However, 16 years into the program, the interaction between housing price and shoreline condition was insignificant. Would it be possible to formulate where the region was on the curve in 1996? Could we say anything about the shape of the curve? Given that the benefits mathematically are represented by the area under the curve, more insight could be gained if the shape of the curve was better understood. The findings, as shown in Chapter 4, were consistent with the hypothesis of buyer decision making, that is, over time the impact of beach width on housing prices has diminished, likely due to the State's proactive shore management.

Economic Activity: The Loss of Revenues Related to Reduced Visitors

Tourists spending results in revenues to local businesses, associated employment and indirect activity (stimulated by the purchases of inputs to the goods and services sold). The direct economic activity includes expenditures by tourists, costs to maintain tourism infrastructure (lifeguards, maintenance of boardwalks, piers, parking lots, bath houses) and monies spent to attract visitors (advertisement via radio, television, web sites, internet advertising, skywriting, billboards, newspapers, etc.).

Losses in expenditures mean losses in total revenue to businesses. These losses translate into a reduced work force, reduced purchases of nonlabor inputs and reduced profits. In addition to direct expenditures, indirect losses will result from the reduction in purchases of inputs (labor and materials). Indirect losses are difficult to measure in a shoreline area, estimates contained herein are based on ratios observed in a 1990 study[4] commissioned by the State. The losses related to a reduction in economic activity are presented in Chapter 5.

Finally, in an effort to relate losses that are avoided by the State's nourishment program to those directly impacted, the geographic distribution of shoreline property owners and the distribution of the state of residence of visitors is provided in Chapter 6.

The Appendices provide supporting information. Appendix A provides an exposition of the hedonic model constructed in this study. Appendix B details the beach width by station based on 2002 digital aerial photography. The beach width measure used in this study is the "House to Swash", adjusted to the wet-dry line from 1992 as required.

[4] The Economic Impact of Expenditures by Tourists on Delaware Beaches: 1990," Davidson-Peterson Associates, Inc., 1991.

CHAPTER 3: THE RECREATION VALUE OF BEACH NOURISHMENT

Consumer's surplus is the economic measure used herein to estimate the value of beach nourishment to beach visitors. Consumer's surplus is the difference between what a person is willing to pay for a good or service and the actual amount paid for the good or service. For beach visitors, consumer's surplus is the difference between the total willingness to pay for a recreation day at the beach and the cost of undertaking that recreation day at the beach. The values estimated herein are based on a study conducted by Falk et al.[5]

Besides Falk's study, a 2000 study[6] funded by the New Jersey Department of Environmental Protection's Division of Fish and Wildlife revealed the impacts of ecotourism on Delaware Bay[7]. The study is based on a 1998 survey of more than 600 respondents (out of 1,034 surveys mailed), including members of New Jersey Audubon Society and Cape May Bird Observatory, and birdwatchers encountered along bayshore beaches during the migration season. These dedicated birders, threatened by the declining spawning horseshoe crabs and thus reduced food sources for the migrating birds, would be willing to contribute additional $259.49 ($67.93 per day) before deferring from taking their most recent trip to see the horseshoe crab/shorebird migration spectacle.

Efforts to estimate consumer's surplus in other areas using various techniques have resulted in significantly different estimates of this value. Walsh, et. al.[8] reviewed almost 300 studies that included data from 225,000 visitor days and provided estimates of the willingness-to-pay for various recreation experiences above the actual out-of-pocket expenses of users. Estimates of daily willingness-to-pay in 1987 dollars ranged from less than four dollars to over $200 with a mean of about $34. Activities with high average willingness-to-pay included: nonmotorized boating ($49), big game hunting ($46) and salt water fishing ($72). Activities with lower average willingness-to-pay included: camping ($20), swimming ($23) and picnicking ($17).

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[5] "Recreational Benefits of Delaware's Public Beaches: Attitudes and Perceptions of Beach Users and Residents of the Mid-Atlantic Region," by James Falk, Alan Graefe and Marc Suddleson for the Delaware Dept of Natural Resources and Environmental Control and the US Army Corps of Engineers, Philadelphia District; published August 1994 by the Univ of Delaware, Sea Grant College Program, Newark, DE.

[6] Eubanks, Ted Lee Jr., Stoll, John R., and Kerlinger, Paul, "Wildlife-Associated Recreation on the New Jersey Delaware Bayshore: The Economic Impact of Tourism Based on the Horseshoe Crab-Shorebird Migration in New Jersey", prepared for the New Jersey Division of Fish and Wildlife, February 2000, Fermata Inc.

[7] Inlet of the Atlantic Ocean. Forming part of the New Jersey-Delaware state border, it extends southeast for 52 mi (84 km) from the junction of the Delaware River with Alloway Creek to its entrance between Cape May and Cape Henlopen. Bordered by marshy lowlands, the bay is an important link in the Atlantic Intracoastal Waterway.

[8] Walsh, Johnson and McKean, "Nonmarket Values From Two Decades of Research on Recreation Demand, Advances in Applied Micro-Economics", Volume 5, pages 167-193. 1990, JAI Press Inc.

With few exceptions, surveys[9,10] regarding willingness-to-pay for general beach use typically generate values under $6. This value varies corresponding to the way the question is constructed and does not necessarily mean that the visitors will choose another location if an admission fee higher than $6 is imposed. In contrast to this contingent valuation method (CV), the travel cost method (TC) for valuing beach visits generally give a higher value amidst its wider range ($0.70-60.79, $1990) of conclusions as well.

For this study of the willingness-to-pay for the use of the Delaware ocean beaches, Falk's estimates ($3.01 and $63.69 in 1993 dollars), updated to the 2002 price using the Consumer Price Index[11] from 1993 to 2002, were utilized. The total adjustment is 24.5%. The consumer's surplus used to calculate the 2002 total consumer's surplus for beach visitors per day of beach use is $3.75, while the total amount that visitors would be willing to contribute to a voluntary annual beach maintenance fund is $79.30. The average length of stay for Delaware ocean beach visits was 2.5 days. Thus, the consumers' surplus per day is $33.28 ($3.75 plus ($79.30 divided by 2.5 days)). These estimates fall in the range of unit value of a day's general beach use and are lower than the recent estimates from the Delaware shore.

The next section below, **The Measurement of Consumer's Surplus**, presents the estimates used by Falk and the price-updated values used to estimate consumer's surplus in this effort. The second section below, **The Number of Beach Visitors**, provides 2001 estimates of beach days and visitors to Delaware beaches. The third and final section below, **Consumer's Surplus With and Without Beach Nourishment**, calculates the loss in consumer surplus based on the loss in beach visitors expected without nourishment in the five-year scenario.

THE NUMBER OF BEACH VISITORS

The number of beach visitors was estimated for Delaware in 2000 based on "Delaware Travel Barometer: 2000 Travel Trends" developed by Travel Industry Association of America (TIA). The number of visitors in the TIA database TravelScope is estimated from survey respondents. Beach visitors were estimated according to the 1995[12] number of respondents who indicated that visiting the beaches was an activity pursued while visiting Delaware. Non-respondents (to the activity question) who visited the beach were estimated in the same proportion as respondents, after a review of the data did not reveal a significant bias among non-respondents. Exhibit 3-1 provides these estimates by TIA definitions of person trips, adjusted to reflect non-respondents.

[9] Chapman, David J. and Hanemann, W. Michael, "Environmental Damages in Court: The American Trader Case", The Law of Economics of the Environment, pp.319-67, 2001.
[10] Deacib, Robert T. and Kolstad, Charles D., "Valuing Beach Recreation Lost in Environmental Accidents", February 29, 2000.
[11] Consumer Price Index-All Urban Consumers, Series ID: CUUR0000SAO.
[12] Only year 2000 Delaware visitor totals were available to the research team, all other values were estimated from 1995 ratios developed from the detailed TravelScope State Tables for 1995.

Exhibit 3-1: Estimated Annual Beach Visitors and Beach Days

	TOTAL	NO OVERNIGHT STAY	WITH OVERNIGHT STAY	PERSON DAYS AT THE BEACH
ALL VISITORS TO DELAWARE				
Total Person Trips*	12,128,000	8,036,705	4,091,295	
Pass Throughs*	5,774,000	3,986,460	1,787,540	
Dest/Overnight Trips*	6,354,000	2,341,345	4,012,655	
BEACH VISITORS**				
Total Person Trips	1,839,413	1,218,900	620,513	
+Adjustment for Nonresponses	2,927,310	2,021,061	906,250	
Adjusted Total Person Trips	**4,766,724**	**3,239,961**	**1,526,763**	**8,278,278**

*From Delaware Travel Barometer, based on 2001 TravelScope.
**Estimated based on 1995 ratios applied to 2001 visitors.

There were over 4.76 million person trips to the beach for those traveling more than 50 miles and/or staying overnight. Of these visitors, about 3.24 million were day visitors and 1.53 million were overnight visitors. Of those visitors who stayed at least one night at destinations in Sussex County[13], 35 percent stayed five nights or more, 5 percent stayed four nights, 17 percent stayed three nights, 27 percent stayed two nights, and 17 percent stayed one night. Assuming that those who stayed five nights or more have an average stay of 5.5 nights, the average stay of those who stayed at Sussex County is 3.3 nights. This number is lower than the 5.3 nights (1994) in a Delaware beach visitor study[14] and is considered a conservative estimate.

The TravelScope estimates exclude visitors who travel less than 50 miles and do not stay (as a visitor) overnight. These nearby day visitors to the beaches can be divided into three categories:

1. Year round residents of the beach communities.
2. Second home owners within the beach communities i.e., those who own homes and use these homes (do not offer them for rental), during the peak season.
3. Residents of nearby communities who travel less than 50 miles to the beach and do not stay overnight. This would include residents of Delaware and Maryland who make day trips to the beach areas.

[13] "Sussex County Visitor Profile Study," prepared by Delaware Economic Development Office, Business Research Section; October 2002.
[14] Delaware Public Administration Institute, College of Urban Affairs and Public Policy, University of Delaware, "South Delaware Beach Region Visitor Profile Study", August 1995.

Estimates of visits by year round residents were based on the population within 10 miles of the focal point (38.695555, 75.074387) as shown in Exhibit 3-2.

Exhibit 3-2: Local Population and Annual Beach Visits

	Population	Housing Units	Average number of Visits	Total Annual Visits
40-50 Mile Radius	179,734	87,006	N/A	N/A
30-40 Mile Radius	176,517	80,765	N/A	N/A
20-30 Mile Radius	146,005	94,390	N/A	N/A
10-20 Mile Radius	62,935	53,566	N/A	N/A
10 Mile Radius	38,558	34,438	26.04	1,004,050
Second Homes	12,421	4,890	29.67	368,542
Total Annual Visits from Population within 10 Mile Radius				**1,372,592**

*The Population and housing units within the radius is estimated by using LandView5 Population Estimator based on Census Block points located within or touching the circle defined by the radius.

Those using summer homes were based on the housing units within Census Tract 511 and 512. The estimates of summer residents were based on the number of second homes times the average Delaware household size. Housing units within the local area total 16,301, of which 12,622 are vacant and 11,250 are for seasonal, recreational, or occasional use. The percent of residential units that are operated as second homes, i.e., the owners do not rent their properties to others during the peak season, is estimated as 30% of total housing units[15] or 4,890 housing units. Based on an average household size of 2.54, [16] the estimated number of second home (summer) residents is 12,421. The numbers of beach visits undertaken by both year round and summer residents were estimated according to research undertaken by the Marine Policy Center of the Woods Hole Oceanographic Institution [17] in a survey of tourists and local residents. In this survey, year round residents indicated that they visited the beach an average of 26.04 times per summer, while summer residents averaged 29.67 visits. Accordingly, beach residents visit the beach an estimated 1,004,050 times per season and second home owners are estimated to make an additional 368,542 visits for a total visits by residents and second home owners of 1,372,592. Estimates of day visits by those who reside outside of the local communities but within 50 miles of the beach are currently not available.

CONSUMER'S SURPLUS WITH AND WITHOUT BEACH NOURISHMENT

To determine the effect of erosion loss on consumer's surplus, it is necessary to anticipate how visitors will react to the loss in beach width. Since – absent major storms -- within a five-year time

[15]Estimated by Delaware coastal real estate expert Bill Lingo of Jack Lingo Realty Co.
[16] Average household size, Delaware, 2000, from US Bureau of Census.
[17]"Recreation Benefits at State Beach on Martha's Vineyard," by Yoshiaki Kaoru, Marine Policy Center, Woods Hole Oceanographic Institution, 1992.

frame the nature and conditions of the Delaware beaches will change little, total willingness to pay for a beach visit, holding beach area constant, is not expected to change. However, since there is less beach area, the holding capacity of all the beaches will be reduced. This effect will be most pronounced in the public beach areas that are typically crowded during high use periods. In Exhibit 3-3, the shoreline is divided according to park, public or private use. The public access beaches of the incorporated townships of Fenwick Island, South Bethany, Bethany, Dewey and Rehoboth are those which can be accessed most conveniently by visitors who do not have access to the private beach areas (the majority of visitors). While all visitors have access to park beach areas, these beaches are usually not within easy access (walking distance) of lodging. Thus the reduction in holding capacity of the selected public beach areas during the in-season is used to estimate the visitor loss expected from erosion in a five year framework.

Exhibit 3-3: Erosion Beach Loss by Reach and Community

Reach #	Name	Park/Public/ Private	Length (Ft.)	Erosion Rate (Ft/Yr)	Loss (Sq.Ft./Yr)	Sq. Ft./Yr Public	Cum Loss, 5th Yr*
1	Unic. Fenwick	Private	1,900	4	7,600	-	
2	Inc. Fenwick	Public	4,000	4	16,000	16,000	64,000
3	FISP	Park	3,600	4	14,400	-	57,600
4	Fenwick Acres	Private	600	4	2,400	-	9,600
5	Unic. Sussex Cty	Private	2,800	4	11,200	-	44,800
6	Fenwick Isl. St. Pk.	Park	6,600	4	26,400	-	105,600
7	(York Beach w/o Rt 1)	Private	1,400	4	5,600	-	22,400
8	S. Bethany	Public	3,600	4	14,400	14,400	57,600
9	(S. Bethany, N)	Public	500	4	2,000	2,000	8,000
10	Middlesex	Private	1,900	4	7,600	-	30,400
11	Sea Colony	Private	2,300	4	9,200	-	36,800
12	Bethany	Public	5,100	4	20,400	20,400	81,600
13	Unic Sussex	Private	16,200	3	48,600	-	194,400
14	DSSP (Ind River Inlet)	Park	6,300	2	12,600	-	50,400
15	DSSP	Park	26,900	2.5	67,250	-	269,000
16	Indian/N Indian Beach	Private	2,500	2.5	6,250	-	25,000
17	Dewey Beach	Public	5,700	2	11,400	11,400	45,600
18	Silver Lake	Private	1,000	1.5	1,500	-	6,000
19	Rehoboth (S resid)	Public	2,400	1.5	3,600	3,600	14,400
20	Rehoboth (comm)	Public	3,800	2	7,600	7,600	30,400
21	Rehoboth (Surf Ave)	Public	1,900	2.5	4,750	4,750	19,000
22	Henlopen Acres	Private	1,300	3.5	4,550	-	18,200
23	North Shores	Private	2,100	4	8,400	-	33,600
24	Cape Hen. St. Pk.	Park					
Total Park Shoreline			43,400		120,650		482,600
Total Private Shoreline			34,000		112,900		421,200
Total Public Shoreline			27,000		80,150		320,600
Total Shoreline			104,400		313,700	80,150	1,224,400

*The erosion evidenced in Year 5 is equal to the erosion occuring in the first 4 years.

The Timing of Erosion

Erosion takes place over time, for convenience it is measured via an average annual rate. Note that actual year-to-year erosion follows no such pattern, i.e., the beach size in Delaware varies tremendously throughout the season and each year's gains or losses are conditioned by the severity of weather events that occur within a given year. The average annual erosion rate is used in analysis to represent the long term trend expected for the shoreline. For the purposes of this study, the erosion is considered to happen over the course of each year but the loss is not evidenced until the following year so that at the end of year one (beginning of year two) one year's worth of erosion will be in evidence. The erosion loss expected within a five year period is equal to four years of average annual erosion (at the beginning of the sixth year, five years of erosion loss will be in evidence.). Within the five-year period of analysis, the average annual erosion loss of two to four feet evidenced in the various reaches of the Delaware shoreline will result in an 8 to 16 foot loss in beach width.

The Behavioral Response

The shoreline of Delaware is divided among sections that are open to the public, areas that are privately owned and from which the public is restricted, and park areas that offer beach access in less developed shoreline areas. Park areas are mostly accessed by car. Public reaches include open access townships and limited access outlying reaches. Visitors facing a reduced holding capacity of the already crowded public beach areas of the towns will first attempt to overcome the increased congestion by changing their vacation timing or daily routines while at the beach. Visitors may have flexibility within the season to choose relatively less crowded days (early or late season, mid-week visits) and/or may choose shopping, visits to the State's park beaches or other pastimes on days of their vacation when the high-use public beaches are most crowded.

However, the responses by visitors to mitigate beach losses are limited. The timing of vacations often is locked, by workplace requirements or early reservations required to secure lodging. The willingness to pursue other activities or travel to another beach that is less crowded, e.g., a park beach, is less desirable than having access to the closest available public beach. In this study, visitors are predicted to offset one year of (average annual) erosion of the public beach areas, or 80,150 square feet of beach loss, by altering their vacation days or activities. Thus, no losses in consumer's surplus are predicted until the third year of a five year without nourishment scenario (note the first year of erosion is not in evidence until year two and visitors are able to mitigate the year two loss by a change in vacation timing or activities).

After year two, erosion will continue to diminish the beach width but visitors will no longer be able to compensate for the reduced beach with on-site strategies. From year three on, the holding capacity of the beach will be reduced. If the same number of visitors return to the beach in year

three, beach congestion will occur resulting in a reduction of the consumer's surplus for all affected visitors. Alternatively, if visitors are not willing to accept a reduction in consumer's surplus (a measure of their enjoyment of a beach visit), visitors will choose other activities in place of a beach visit. To measure the loss of consumer's surplus in this study, beach congestion is held constant and the result of a diminished beach is translated into a reduction in the number of visitors, equivalent to the lost holding capacity of the public beach areas. Note that the loss would be the same if crowding occurred (the number of visitors did not decrease) and the consumer's surplus of each visitor was reduced proportional to the reduction in beach area), assuming that consumer's surplus from beach recreation is proportional to the amount of area available on a congested beach .

To estimate the number of visitors who would decide not to visit to Delaware beaches because of the diminished beach size, the erosion loss in the already congested public beach areas is translated into the number of visitors who will no longer 'fit' on the beaches, holding beach congestion constant. The number of visitors electing to go elsewhere was estimated to be equal to the reduced holding power of the diminished public beaches times the number of days during the peak season. According to the average annual erosion rates in the (selected) public beach areas, as shown in Exhibit 3-4, 80,150 square feet of public beach will be lost each year. The U.S. Army Corps of Engineers[18] estimates that 100 square feet is required per beach user. Assuming a 14-week season from Memorial Day to Labor Day, there are 98 beach days in the peak beach season. With an 80,150 square foot loss, the daily beach holding power in the congested public access beach communities is reduced each year by 801.5 visitors (average stay is at 1.74 days/visitor). For the entire season, the beach capacity is reduced 78,547 beach visitor days or 45,246 visitors. As shown in Exhibit 3-4, in years three - five, a cumulative loss of 471,282 visitor days or 271,476 visitors is expected. This reduction in visitors assumes that visitors will remove themselves from the Delaware beach areas each day of the 98 day season up to the point that the congestion is no worse than experienced in the 2001 season, after adjusting for one year of erosion wherein visitors alter their plans to mitigate potential crowding. If the erosion continues unchecked after five years, an additional 45,246 visitors will be lost each year.

[18]Rehoboth Beach/Dewey Beach Interim Feasibility Study, April 1995, page 26.

Exhibit 3-4: Loss in Public Beach Size, Visitors-days and Visitors, by Year

*									
		Year Three		Year Four		Year Five		Cumulative	
Reach Name, Public Beach Areas	Annual Erosion (Sq Ft)	Loss in Visitor Days**	Loss in Visitors	Loss in Visitor Days	Loss in Visitors	Loss in Visitor Days	Loss in Visitors	Loss in Visitor Days	Loss in Visitors
Inc. Fenwick	16,000	15,680	9,032	31,360	18,065	47,040	27,097	94,080	54,194
S. Bethany	14,400	14,112	8,129	28,224	16,258	42,336	24,387	84,672	48,774
(S. Bethany, N)	2,000	1,960	1,129	3,920	2,258	5,880	3,387	11,760	6,774
Bethany	20,400	19,992	11,516	39,984	23,032	59,976	34,548	119,952	69,097
Dewey Beach	11,400	11,172	6,435	22,344	12,871	33,516	19,306	67,032	38,613
Rehoboth (S resid)	3,600	3,528	2,032	7,056	4,065	10,584	6,097	21,168	12,194
Rehoboth (comm)	7,600	7,448	4,290	14,896	8,581	22,344	12,871	44,688	25,742
Rehoboth (Surf Ave)	4,750	4,655	2,681	9,310	5,363	13,965	8,044	27,930	16,089
Total	80,150	78,547	45,246	157,094	90,492	235,641	135,738	471,282	271,476

*The erosion evidenced in Year two is mitigated by visitor behavior changes so that visitors do not decline until year three.

**Loss in visitors = visitor days/(68% day visitors*1 day per visitor + 32% overnight visitors *3.3 days per overnight visitor) = Visitor days/1.736

To estimate the dollar value of the loss in recreation value by year, the number of beach visitor days lost per year is multiplied by the average consumer's surplus for beach visitors in 2002 dollars, by year. In Exhibit 3-5, the number of beach visitors not returning to Delaware beaches is multiplied by the annual willingness to contribute to a voluntary beach fund to estimate the total reduction in contributions to the annual beach fund. A loss in consumers' surplus of over $23 million is predicted for the five year period.

Exhibit 3-5: Loss in Consumer's Surplus from Beach Visitors, Cumulative Yrs 1-5

Reach Name, Public Beach Areas	Loss in Visitor Days	Loss in Daily Visit Consumers' Surplus ($3.75 per daily visit)	Loss in Visitors	Loss in Maintenance Fund Consumer Surplus ($ 79.3 per visitor)	Total Loss in Consumers' Surplus
Inc. Fenwick	94,080	352,555	54,194	4,297,166	4,649,721
S. Bethany	84,672	317,300	48,774	3,867,450	4,184,749
(S. Bethany, N)	11,760	44,069	6,774	537,146	581,215
Bethany	119,952	449,508	69,097	5,478,887	5,928,395
Dewey Beach	67,032	251,196	38,613	3,061,731	3,312,927
Rehoboth (S resid)	21,168	79,325	12,194	966,862	1,046,187
Rehoboth (comm)	44,688	167,464	25,742	2,041,154	2,208,618
Rehoboth (Surf Ave)	27,930	104,665	16,089	1,275,721	1,380,386
Total	471,282	1,766,081	271,476	21,526,117	23,292,198

CHAPTER 4: THE PRICE EFFECT OF BEACH CONDITION ON BEACH COMMUNITY PROPERTIES

An important factor in the value of coastal property is proximity to the beach. The type of beach matters: bluffs offer different amenities than sandy beaches; rocky shorelines are not as appealing as sandy, walking beaches; and polluted beaches are frustrating. This chapter goes deeper into the relationship of property value and the shore, and examines how the size of the sandy beach, as a proxy for overall beach condition, may impact surrounding land values. The 1998 study demonstrated that as the shoreline narrows with erosion, the contribution to property value from the nearby presence of the recreational beach was reduced. The reduction in value can be traced to a reduction in the willingness-to-pay of beach owners and visitors for lodging/property near the beach. When properties are sold, this translates into a reduced price. When properties are held in rental, the rental value can be expected to decrease with a decrease in the quality of the beach, which in turn may decrease the resale value of the property. The relationship of housing prices to the beach width, a proxy for beach condition, has been examined in this study through the construct of a hedonic model. The model was estimated using the Multiple Listing Service (MLS) data on property transactions from December 1997 through September 2003.

OVERVIEW OF THE HEDONIC MODEL[19]

A hedonic model was used to estimate the effects of beach erosion on beach community properties. The hedonic approach relates the price of a commodity to its attributes. It assumes that commodities are composites of numerous attributes that are not sold individually in the market but for which there are levels of demand. The price of a commodity, then, is determined by the various combinations of these attributes as well as the different levels of supply and demand for each.

In this effort, the price of a piece of property is related to several different property attributes: square footage, the number of bathrooms, the age of the structure, how far the property was from the beach, and the width of the closest beach. In addition, community dummy variables were also included in the regressions to account for different price levels that may exist across communities. A time variable was also included to account for the effects of inflation.

The regressions were estimated using a double-log functional form, where the natural logarithms of both the dependent and independent variables were used. The estimated parameters in such models generally refer to the percentage change in price due to a one percentage point change in the value of an independent variable.

[19] For more information on the model framework and results, see Appendix A

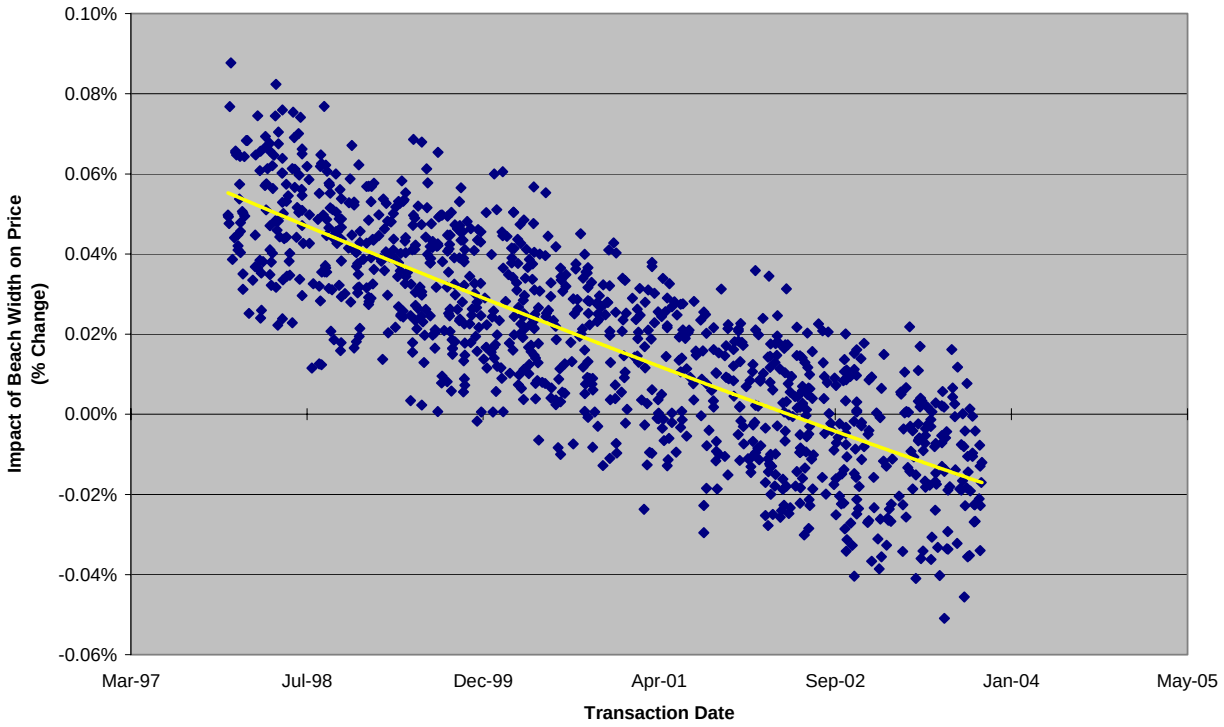
On average, it was found that a 1% increase in beach width results in a 0.01% increase in housing prices. However, this estimate was not statistically different from zero. A likely explanation for this finding is that the impact of beach width on housing prices has been declining over time. With proactive shore management, seasonal users anticipate adequate room for recreational pursuits, even during peak season. Before Delaware's shoreline management program, homeowners located on or near the beach faced more uncertainty in terms of potential damage from future storms. Wider beaches, therefore, would have served as a risk mitigation factor and there would have been a premium for that mitigation in terms of relatively higher housing prices located on wider beaches. After 16 years of successful and consistent nourishment projects by the State, including securing approval for federal nourishment projects, the public likely expects future nourishment projects and see relatively narrow beaches as being somewhat temporary. In other words, current property owners may not feel the same amount of risk that was felt by earlier property owners. If true, the risk mitigation premium of wider beaches would have declined or even disappeared and there could be less divergence between the prices of houses located on relatively wider beaches versus those located on relatively narrow beaches.

Taking that premise one step further, it is possible to envision a sloping demand curve with respect to beach width. Since the State's shoreline management program had been operating 10 years before the earlier study, we can hypothesize that the correlation demonstrated in 1998 was not the peak of the correlation, i.e., the observations represented a point on the downward sloping curve. If true, the prior results may understate the actual correlation of beach width to property value in the absence of a State shoreline management program. We cannot determine the shape of the curve before we have sale price observations, but we attempted to characterize the curve during the period of observation. The results are shown in Exhibit 4-1. While this plot does not indicate statistical confidence, there is a clear indication that the hypothesis may be a good characterization of actual market forces.

The evidence indicates that the quality and consistency of Delaware's nourishment program accounts for the change (when compared to the previous study) in the relationship between beach width and housing prices. While the prior study used this relationship to estimate the housing markets reaction to nourishment efforts, it is not possible to use the current relationship for that purpose. Nonetheless, visitors and property owners would incur a reduction of coastal amenities and additional risk without the nourishment program and would be willing to pay to offset the loss and mitigate the risk. Without ongoing nourishment, owners and visitors likely would choose alternate destinations for coastal recreation, depressing housing values accordingly. To estimate the reduction in value, coefficients from the prior study (which captured the risk/loss premium before Delaware's nourishment program eliminated adverse expectations) are again used to estimate the impact of erosion on property values. In the previous study, it was found that a one foot change in beach width impacted property prices by approximately 0.1% (0.000981).

Exhibit 4-1: Impact of Beach Width Against Transaction Date

Exhibit 4-1: Impact of Beach Width Against Transaction Date



THE PROPERTY INVENTORY

To estimate the total impact of beach nourishment efforts on coastal property values, it was necessary to develop an inventory of affected properties for the base year 2002. The per-unit-benefits estimated in the regression analysis were applied to all of the properties in the inventory to generate a total benefit estimate. The MLS data set was not adequate for this purpose since it only includes data on properties that were sold and excludes all other properties. Data from the Sussex County Courthouse also did not provide current price information, which is needed in the inventory. As a result, the inventory of housing units in the beach communities was developed using data from the 2000 Census of Housing.

Census totals from U.S. Census Bureau tract numbers 511 and 512 were used to approximate the beach communities. In total, there were 16,301 housing units in 2000. An estimate for the number of housing units in 2002 was developed by applying a growth factor to the year 2000 number. The growth factor is based on the estimated number of housing units by county, developed by the Census Bureau's Population Division; the factor is computed as the 2002 estimate for Sussex

County divided by the year 2000 estimate. Applying the factor to the Census 2000 figure yields an estimated 16,967 housing units for the beach communities, as shown in Exhibit 4-2.

The value of the inventory also was derived from the 2000 Census of Housing. The average value for units in the study area was $307,643. This figure was updated to 2002 prices using an inflation factor developed from the MLS data. The factor was computed as the average MLS price in 2002 divided by the average MLS price in year 2000. Multiplying the inflation factor by the average unit value for year 2000 produces $407,182: an estimate of the average unit value for 2002. The value of the total inventory is then calculated by multiplying the estimated number of units in 2002 by the average unit value. The result is $6.9 billion, which represents a 12% average annual increase in the value of the property inventory since 1996.

Exhibit 4-2: Inventory of Affected Properties

	Number of Units	Average Price	Total Value
Year 2000	16,301	$ 307,643	$ 5,014,886,214
Growth or Inflation Factor	1.04	1.32	NA
Year 2002	16,967	$ 407,182	$ 6,908,703,630

Since the State is interested in assessing how nourishment benefits accrue to various groups of property owners, the property inventory was segmented according to the permanent geographic residence of the owner. This geographic distribution of beach property ownership was based on the distribution of ownership in the beach communities included within the two large tax map districts, #1-34 and # 3-34 as determined in the previous study from detailed property tax records. Within the two large tax districts, the beach communities were defined according to the tax maps that represented the geographic area covered by the Multiple Listing Service transactions used in the model. In total, 19,771 properties are included in these districts. Of these, 22 properties are owned by those residing in other countries, 11,837 are owned by residents of other states and 7,912 are owned by those residing in Delaware. By county, 2,028 owners reside in New Castle, 448 in Kent and 5,427 in Sussex County. Within the beach community, Bethany shows 526 property owners, Dewey 32, Rehoboth 2,272, South Bethany 145. Note that these numbers reflect property ownership, including commercial and undeveloped. Also note that one person may own multiple properties, as is clearly the case in Rehoboth, where properties owned by those whose address is Rehoboth outnumber the resident population of Rehoboth. More information on property ownership is provided in Chapter 6.

THE VALUE OF RESIDENTIAL HOUSING WITH AND WITHOUT BEACH NOURISHMENT

In the status quo (nourishment to continue as planned by the State) scenario, property values do not decrease as a result of erosion because while erosion does continue, the State maintains a management program that prevents the nourishment from having a price effect. In other words, with an ongoing State policy to protect the shoreline, the market knows that erosion will be offset by future State nourishment activity. In the without nourishment scenario, it is assumed that owners, buyers and visitors understand that the State will not nourish the shoreline and the willingness to pay for properties is influenced according to the model estimates of the effect of beach loss on property values, beginning in Year 2.

Exhibit 4-3 presents forecasts of the cumulative losses of property values that are predicted to occur over the time horizon if nourishment efforts are not undertaken. The estimates are given in

Exhibit 4-3: Property Value Lost without Nourishment, by Year

(Property Values $2002)	
Average Unit Price	$ 407,182
Unit Loss per Foot of Beach Width	$ 399
Number of Units	16,967
Total Inventory Loss per Foot of Beach Width	$ 6,777,438
Annual Erosion (feet)	2-4 ft.
Total Inventory Loss at End of Year:	
Year 1	$ 21,948,128
Year 2	$ 43,896,256
Year 3	$ 65,844,384
Year 4	$ 87,792,512
Year 5	$ 109,740,639

constant 2002 dollars and are a function of the average annual rate of erosion expected to occur over the period. During this period, erosion is expected to reduce beach width an average of 3.24 feet per year. As shown in the table, after five years the total property value of the coastal area is predicted to fall by 1.59% if no beach replenishment efforts are undertaken.

The estimates are based on the following computations. The per unit loss in property value due to a one foot loss in beach width was developed by multiplying the average 2002 prices by 0.000981, the log coefficient estimated in the previous study. As can be seen, each one foot loss in dry sand is shown to reduce the average property values by $399. Assuming that property owners are willing to pay up to this amount to prevent each foot of erosion (thereby maintaining the value of their asset), the estimates can be inferred as representing the value of beach nourishment efforts to coastal property owners.

Multiplying these unit losses by the number of units yields the total property loss per foot of beach width for all of the units in the inventory. This loss is estimated to be just under $6.8 million.

To estimate the cumulative impacts over the forecast horizon, the total losses per foot of beach width are multiplied by the amount of erosion estimated to occur between the base year and respective forecast year.

The geographic distribution of property owners is provided in Chapter 6 to identify the incidence of the loss in property value during the study period.

CHAPTER 5: LOSS IN BUSINESS REVENUE WITHOUT NOURISHMENT

As the shoreline erodes without nourishment, the shrinking beach forces out visitors, especially in the heavily-used public beach areas. In the constant congestion framework used here to estimate visitor losses, it is assumed that visitors will select other activities over a Delaware beach vacation in numbers sufficient to maintain the beach density at the level prior to erosion, less a one-year margin wherein visitors change their vacation patterns to offset the loss in beach width. Thus it is assumed that the crowding will remain somewhat the same as with nourishment because timing changes followed by a reduction in the number of visitors will offset potential crowding.

As developed in Chapter 3, over 45 thousand visitors are estimated to be lost in year three, over 90 thousand in year four and over 135 thousand in year five, for a cumulative total of over 271 thousand visitors. It is expected that visitors who do not return will be those with relatively higher financial investment in the beach visit, i.e., visitors who travel more than 50 miles and/or remain overnight. These visitors have more alternatives less than 50 miles from the shoreline as they have the longer travel distances and larger travel budgets. Visitors lost are apportioned between overnight visitors and day visitors (traveling more than 50 miles) according to the relative shares of total visitors to the Delaware shoreline.

According to the TIA's TravelScope 2001, on average, each travel party has 2.2 household members (other people not from the household may have been on the same trip) and spends $261 ($119 per person) in Delaware. For destination/overnight visitors, an average travel party to Delaware also has 2.2 persons and spends $324 per travel party. Likewise, the average number of people in a household travel party to Sussex County in 2001 was 2.4 persons with an average tourism expenditure of $180 per person ($431 per household). However, both the Delaware Travel Barometer and Sussex County Visitor Profile study focus on the destination/overnight visitors. They do not provide data whereby the expenditures for day versus overnight visitors can be estimated separately. Therefore, data from the "Southern Delaware: Beach Region Visitor Profile Study" were used to apportion the expenditures corresponding to day and overnight visitors. Based on the average overnight stays of 3.3 nights from the Sussex County visitors who spent at least one night, overnight visitors spend an estimated $556.74, while day visitors spend $80.53[20]. With 68 percent day visitors and 32 percent overnight visitors, the average expenditure with this apportion is estimated to be $232.92, which is below the average expenditures Delaware visitors. To match the most recent expenditure, a multiplier of 1.12[21] is applied and the adjusted overnight visitors spend an estimated $623.86, while day visitors spend $90.24.

[20] $138.98 average daily expenditure of overnight visitors times 3.3 days and updated to 2002 dollars with CPI index (179.9/148.2) and $66.34 average daily expenditure of day visitors updated to 2002 dollars.
[21] 1.12 comes from $261/232.92.

Expenditures from the Southern Delaware: Beach Region Visitor Profile Study[22] for visitors by type of visitor and expenditure category are distributed as follows:

Exhibit 5-1: Visitor Expenditures by Category

Category	Overnight Visitors	Day Visitors
Lodging	37.71%	0.00%
Restaurants	22.32%	28.46%
Entertainment	12.40%	13.24%
Food Shopping	9.52%	16.75%
Non-Food Shopping	14.33%	32.37%
Transportation	3.71%	9.19%
Total	100.00%	100.00%

Exhibit 5-2 provides estimates of the expenditures of tourism by spending category with the State's ongoing nourishment program.

Exhibit 5-2: Expenditures by Category, by Year with Nourishment*

	Annual Values with Nourishment, $2003	
Visitors	**4,766,723**	
Travel Parties (2.2 persons in a Household)	**2,166,692**	
Total Expenditures ($307/household)	**$665,174,528**	
Visitor Expenditure Breakdown	**Overnight ($733.81/travel party)**	**Day Visitors ($106.14/trip)**
Lodging	$191,861,295	$0
Restaurants	$113,559,907	$44,506,160
Entertainment	$63,088,837	$20,704,904
Food Shopping	$48,435,946	$26,193,893
NonFood Shopping	$72,908,310	$50,620,675
Transportation	$18,875,773	$14,371,455
Total	$508,730,068	$156,397,086

*Totals may not add due to rounding

[22]"Southern Delaware: Beach Region Visitor Profile Study," conducted by the Delaware Public Administration Institute, University of Delaware for the Delaware Tourism Office, August 1995.

The $90.6 million loss in visitor expenditures that is expected in years three - five are shown in Exhibit 5-3, by expenditure category.

Exhibit 5-3: Expenditure Losses without Nourishment*

	Avg. Annual Loss w/o Nourishment	Loss, Year 3	Loss, Year 4	Loss, Year 5	Cumulative, Years 3-5
Visitors	45,246	45,246	90,492	135,738	271,476
Travel Parties (2.2 persons/ Household)	20,566	20,566	41,133	61,699	123,398
Total Expenditures ($307/Household)	$15,091,803	$15,091,803	$30,183,607	$45,275,410	$90,550,820
Visitor Expenditure Breakdown					
Lodging	$1,821,158	$1,821,158	$3,642,316	$5,463,474	$10,926,949
Restaurants	$3,998,603	$3,998,603	$7,997,207	$11,995,810	$23,991,621
Entertainment	$1,957,588	$1,957,588	$3,915,176	$5,872,764	$11,745,528
Food Shopping	$2,178,713	$2,178,713	$4,357,426	$6,536,139	$13,072,279
NonFood Shopping	$4,013,997	$4,013,997	$8,027,994	$12,041,991	$24,083,983
Transportation	$1,122,287	$1,122,287	$2,244,574	$3,366,861	$6,733,721

***Totals may not add due to rounding**

The relationship of expenditures to jobs, wages and salaries and profits, as evidenced in the Southern Delaware study, are shown in Exhibit 5-4. These percentages are used to estimate the jobs, income and profits shown in Exhibit 5-5.

Exhibit 5-4: Tourism Expenditures, by Job, Wages, and Salaries & Profits

Expenditure Relationship by Industry*						
	Lodging	Food Service	Entertainment	General Trade	Transportation	Total
Expenditure ($Millions)	$ 246.5	$ 293.6	$ 82.9	$ 113.5	$ 404.6	$ 1,141.1
Job (Thousands)	2.9	5.6	2.3	0.9	3.3	15.0
Payroll ($Millions)	$ 46.1	$ 75.5	$ 37.2	$ 14.3	$ 120.4	$ 293.5
Tax Receipts ($Millions)						
Federal						$ 136.7
State						$ 30.8
Local						$ 16.8
Expenditure per Job	$ 85,000	$ 52,429	$ 36,043	$ 126,111	$ 122,606	$ 76,073
Expenditure per $1 Income	$ 5.35	$ 3.89	$ 2.23	$ 7.94	$ 3.36	$ 3.89
Tax Receipt/Expenditure						
Federal						11.98%
State						2.70%
Local						1.47%

Profit Margins, by Type of Business**	
Industry	Profit
Accommodation	5.48%
Food services and drinking places	5.11%
Amusement, gambling, and recreation industries	6.38%
Food, beverage and liquor stores	2.15%
Retail trade	2.84%
Air, rail, and water transportation	3.90%

* 2000 Delaware, Impact of Travel on State Economies 2002, p.38, TIA.

** Net Income/Business Receipts, from 1999 Corporate Income Tax Returns: Returns of Active Companies, Corporate Tax Statistics, IRS.

Note that the expenditure relationship by industry shown above is not consistent with the prior study. The prior values were estimated from the 1990 report "The Economic Impact of Expenditures by Tourists" by Davidson-Peterson. These estimates are based on the State data provided by the Transportation Industry Association for 2002.

Additional variables that are linked to expenditures include State receipts for income, occupancy, corporation and gross receipts taxes. The loss in State receipts for income taxes was based on an average rate of 4.53%. The reduction in occupancy taxes was based on the relative share of lodging receipts that are paid to hotels (according to USTDC) and taxed at 8 %. Corporate taxes are estimated at 8.7% of profits and gross receipts are estimated at the marginal rate by category as shown in Exhibit 5-3. Local parking revenue losses are estimated at two dollars per car.

Exhibit 5-5: Summary, Economic Variables, Baseline, Years 2-5

(Based on reduction in tourism and property value from diminished beaches, $2002)							
		LOSS WITHOUT NOURISHMENT AT THE END OF:					Cum.
CATEGORY	**BASELINE:**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**5 Yr Loss**
Total Visitors	4,766,723	0	0	45,246	90,492	135,738	271,476
Day Visitors (50+ Mi)	3,241,372	0	0	30,767	61,535	92,302	184,604
Overnight Visitors	1,525,351	0	0	14,479	28,957	43,436	86,872
ECONOMIC BENEFITS							
Consumer's Surplus, Total	$409,044,756	$0	$0	$3,882,033	$7,764,066	$11,646,099	$23,292,198
Daily Visits	$31,043,543	$0	$0	$294,347	$588,694	$883,041	$1,766,081
Annual Maintenance Fund	$378,001,213	$0	$0	$3,587,686	$7,175,372	$10,763,059	$21,526,117
Property Value	$6,908,703,630	$21,948,128	$21,948,128	$21,948,128	$21,948,128	$21,948,128	$109,740,640
Total Economic Benefits	$7,726,793,141	$21,948,128	$21,948,128	$29,802,686	$37,657,244	$45,511,802	$133,032,838
ECONOMIC TRANSFERS							
Tourism Revenues (total):	$665,174,528	$0	$0	$15,091,803	$30,184,693	$45,277,040	$90,550,820
Lodging	$191,861,295	$0	$0	$1,821,158	$3,642,316	$5,463,474	$10,926,949
Restaurants	$113,559,907	$0	$0	$3,998,603	$7,997,207	$11,995,810	$23,991,621
Entertainment	$63,088,837	$0	$0	$1,957,588	$3,915,176	$5,872,764	$11,745,528
Food Stores	$48,435,946	$0	$0	$2,178,713	$4,357,426	$6,536,139	$13,072,279
Non Food Stores	$72,908,310	$0	$0	$4,013,997	$8,027,994	$12,041,991	$24,083,983
Transportation	$18,875,773	$0	$0	$1,122,287	$2,244,574	$3,366,861	$6,733,721
Profits (total):	$32,914,835	$0	$0	$976,475	$1,952,950	$2,929,424	$5,858,849
Lodging (6.47%)	$12,413,426	$0	$0	$117,829	$235,658	$353,487	$706,974
Restaurants, 5.58%	$7,347,326	$0	$0	$258,710	$517,419	$776,129	$1,552,258
Entertainment, 7.56%	$4,081,848	$0	$0	$126,656	$253,312	$379,968	$759,936
Food Stores, 1.79%	$3,133,806	$0	$0	$140,963	$281,925	$422,888	$845,776
Non Food Stores, 3.3%	$4,717,168	$0	$0	$259,706	$519,411	$779,117	$1,558,234
Auto Repair, 3.67%	$1,221,263	$0	$0	$72,612	$145,224	$217,836	$435,672
Total Jobs	8,948	0	0	258	516	774	1,549
Direct	7,290	0	0	210	421	631	1,262
Indirect	1,658	0	0	48	96	143	287
Wages and Salaries (total):	$140,231,356	$0	$0	$4,124,374	$8,248,748	$12,373,123	$24,746,245
Direct	$114,246,102	$0	$0	$3,360,116	$6,720,233	$10,080,349	$20,160,699
Indirect	$25,985,254	$0	$0	$764,258	$1,528,516	$2,292,773	$4,585,547
State Receipts total	$31,550,313	$0	$0	$547,611	$1,095,223	$1,642,834	$3,285,668
Income Tax-4.53%	$6,352,480	$0	$0	$186,834	$373,668	$560,502	$1,121,005
Occupancy Tax, 8%	$15,348,904	$0	$0	$145,693	$291,385	$437,078	$874,156
Corporate Income Tax, 8.7%	$2,863,591	$0	$0	$84,953	$169,907	$254,860	$509,720
Gross Receipts (Marginal Rate) total	$2,651,954	$0	$0	$88,999	$177,997	$266,996	$533,991
Retail, 0.720%	$873,679	$0	$0	$44,588	$89,175	$133,763	$267,525
Restaurants,0.624%	$726,783	$0	$0	$25,591	$51,182	$76,773	$153,546
Services, 0.384%	$1,051,491	$0	$0	$18,820	$37,640	$56,460	$112,920
Parking Fees $2/party	$4,333,385	$0	$0	$41,133	$82,265	$123,398	$246,796

Totals may not add due to rounding

CHAPTER 6: GEOGRAPHIC DISTRIBUTIONS OF ECONOMIC BENEFITS AND ACTIVITIES

To assist policy-makers in understanding the incidence of losses in economic benefits and economic activity that is correlated with beach nourishment, the losses as estimated herein are allocated according to the geographic location of the residence of the beneficiary. Thus, property losses and losses in profits, jobs and salaries are allocated according to the residence of the owners of beach community properties while losses in consumer's surplus are estimated based on the residence of visitors to the beach communities. The distribution assumes that the residence of beach area job holders is the same as that of beach area property owners.

Exhibit 6-1 presents the distribution of beach community property owners based on information contained in detailed property assessment records used in the 1998 study. This distribution is used to estimate the incidence of losses in property value, profits, jobs and wages and salaries in the beach communities. As shown, 40% of properties in the beach communities are owned by Delaware residents. Of the 40 percent of beach properties owned by Delaware residents, about 69 percent reside in Sussex County, 26 percent in New Castle County and 6 percent in Kent County whereas by total population the county distribution is 17 percent, 66 percent and 17 percent respectively. In Sussex County, 31 percent of the beach properties are owned by Sussex County residents who do not reside within the beach communities. Note that this distribution reflects all records contained in the tax assessor records, including commercial and undeveloped properties.

Exhibit 6-2 presents the distribution of the state of residence of visitors to the shoreline. This distribution is used to allocate losses in consumer's surplus. Accordingly, eight percent of the loss in consumer's surplus is from Delaware residents, whereas the remaining 92 percent is lost by residents of other states or countries. As shown, states with more visitors than Delaware are Maryland (23 percent), Pennsylvania (20 percent), New Jersey (19 percent), New York (10 percent) and Virginia (eight percent).

Exhibit 6-1: Distribution of Property Ownership in Beach Communities and Associated Distribution of Profits, Jobs, and Wages & Salaries

Property Ownership:			5 YEAR LOSSES:			
		Percent	Property Value	Profits	Jobs	Wages & Salaries
Total			$109,740,639	$3,801,788	1,727	$29,340,186
Distribution of Ownership:		100.01%				
Out of Country		0.11%	$120,715	$4,182	2	$32,274
Out of State		59.87%	$65,701,721	$2,276,130	1,034	$17,565,969
	MD	29.37%	$32,230,826	$1,116,585	507	$8,617,213
	VA	10.76%	$11,808,093	$409,072	186	$3,157,004
	PA	9.32%	$10,227,828	$354,327	161	$2,734,505
	DC	3.75%	$4,115,274	$142,567	65	$1,100,257
	NJ	1.74%	$1,909,487	$66,151	30	$510,519
	FL	1.33%	$1,459,550	$50,564	23	$390,224
	NY	0.93%	$1,020,588	$35,357	16	$272,864
	CN	0.32%	$351,170	$12,166	6	$93,889
	CA	0.27%	$296,300	$10,265	5	$79,219
	OH	0.17%	$186,559	$6,463	3	$49,878
	Other	1.92%	$2,107,020	$72,994	33	$563,332
Delaware		40.02%	$43,918,204	$1,521,475	691	$11,741,942
Counties:						
	Kent	2.27%	$2,491,113	$86,301	39	$666,022
	New Castle	10.27%	$11,270,364	$390,444	177	$3,013,237
	Sussex	27.45%	$30,123,805	$1,043,591	474	$8,053,881
Beach Communities		18.87%	$20,708,059	$717,397	326	$5,536,493
	Bethany	5.34%	$5,860,150	$203,015	92	$1,566,766
	Dewey Beach	0.16%	$175,585	$6,083	3	$46,944
	Fenwick Island	1.09%	$1,196,173	$41,439	19	$319,808
	Henolpen Acres	0.01%	$10,974	$380	0	$2,934
	Rehoboth Beach	11.47%	$12,587,251	$436,065	198	$3,365,319
	South Bethany	0.79%	$866,951	$30,034	14	$231,787
	North Bethany	0.01%	$10,974	$380	0	$2,934

Note that the distribution of property ownership is based on the distribution reflected in the 1996 property tax records. The distributions were not recalculated in this update.

Exhibit 6-2: State of Residence, Beach Visitors

(BASED ON ALL VISITORS TO Delaware who travel more than 50 miles and /or remain overnight)				
STATE OF RESIDENCE	VISITORS	PERCENT	LOSS, 5 YEARS WITHOUT NOURISHMENT	
			VISITORS	CONSUMERS SUPLUS
Total	12,128,000	100.00%	271,476	$23,292,198
MD	2,740,928	22.60%	61,354	$5,264,037
PA	2,375,875	19.59%	53,182	$4,562,942
NJ	2,338,278	19.28%	52,341	$4,490,736
NY	1,177,629	9.71%	26,360	$2,261,672
VA	1,006,624	8.30%	22,533	$1,933,252
DE	999,347	8.24%	22,370	$1,919,277
CN	234,070	1.93%	5,239	$449,539
MA	185,558	1.53%	4,154	$356,371
FL	127,344	1.05%	2,850	$244,568
WV	126,131	1.04%	2,823	$242,239
GA	118,854	0.98%	2,660	$228,264
NC	112,790	0.93%	2,525	$216,617
DC	88,534	0.73%	1,982	$170,033
CA	87,322	0.72%	1,955	$167,704
SC	65,491	0.54%	1,466	$125,778
MI	60,640	0.50%	1,357	$116,461
IL	47,299	0.39%	1,059	$90,840
OH	47,299	0.39%	1,059	$90,840
Other	187,984	1.55%	4,208	$361,029

Note that the values shown in Exhibit 6-2 are based on the visitor distribution from the Transportation Industry Association data in 1996. The 2002 data files made available for this study did not contain the visitor origination data.

APPENDIX A: THE HEDONIC MODEL

I. OVERVIEW

To estimate the effects of beach nourishment efforts on Delaware Beach property values, we slightly modified the hedonic modeling approach developed under the previous effort. The hedonic approach relates the value of a commodity to the attributes or characteristics of that commodity. It assumes that commodities sold in the market are composites of various goods (attributes) not sold individually in the market but for which there are individual levels of demand. The price of an aggregate (or composite) commodity is determined in part by the various combinations of attributes that form the aggregate and the different levels of demand for each.

The hedonic approach has been used in many studies to estimate the value of shoreline replenishment. In these studies, the aggregate commodity of interest is the housing market. In general, the price of a house is assumed to be a function of its structural attributes (e.g., number of bedrooms) and its neighborhood or location characteristics (e.g., quality of school district). In coastal areas, distance from the beach and the quality of the beach (neighborhood characteristics) are thought to be important determinants of housing prices and are, therefore, independent variables used in those beach value studies. These variables capture the recreational/esthetic benefit of the shoreline, as well as property damage mitigation benefits.

II. DATA SOURCES AND VARIABLE CONSTRUCTION

Three primary sources were used to obtain or develop the variables needed for the analysis; these include real estate transaction data from the Multiple Listing Service (MLS), property maps from Sussex County, and 2002 aerial photographs of the Delaware Beach from DNREC. These sources are described in more detail below.

MULTIPLE LISTING SERVICE

The real estate industry maintains the Multiple Listing Service database to track information about properties sold. The electronic files we received included information on property type (e.g., condos vs. single family homes), number of bedrooms, number of baths, square footage, year built,

address and community identifiers, school district, type of garage, type of foundation, transaction date, and selling price. Some of these variables were more complete than others and for this reason it was necessary to exclude some of the variables from the analysis.

In the previous effort, we used the Sussex County Courthouse data to obtain some limited information on structural characteristics. While the data set does contain information on each piece of property in the state of Delaware, it is difficult to extract that information in a format that is consistent with the MLS data. In addition, many of the fields in the data are inconsistent or incomplete. For these reasons, we decided to rely solely on the MLS data to update the study.

The MLS file contained data for the period April, 1997 – October, 2003. Transactions that took place immediately after hurricane Isabelle (September 18, 2003) were discarded given the effect that event could have had on property values relative to the other properties in the data set. As an alternative, we could have used dummy variables for the post-Isabelle period; however, the number of transactions in the period was very small and as a result we did not feel that the approach would have accurately captured the impact of the hurricane on the effected property values.

As explained below, the beach width measurements are based upon aerial photographs taken in 2002. For that reason, we had to make a decision as to whether to use all of the MLS data or limit it to properties that were sold in 2002. The opinions of our coastal engineer and contacts within DNREC were that the coastline had changed very little over that time period. Based upon those opinions, we chose to include data for all of the years in order to increase the number of observations in the regressions.

SUSSEX COUNTY PROPERTY MAPS

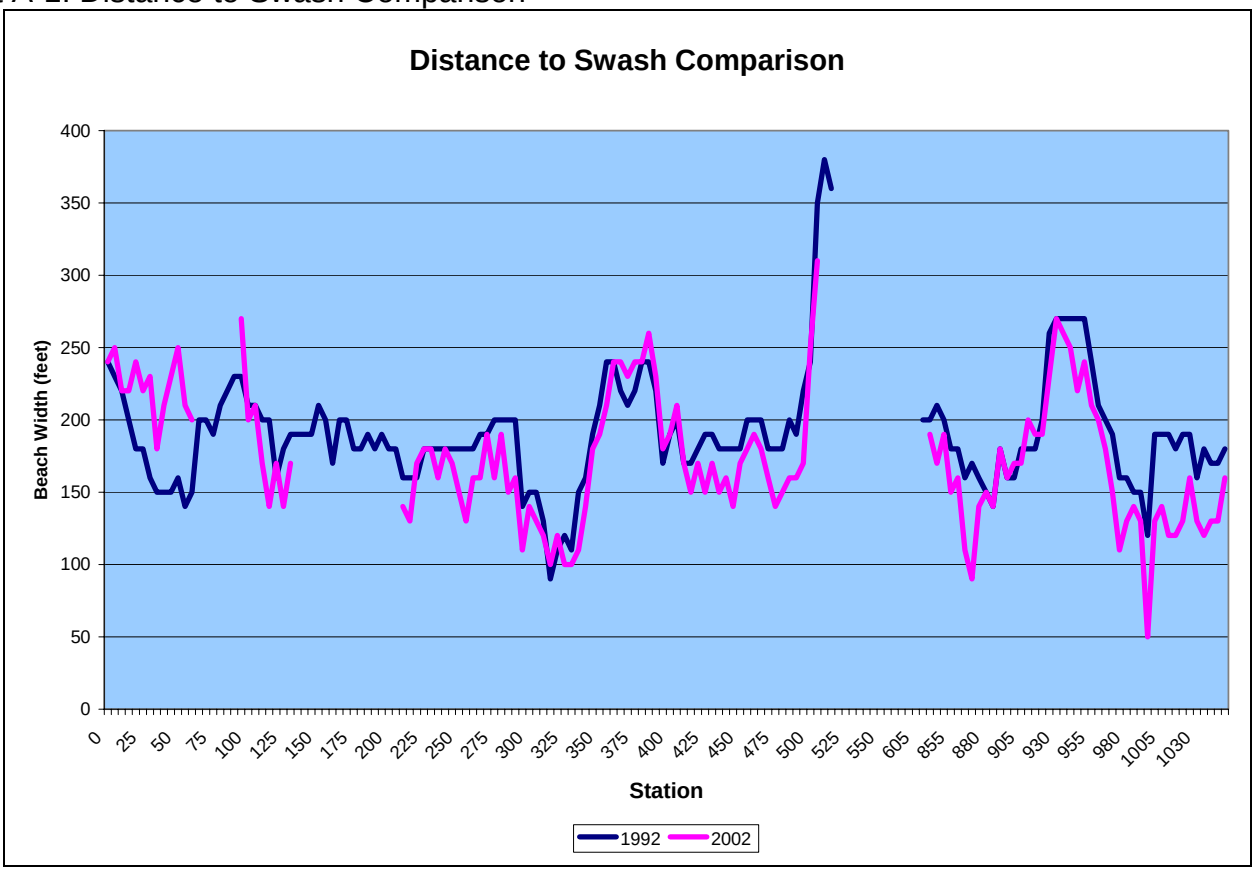
The property maps were used to calculate the distance between each property that was sold and the nearest beach. Notice that each property was associated with one particular beach. The southern Delaware coast was divided into twenty-four reaches and each property was assigned to one of those reaches. Although many coastal properties are in proximity to many different beaches, the simplification was introduced to keep the model tractable.

AERIAL PHOTOGRAPHS OF THE DELAWARE BEACH

2002 aerial photographs of the Delaware Beaches were obtained from DNREC. These photographs were used to calculate the average widths of the twenty-four beach reaches. Different measures of width were constructed and evaluated in the analysis. Due to the construction of dunes or other types of development, the 1992 reference line could not be replicated; therefore, the widths were measured by calculating a distance from the structure nearest to the beach.

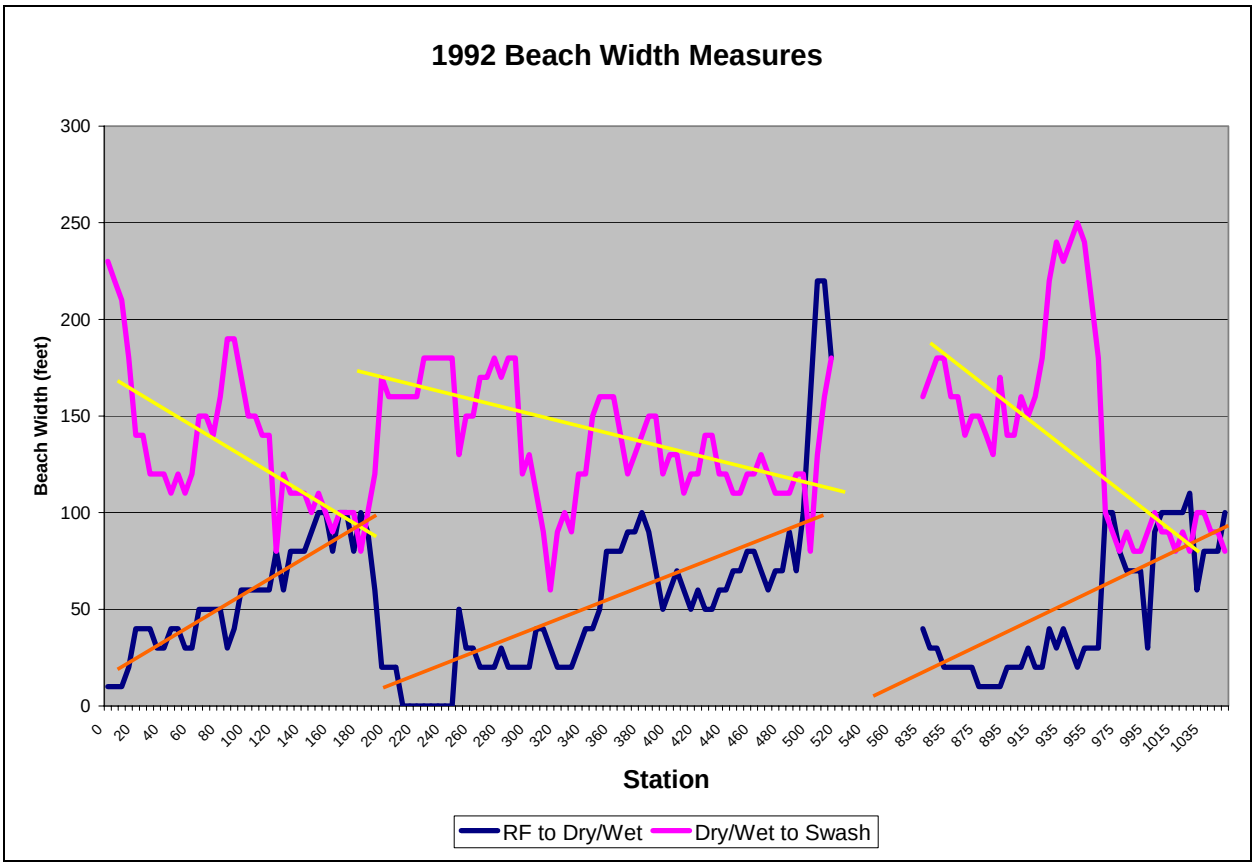
In the earlier study, the 1992 measure of beach width was calculated as the distance from the reference line to the dividing point between dry sand and wet sand, i.e., the most recent high tide line. This measure was chosen because it reflected the least amount of beach available in the prior 24 hours to the public for recreational use and storm mitigation: factors thought to be important in influencing property values. Deciphering the dry/wet line in the 2002 photographs was more challenging and the line could not be distinguished in all cases. Our initial response to this difficulty was to use a different measure based upon the distance to the swash line (water-sand interface at the time of the photography). We assumed that the distance to the swash line would be highly correlated with the distance to the dry/wet line and the 1992 and 2002 swash line measurements tracked closely (see Figure A-1).

Exhibit A-1: Distance to Swash Comparison



However, the preliminary results based upon the distance to swash measure were somewhat questionable. After numerous model specifications, we closely examined the distance to swash measure and discovered that the distance to swash was in fact inversely correlated with the distance to dry/wet sand (demonstrated in Figures A-2).

Exhibit A-2: 1992 Beach Width Measures



To address the issue, we developed a modified 2002 measure of the distance to dry/wet sand. First, actual measurements of the 2002 distance to dry/wet sand were taken for all stations where they could be obtained from the aerial photographs. For the remaining stations, distances were estimated using the 1992 ratios between the distances to dry/wet sand and the distances to swash.

III. EMPIRICAL MODEL

Our modeling effort started with a general specification that relates the price of a given piece of property to its characteristics:

$$P = f(S, Dist2Bch, BW, ONC) \quad (1)$$

where *P* is the property price, *S* is a vector of structural characteristics (e.g., number of bedrooms, number of baths, etc.), *Dist2Bch* is the distance from the house to the beach, *BW* refers to an index of beach quality, and *ONC* is a vector of other neighborhood characteristics (e.g., number of restaurants in close proximity).

Numerous specifications were tested, where the results of any given regression provided information that was further used to refine the model. One of the biggest obstacles we faced was the trade-off between the number of variables and the number of observations used in the regression. Due to missing data, adding an additional variable to the regression could sometimes significantly reduce the number of observations that were used. Some specifications were run on less than 200 observations whereas others utilized almost 1500 observations. An increases in explanatory power provided by an additional variable had to be balanced against the loss in robustness as a result of using fewer observations.

In almost all instances, a double-log specification was estimated, where the natural logarithms of both the dependent and independent variables were used. The estimated parameters in such models generally refer to the percentage change in price due to a one percentage point change in the value of an independent variable. As explained in more detail below, there is an exception to this interpretation when interaction terms are used.

Structural characteristics used in the regression were derived primarily from the MLS data. These include the number of bedrooms, the number of baths, square footage, year built, and whether or not the property was furnished when it was sold (a dummy variable). Because multiple years were used in the regression, it was necessary to convert the Year Built variable into the age of the property at the time it was sold.

Due to a significant amount of missing data in the square footage variable, we had a difficult choice in deciding whether to incorporate square footage in the analysis. When the variable was included in the regression, more than a thousand observations had to be dropped, resulting in a dataset of less than 200 records. However, scatterplots of price against square footage, as well as its t-statistic when it was included in the regression, indicate that square footage is a very strong determinant of price. Although comparisons of different regression runs revealed that some of this effect is picked up by the number of bedrooms when the square footage variable is not included, the number of bedrooms still does not provide the same explanatory power.[23] The final decision was to retain the square footage variable. We then removed the number of bedrooms because that variable became insignificant when square footage was included and we were able to increase the

[23] Using the number of bedrooms instead of square footage, we were able to use a much larger data set (over 1000 records) to estimate the regressions; however the Adjusted R^2 was between five and ten percentage points lower than when the square footage variable was used.

R^2 by removing the number of bedrooms. We also removed the dummy variable indicating whether the property was furnished. That variable is also highly correlated with square footage and becomes insignificant when square footage is included in the regression.

The age variable was characterized by a considerable amount of missing data. Although it does not have the same explanatory power as square footage, we decided to retain it for other reasons. Numerous regression runs indicated that the age variable is correlated with the community dummy variables that were used. This makes sense as the communities probably experienced different levels of development at different times. The dummies themselves are also correlated with beach width. As a result, to isolate the effects of beach width from the community variables, it was necessary to include age so the community impacts could be accurately gauged.

Neighborhood characteristic variables that were evaluated included a dummy variable for school district and dummy variables for the different communities. There are only two school districts identified in the data, which meant that one dummy variable could be used. The variable was eventually dropped as it was perfectly correlated with one of the community dummy variables. Community dummies were created for Bethany Beach, Dewey Beach, Fenwick Island, North Bethany, South Bethany, and Rehoboth. There were no observations in the remaining dataset for either Millville or Henlopen Acres.

The community dummy variables affect the intercept estimated in the regression, but not necessarily the slope coefficients. To explore the possibility that the impact of beach width on housing prices could differ significantly across communities, we did run some regressions with interaction terms between beach width and the community dummies. However, none of these turned out to be statistically significant and their inclusion did not affect the other coefficients or alter the overall results of the regression. Therefore, the interaction terms were dropped.

Given that seven years of transaction data were included in the dataset, we had to address the effect of inflation on housing prices. Two approaches to dealing with this issue were considered. In the first approach, the transaction date was converted into a serial number that was added to the regression as a continuous variable. The second approach consisted of using dummy variables for each of the seven years in which transactions occurred. In contrast to the second approach, the first approach provided more information to the regression and yielded much better results; therefore, we used it for the final regression.

Finally, two interaction variables were evaluated to test hypotheses and see if they could increase the explanatory power of the regression. The first interaction term addressed the possibility that the impact of beach width on property price is a function of how far away the property is located from the beach. To capture this effect, the term consisted of the logged distance variable multiplied by the logged beach width variable. In almost all of the regressions that were run, the coefficient for this term was very insignificant and the variable was eventually dropped. This finding is not surprising. Aside from this interaction term, distance from the beach is held constant

and, as expected, it was found to be significantly related to price. The interaction term measures the impact of distance on price through its secondary effect on beach width. But as the findings suggest, distance from the beach has no effect on beach width, which intuitively makes sense.

The second interaction term was used to evaluate whether the impact of beach width on housing prices has been changing over time. In this study, beach width was measured as the distance from the oceanfront structure to the wet-dry line. Our hypothesis was that the impact has been declining. With proactive shore management, seasonal users anticipate adequate room for recreational pursuits, even during peak season. Before Delaware's shoreline management program, homeowners located on or near the beach faced more uncertainty in terms of potential damage from future storms. Wider beaches, therefore, would have served as a risk mitigation factor and there would have been a premium for that mitigation in terms of relatively higher housing prices located on wider beaches. After 16 years of successful and consistent nourishment projects by the State, including securing approval for federal nourishment projects, the public likely expects future nourishment projects and see relatively narrow beaches as being somewhat temporary. In other words, current property owners may not feel the same amount of risk that was felt by earlier property owners. If true, the risk mitigation premium of wider beaches would have declined or even disappeared and there could be less divergence between the prices of houses located on relatively wider beaches versus those located on relatively narrow beaches.

IV. MODEL RESULTS

The statistical results of the estimated regressions are presented below. The model fit is indicated by the Adjusted R^2, which is 0.82. This statistic varied quite a bit, depending on the number of observations and variables used in a given run. When the maximum number of observations was used, the highest R^2 we obtained was 0.71.

```
      Source |       SS       df       MS              Number of obs =     172
-------------+------------------------------           F( 12,   159) =   64.95
       Model |  62.9763205    12  5.24802671           Prob > F      =  0.0000
    Residual |  12.8466076   159  .080796274           R-squared     =  0.8306
-------------+------------------------------           Adj R-squared =  0.8178
       Total |  75.8229281   171  .443408937           Root MSE      =  .28425

------------------------------------------------------------------------------
     lnprice |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
  lnselldate |   25.30268   8.294622     3.05   0.003      8.92083    41.68452
      lnbath |   .3200636   .0972355     3.29   0.001     .1280239    .5121033
       lnage |   .0157999   .0155826     1.01   0.312    -.0149756    .0465755
      lnsqft |   .6302804    .089885     7.01   0.000     .4527579    .8078029
  lndistance |  -.3623673   .0252775   -14.34   0.000    -.4122903   -.3124442
lnbeachwidth |    23.7685   20.49622     1.16   0.248    -16.71146    64.24847
  lnbwlndate |  -2.259727   1.949748    -1.16   0.248    -6.110472    1.591018
```

```
bethanybeach |   .3885195   .2395458     1.62   0.107    -.0845824    .8616215
  deweybeach |  -.0561657   .2365498    -0.24   0.813    -.5233507    .4110193
fenwickisl~d |   .2401547   .2731204     0.88   0.381     -.299257    .7795663
northbethany |    .461645   .2577876     1.79   0.075    -.0474845    .9707745
    rehoboth |   .6010063   .2476653     2.43   0.016     .1118682    1.090144
       _cons |  -256.0505   87.09247    -2.94   0.004    -428.0578    -84.0432
------------------------------------------------------------------------------
```

With the exception of the age variable, all of the coefficients had the expected signs. The age coefficient is insignificant under a 30% confidence interval, so the direction of its sign does lose some of its importance. Also, there appears to be some interaction between the age variable and the community and square footage variables; it is possible that we did not completely isolate the age variable from all of these other effects.

Looking at the statistical significance of the coefficients, it can be seen that the most important predictors are square footage, the number of bathrooms, distance from the beach, whether or not the property is in Rehoboth, and the transaction date. All of these variables are significant at a 99% confidence level.

With the exception of Rehoboth, the community dummy variables are insignificant (North Bethany would be significant under an 8% confidence interval), as shown in Exhibit A-3. These coefficients refer to the amount of deviation from the intercept terms and, as such, are very small on a relative basis. If we calculate the intercepts for each community[24], and then rank them in ascending order we get the following:

Exhibit A-3: Coefficients by Community

Community	% Increase Above Dewey
Dewey	Baseline
South Bethany	0.02%
Fenwick Island	0.12%
Bethany	0.17%
North Bethany	0.20%
Rehoboth	0.26%

Due to the inclusion of the interaction term between beach width and the transaction date, the impact of beach width on housing prices cannot be obtained directly from the table of coefficients. Rather, the impact is estimated as the following:

[24] Note that the intercept reflects South Bethany.

$$\frac{\partial \ln(\mathrm{Pr}\,ice)}{\partial \ln(BeachWidth)} = \beta_{BeachWidth} + \left(\beta_{BeachWidth,TransactionDate} \times \ln(TransactionDate)\right)$$

Using this formula, impacts were estimated for each observation in the dataset upon which the regression is based. The average impact was then calculated: on average, a 1% increase in beach width was estimated to produce a 0.01% increase in housing prices. This estimate is not significantly different from zero since neither of the coefficients used to calculate the estimates is statistically significant.

APPENDIX B: BEACH WIDTH BY STATION, 2002 DIGITAL PHOTOGRAPHY

APPENDIX B: BEACH WIDTH BY STATION, 2002 DIGITAL PHOTOGRAPHY						
		1992		2002	2002	2002
Location	Measurement Station (100 ft increments from MD border)	Reference Feature to Dry Sand (ft)	Reference Feature to Swash (ft)	Reference Feature to Vegetation (ft)	House to Swash (ft)	House to Dry Sand (est) (ft)
State Line (LRP 67)	0	-10	-240	-110	-320	-90
Unincorp Fenwick	5	-10	-230	-90	-310	-90
"	10	-10	-220	-60	-280	-70
"	15	-20	-200	-40	-260	-80
Incorp Fenwick	20	-40	-180	-50	-260	-120
"	25	-40	-180	-60	-235	-95
"	30	-40	-160	-40	-265	-145
"	35	-30	-150	-10	-220	-100
"	40	-30	-150	-20	-280	-160
"	45	-40	-150	-40	-250	-140
" (LRP 66)	50	-40	-160	-40	-265	-145
"	55	-30	-140	-20	-270	-160
Unincorp Sussex	60	-30	-150	-10	-230	-110
" (park)	65	-50	-200			
"	70	-50	-200			
"	75	-50	-190			
"	80	-50	-210			
"	85	-30	-220			
"	90	-40	-230			
Ocean Park La	95	-60	-230	-40	-295	-125
Ocean Park La (LRP 65)	100	-60	-210	-20	-250	-100
Unincorp Sussex	105	-60	-210	-10	-235	-85
" (park)	110	-60	-200	-10	-195	-55
"	115	-60	-200	0	-185	-45
"	120	-80	-160	0	-390	-310
"	125	-60	-180	30	-380	-260
"	130	-80	-190	10	-410	-300
"	135	-80	-190			
"	140	-80	-190			
"	145	-90	-190			
"	150	-100	-210			
"	155	-100	-200			
"	160	-80	-170			
"	165	-100	-200			
"	170	-100	-200			
"	175	-80	-180			
"	180	-100	-180			
"	185	-90	-190			
"	190	-60	-180			
"	195	-20	-190			
" (LRP 63)	200	-20	-180			
"	205	-20	-180			
S. Bethany	210	0	-160	0	-85	0
"	215	0	-160	0	-60	0

APPENDIX B: BEACH WIDTH BY STATION, 2002 DIGITAL PHOTOGRAPHY						
		1992		2002	2002	2002
Location	Measurement Station (100 ft increments from MD border)	Reference Feature to Dry Sand (ft)	Reference Feature to Swash (ft)	Reference Feature to Vegetation (ft)	House to Swash (ft)	House to Dry Sand (est) (ft)
"	220	0	-160	0	-100	0
"	225	0	-180	0	-100	0
" (LRP 62A)	230	0	-180	0	-110	0
"	235	0	-180	0	-85	0
"	240	0	-180	0	-105	0
"	245	0	-180	-20	-80	0
Middlesex	250	-50	-180	-10	-190	-60
"	255	-30	-180	-20	-175	-25
"	260	-30	-180	-20	-210	-60
"	265	-20	-190	-20	-225	-55
Sea Colony	270	-20	-190	-30	-230	-60
"	275	-20	-200	-30	-190	-10
"	280	-30	-200	-50	-230	-60
"	285	-20	-200	-30	-180	0
"	290	-20	-200	-20	-210	-30
Bethany	295	-20	-140	-20	-160	-40
"	300	-20	-150	-40	-210	-80
"	305	-40	-150	-30	-180	-70
"	310	-40	-130	0	-205	-115
"	315	-30	-90	0	-125	-65
"	320	-20	-110	0	-120	-30
"	325	-20	-120	0	-100	0
"	330	-20	-110	0	-120	-30
" (LRP 60A)	335	-30	-150	-20	-190	-70
"	340	-40	-160	-30	-200	-80
Unincorp sussex	345	-40	-190	-60	-270	-120
" (LRP 60)	350	-50	-210	-50	-290	-130
"	355	-80	-240	-50	-290	-130
"	360	-80	-240	-80	-320	-160
"	365	-80	-220	-80	-320	-180
" (LRP 59)	370	-90	-210	-50	-310	-190
"	375	-90	-220	-70	-320	-190
"	380	-100	-240	-80	-310	-170
"	385	-90	-240	-100	-310	-160
"	390	-70	-220	-80	-270	-120
"	395	-50	-170	-40	-195	-75
"	400	-60	-190	-20	-260	-130
"	405	-70	-200	-40	-270	-140
"	410	-60	-170	-30	-225	-115
"	415	-50	-170	-10	-205	-85
"	420	-60	-180	-50	-185	-65
" (LRP 58)	425	-50	-190	-50	-160	-20
"	430	-50	-190	-50	-170	-30
"	435	-60	-180	-60	-180	-60

APPENDIX B: BEACH WIDTH BY STATION, 2002 DIGITAL PHOTOGRAPHY						
		1992		2002	2002	2002
Location	Measurement Station (100 ft increments from MD border)	Reference Feature to Dry Sand (ft)	Reference Feature to Swash (ft)	Reference Feature to Vegetation (ft)	House to Swash (ft)	House to Dry Sand (est) (ft)
"	440	-60	-180	-50	-190	-70
"	445	-70	-180	-30	-190	-80
"	450	-70	-180	-40	-210	-100
"	455	-80	-200	-60	-215	-95
"	460	-80	-200	-60	-230	-110
"	465	-70	-200	-40	-255	-125
" (LRP 57)	470	-60	-180	-40	-165	-45
"	475	-70	-180	-40	-150	-40
"	480	-70	-180	-50	-200	-90
"	485	-90	-200	-50	-220	-110
"	490	-70	-190	-20	-165	-45
"	495	-100	-220	-10	-170	-50
"	500	-160	-240	-100	-330	-250
"	505	-220	-350	-150	-390	-260
park	510	-220	-380			
"	515	-180	-360			
"	520					
" (LRP 56)	525					
"	530					
"	535					
"	540					
"	545					
"	550					
"	555					
"	560					
" (LRP 55)	565					
Indian River Inlet	600					
	605					
DSSP	835	-40	-200			
"	840	-30	-200	-20	-255	-85
Indian Beach	845	-30	-210	-20	-245	-65
"	850	-20	-200	-30	-260	-80
"	855	-20	-180	0	-210	-50
"	860	-20	-180	-30	-170	-10
N Indian Beach	865	-20	-160	0	-155	-15
Dewey Beach	870	-20	-170	-10	-125	0
"	875	-10	-160	-40	-140	0
"	880	-10	-150	-50	-145	-5
" (LRP 47)	885	-10	-140	-50	-100	0
"	890	-10	-180	-60	-180	-10
"	895	-20	-160	-40	-160	-20
"	900	-20	-160	-40	-145	-5
"	905	-20	-180	-40	-170	-10

APPENDIX B: BEACH WIDTH BY STATION, 2002 DIGITAL PHOTOGRAPHY						
		1992		2002	2002	2002
Location	Measurement Station (100 ft increments from MD border)	Reference Feature to Dry Sand (ft)	Reference Feature to Swash (ft)	Reference Feature to Vegetation (ft)	House to Swash (ft)	House to Dry Sand (est) (ft)
"	910	-30	-180	-70	-200	-50
"	915	-20	-180	-60	-190	-30
"	920	-20	-200	-40	-220	-40
"	925	-40	-260	-80	-280	-60
Silver Lake	930	-30	-270	-50	-290	-50
Rehoboth	935	-40	-270	-40	-300	-70
"	940	-30	-270	-60	-290	-50
"	945	-20	-270	-40	-310	-60
"	950	-30	-270	-50	-310	-70
"	955	-30	-240	-40	-290	-80
"	960	-30	-210	0	-200	-20
"	965	-100	-200	0	-180	-90
"	970	-100	-190	0	-150	-75
"	975	-80	-160	0	-100	-45
"	980	-70	-160	0	-130	-65
"	985	-70	-150	0	-140	-70
"	990	-70	-150	-10	-130	-70
"	995	-30	-120	0	-50	-25
"	1000	-90	-190	0	-170	-105
"	1005	-100	-190	0	-170	-100
"	1010	-100	-190	0	-170	-110
Henlopen Acres	1015	-100	-180	20	-180	-110
"	1020	-100	-190	10	-200	-130
"	1025	-110	-190	10	-210	-125
"	1030	-60	-160	10	-150	-80
North Shores	1035	-80	-180	30	-150	-75
"	1040	-80	-170	-20	-110	-55
"	1045	-80	-170	0	-150	-85
"	1050	-100	-180	20	-190	-100