The Impact of Development on Shoreline Movement in Stone Harbor and Avalon, New Jersey

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ABSTRACT
A study area of 70 blocks was utilized in Stone Harbor and Avalon, NJ to determine the effect that development has on the movement of a shoreline. A forested area of 30 blocks was compared to a slightly larger length of developed shoreline. The shoreline was sectioned into bins for the purpose of analyzing each segment of shore movement more closely. The distance between a given historical shoreline and the western boundary of the bin was measured for every bin and summary statistics were calculated using all distances measured. By color-coding a standard deviation of the bins, it is apparent which bins sustained the greatest shoreline migration. The forested shoreline was found to have the greatest deviation from a theoretical average shoreline while the developed shoreline showed the least deviation from the average. The results of this study support the idea that development of a barrier island has a stabilizing effect on the migration of the shoreline. The forested area allowed far greater movement of the shoreline, similar to the type of movement that would be seen on a completely natural barrier island.

INTRODUCTION
Coastal management professionals as well as coastal zone property owners need to be aware of the potential hazards that are associated with living in close proximity to the shoreline. The movement of the shoreline is a constant risk for those who make their homes and livelihoods so close to the ocean; the degree of movement directly impacts the degree of risk to oceanfront properties.
Barrier islands protect most of New Jersey's mainland coast. In New Jersey, as well as along most of the eastern shore of the United States, the barrier islands have become highly developed vacation towns that bring in most of the income for coastal counties in the summer tourist season. Increased development of these island towns brings in additional income to the town in the form of property taxes, summer rent income, and more people to shop and eat in the town's tourist centers.
This project explores the effect that development has had on shoreline movement from 1836 to 2002. By studying the historical shorelines in two main sites along Seven Mile Island, it is possible to see changes in the developed shoreline when compared to an equal length of forested shoreline.

OBJECTIVES
The objective of this study was to determine which areas of the study site sustained the greatest shoreline change over time. The effect of development on New Jersey's barrier islands is a very real influence on the behavior of the island; this study seeks to quantify that change by comparing a forested shoreline to a developed shoreline on the same barrier island.

REFERENCES
Van Dusen, Charles. (1996) Vector Based Shoreline Change Analysis. Retrieved April 11, 2004, from http://www.appgeo.com/atlas/project_source/czmcc/methods/p350.htm

ACKNOLEDGEMENTS
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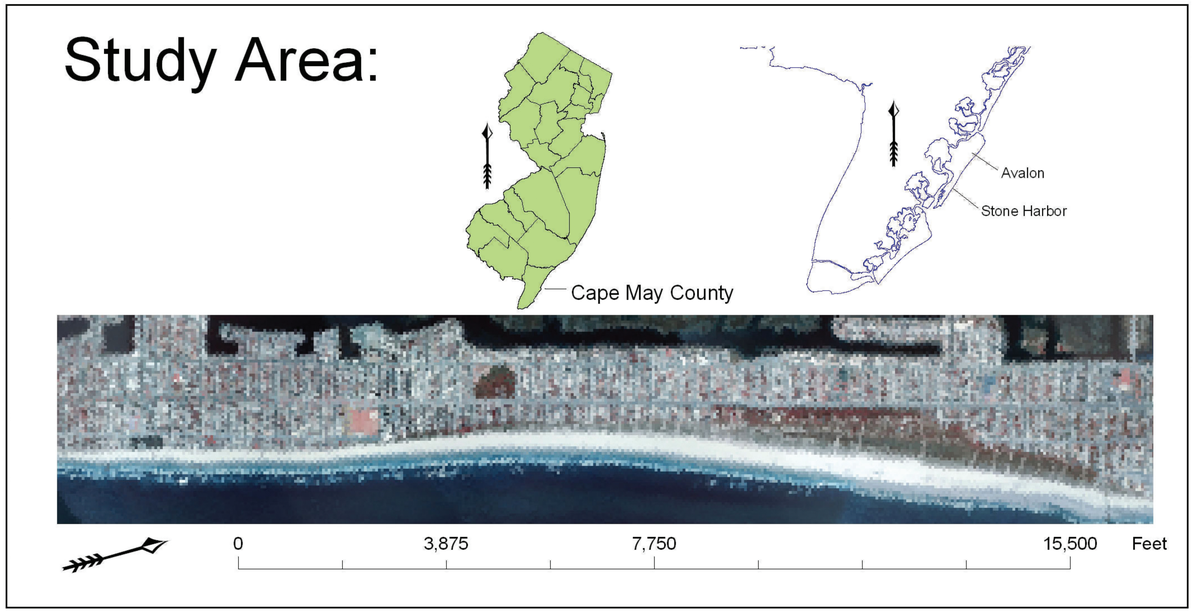
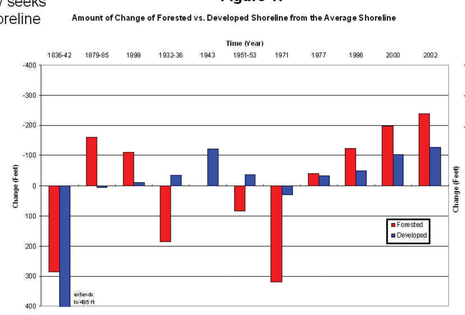


Figure 1:



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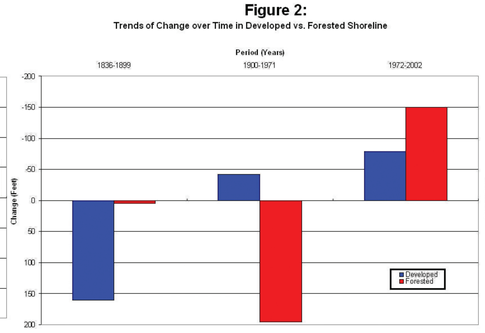

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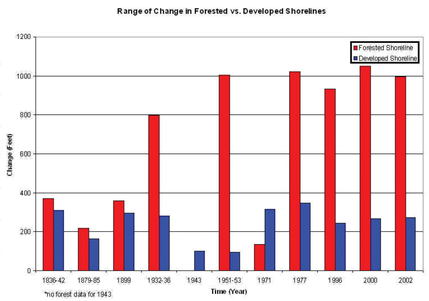

METHODOLOGY
Seven Mile Island, which contains the towns of Stone Harbor and Avalon in Cape May County, was examined using 13 historical shorelines spanning the years 1836 -2002. The study site was composed of 70 blocks spanning from Avalon into northern Stone Harbor. The forested region was to the north of the developed region.
The historical shorelines were obtained from the Stockton server, DEP data file using ArcView 3.3 software. Seven Mile Island was extracted from this data than spanned the entire NJ coast. The historical shoreline information was a compilation of various data collection methods. Because of incomplete information on the time of year that source data was collected, the tidal conditions, and the mixed scales used in collecting data over so many years, the shorelines may vary by as much as 100 feet relative to each other, but are assumed to be accurate for the purpose of this study. The most recent data was extrapolated from aerial photos of 1996, 2000, and 2002 to complete the history of the shorelines.
Shoreline positions were analyzed by segmenting the shore zone into 70 "bins", each 280 ft wide that extend perpendicular to Second Avenue, a road that extends the length of the island. The width of each bin was 280 feet, approximately equal to the width of each town block. The length of each bin was approximately 3420 feet for the purpose of analyzing movement between the main road and the furthest shoreline. The distance from the Second Ave. boundary to where each shoreline cut the bin was measured and recorded. This data was taken for all 70 bins created. Summary statistics were calculated using distance measurements and the bins were color-coded to clearly convey the difference in shoreline migration between forested shores and developed shorelines.
This project was modeled after a shoreline change analysis publication by Charles Van Dusen who analyzed Massachusetts shorelines.

RESULTS AND CONCLUSIONS
Figure 1 shows the yearly difference in average movement between the developed and forested shorelines. It is clear that the forested shoreline has a far greater width of movement than the developed shoreline displays. A similar trend is observed in Figure 2, where trends of shoreline movement can be seen over greater periods of time. The break point years are delineated by obvious shifts in the data. Figure 3 shows difference in range that each year sustained relative to the conditions of the shoreline, forested or developed. Again, the forested shoreline showed greater width of movement.
The results of the shoreline change standard deviation analysis are shown in Figure 4. The bins have been clipped to highlight the spatial range over which the shorelines migrated. The colors represent the degree of shoreline position variability within a given bin area. Warmer colors represent larger deviations (while cool colors represent the smallest deviations) from the theoretical average shoreline position.
As the colors show very clearly, the warmest colors are located furthest to the right on the illustration. The warmest colors represent the largest deviation from a theoretical average shoreline position and this large deviation is present only on the forested shoreline. The cool and medium colors are distributed to the south the forest; this area is highly developed and represents the lowest amount of shoreline deviation from a mean.
It can be concluded from these data that forested shoreline allows the beach to behave more naturally that development on a barrier island system. The islands protect the mainland by sustaining the brunt of major storms; therefore, they must be permitted to shift and change with changes in weather and storm activity.
Further research will focus on the protection the forest provides to the structures behind it compared to the relatively little protection offered by the fully developed shore.
It cannot be determined from these data what beaches have undergone beach nourishment projects and which have been permitted to behave naturally without interference. It is therefore impossible to state whether the beach has naturally accreted or eroded but only where the beach has advanced seaward or retreated landward, as compared to the initial 1836 shoreline.

Figure 4: