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A Complex Bayside Beach: Herring Cove Beach, Cape Cod, Massachusetts, USA

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ABSTRACT

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Herring Cove Beach is a bayside beach, sheltered from Atlantic Ocean waves, located at the terminus of Cape Cod, Massachusetts. It is an 8 km long, mixed sand and gravel reflective beach which faces Cape Cod Bay with over 30 km of fetch. Prevailing northwest winds produce a net southeast longshore drift from Race Point to Long Point. Seven profile locations were surveyed between 1985 and 1989, and historical shoreline changes over a 155 year period were calculated to test if this bayside beach, located over 30 km from the mainland, is similar to other bayside beaches. Storm surges generated in Cape Cod Bay and longshore drift from Cape Cod oceanside beaches cause Herring Cove Beach to exhibit some characteristics which are atypical of bayside beaches. Most bayside beaches are not influenced significantly by storms because they face small bays with limited fetch. In contrast, Herring Cove Beach has experienced severe storm erosion. Atlantic Ocean waves erode Outer Cape oceanside beaches and probably control rates and volumes of sediment supply around Race Point onto Herring Cove Beach. Profiles 1 to 3 exhibit short cycles of erosion and accretion during this study and on a larger scale through historical shoreline changes. This probably reflects the influence of sediment supplied from oceanside beaches transported around Race Point. With increased distance from this sediment source, beach mobility decreases and downdrift profiles (4-7) behave as typical bayside beaches exhibiting seasonal response.

ADDITIONAL INDEX WORDS: *Mixed sand and gravel, reflective beach, recurved spit, longshore drift, shoreline change.*

INTRODUCTION

Herring Cove Beach is a mixed sand and gravel bayside beach located on an 8 km long recurved spit at the terminus of Cape Cod, Massachusetts (Figure 1). The beach is part of the Cape Cod National Seashore and is under National Park Service jurisdiction. The coast has an average semidiurnal tidal range of 2.1 m (neap) to 3.5 m (spring), and a mean wave height of 0.42 m (NUMMEDAL and FISCHER, 1978; ASHLEY, 1987). The beach orientation is northwest-southeast. Northwest prevailing winds produce a net direction of longshore drift southeast from Race Point to Long Point (ZEIGLER and TUTTLE, 1961) (Figure 2). The coast is sheltered from ocean storm and swell waves generated in the Atlantic, but is subjected to waves generated in Cape Cod Bay with a fetch of over 30 km.

Herring Cove Beach is a reflective beach possessing a short steep foreshore, no offshore bar or rip currents, with more than 90% of its waves plunging at the coarse sediment step (WRIGHT *et al.*, 1979). The grain size distribution is bimodal with a fine-fraction mean of 1.3 mm and a coarse-fraction mean of 28 mm. The beach is perched on a sandy gravel spit platform. The platform extends 0.1 km to 1.3 km offshore from Herring Cove Beach. The edge of the spit platform drops off immediately offshore to 50 m depths in Cape Cod Bay (SCHLEE *et al.*, 1973). The shallow bathymetry of this narrow spit platform is the only protection Herring Cove Beach has against waves generated in Cape Cod Bay.

Herring Cove Beach formed during Holocene sea level rise from reworked glacial outwash deposited between the Cape Cod Bay Lobe and South Channel Lobe of the Wisconsinan ice sheet (WOODWORTH and WIGGLESWORTH,

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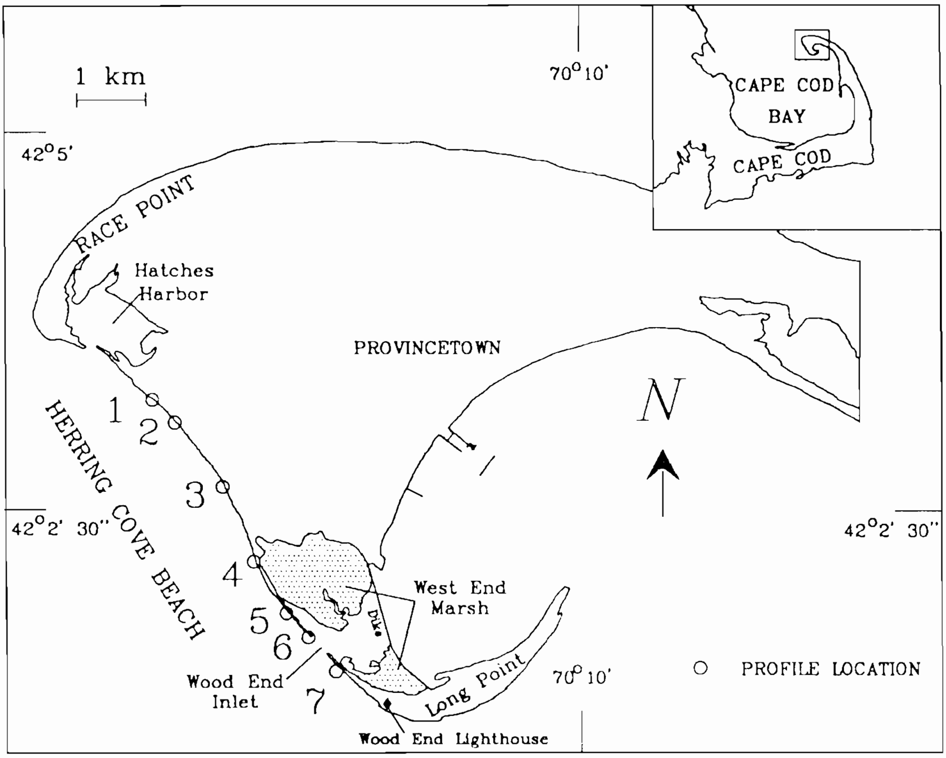

Figure 1. Location of Herring Cove Beach study area. Seven profiles are located along a 5 km section between Hatches Harbor and Wood End Lighthouse.

1934; OLDALE and BARLOW, 1986). Erosion of the Outer Cape glacial deposits, during the rapid rise in sea level (5,500-2,100 BP), provided a positive sediment budget for forming a series of prograding spits (ZEIGLER *et al.*, 1965). According to REDFIELD and RUBIN's (1962) sea level curve, the rate of sea level rise changed dramatically 2,100 years ago from a previous rate of 3 mm/year to 1 mm/year. This date corresponds to a change in spit evolution. The slower rate of sea level rise allowed sedimentation to keep pace with or exceed sea level rise, allowing the spit to widen (ZEIGLER *et al.*, 1965). The Herring Cove Beach spit began forming over 1,500 years ago, according to a Wood End peat sample (1,500 ± 150 years BP) (SMITH and MELLO, 1985).

Maps from 1833 of Herring Cove Beach and Long Point spit document rapid coastal changes (Figure 3). The section of the beach separating Wood End tidal flats and Cape Cod Bay has suffered several breaches by storms. The last one occurred during the blizzard of 1978 (February 7-8) with a 1 m storm surge on an extreme 4 m high tide (ASHLEY, 1987). The section near the present bathhouse has also had a dynamic history. Early maps depict a back bay area known as Lancy's Harbor. This embayment filled in after the Corps of Engineers, in 1871, built an 85 m dike across the head of Lancy's Harbor to prevent sediment movement through the harbor onto Wood End tidal flats (Figure 3). However, the section of the beach near the present bathhouse has been eroding during this century. The average rate of erosion, based on BEACH EROSION BOARD (1960) surveys, was 0.8 m per year and GATTO (1979) recorded 36 m of net erosion between 1938 and 1974, or 1 m per year.

The goals of this study are: 1) to determine the physical processes operating on this protected bayside beach, and 2) to explain why sec-

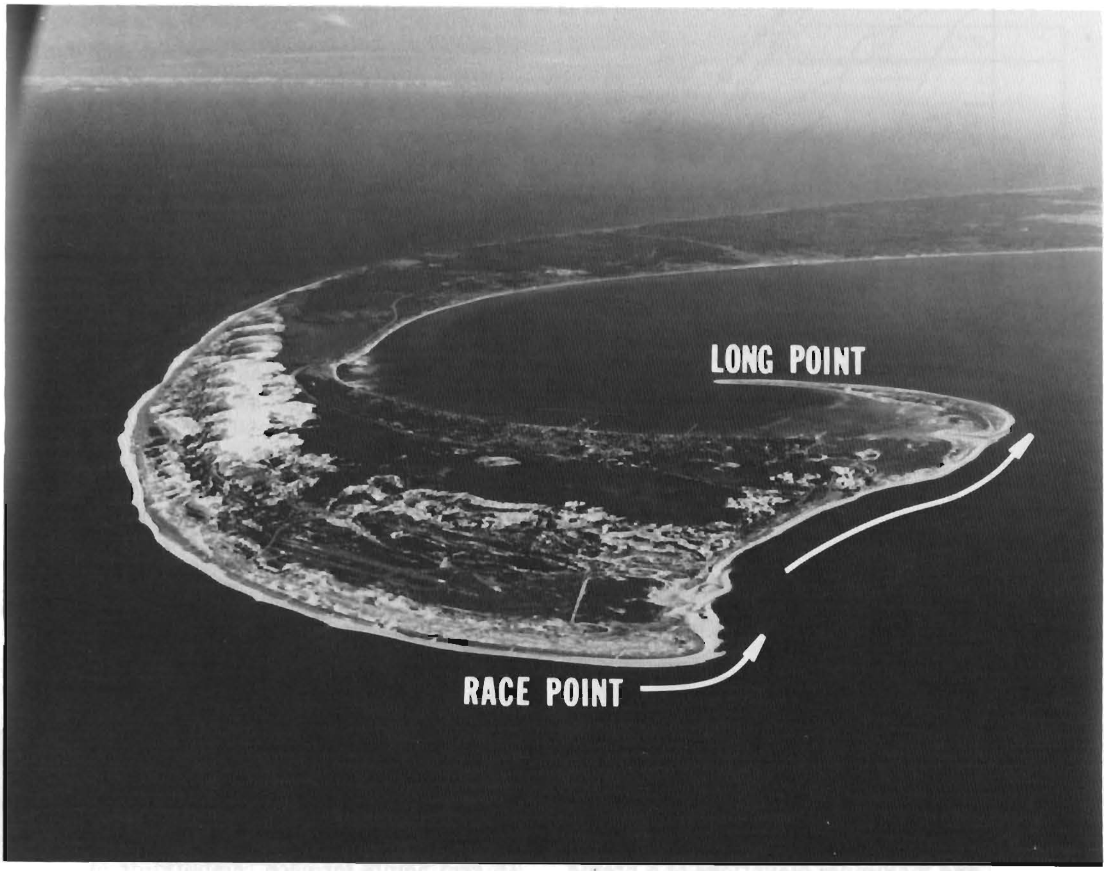

Figure 2. Aerial view of the tip of Cape Cod. View is southeast. Longshore drift travels around Race Point along Herring Cove Beach toward Long Point. Arrows indicate direction of longshore drift. Photo taken by Richard Kelsey on October 15, 1980 at low tide.

tions of the beach are consistently prone to erosion.

METHODS

Beach Profiles

Seven permanent profile locations were established between Hatches Harbor and Wood End Lighthouse (Figure 1). Profiles were surveyed using the EMERY (1961) method over a four year period: once every month from August 1985 to August 1986, plus semi-annually through 1989. Measurements were taken at two meter intervals and each profile was measured from permanent stakes located in the dunes to one meter below the water surface. All profiles were surveyed within two hours of low tide.

Sediment volumes were calculated as the area between the profile curve and the plane of spring low water (SLW) times one meter length of beach perpendicular to the profile azimuth. Before volumes were calculated, each profile was cut off at, or projected to, the elevation of spring low water (− 1.5 m). If the last measured elevation did not reach SLW, a least squares regression was performed on the last four points. A line was drawn from the last measured elevation of SLW using the slope of the regression line (BOOTHROYD *et al.*, 1986).

Sweep zones were constructed using the method first described by KING and BARNES (1964) to analyze the spatial and temporal response of each profile. Sweep zones plot the

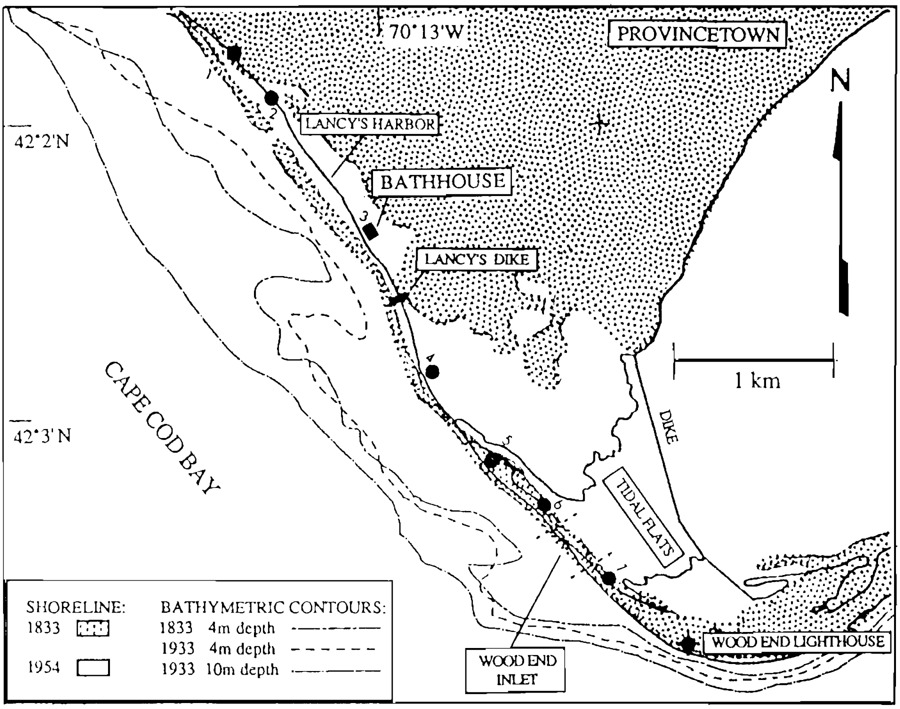

Figure 3. Shoreline and offshore depth changes from 1833 to 1954 (adapted from Beach Erosion Board, 1960). The black circles are stake locations for each profile surveyed in this study. Parallel dashed lines indicate the position of Wood End Inlet, which formed during the blizzard of 1978.

minimum and maximum elevations of a profile during a specified time period. This highlights areas of stability and dynamic change along the profile. The first year of monthly survey data were divided into two six month periods which bracket the winter season (October to March) and the summer season (April to September) to test if seasonal variations exist.

Wave Refraction

A wave refraction computer program, developed by R. Dobson, Civil Engineering Department, Stanford University and modified by W. T. Fox at Williams College to fit on an IBM 1130 mainframe computer, was used to assess the influence the spit platform had on waves approaching Herring Cove Beach. A grid with a spacing of 1.2 km was placed over the bathymetric chart for Provincetown and depths were entered for each grid point. The program used 16 grid points for each computation of a depth surface. A digitizer was used to trace the shoreline and the 18 m bathymetric contour line.

A constant wave height of 1.5 m was chosen as a relative reference to isolate the effects of wave period and angle of approach. Based on field data, historical wind roses and wave hindcasting data (JENSEN, 1983), the following approach angles were run: north, northwest, west, southwest and south. For each wave approach angle, wave periods from 3 to 8 seconds were calculated. Wave refraction diagrams plot the wave orthogonals, shoreline and 18 m bathymetric contour, and breaking wave heights for each orthogonal.

Unfortunately, at the time of this study no wave gauge data existed for oceanside beaches near Race Point. Therefore, a direct comparison between oceanside wave activity and profile response at Herring Cove Beach could not be performed.

Historical Shoreline Change

The magnitude and direction of shoreline change was calculated for each profile location over a 155 year period (1833-1988) to compare survey data collected in this study with historical shoreline change. Historical data collected from four historical maps (BEACH EROSION BOARD, 1960) were compared with 1988 survey data. The stake locations on the maps were located by triangulating three known landmarks. A line was drawn from each stake location along the azimuth used for surveying each profile. Then distances were measured between the intersections of each historical shoreline and the profile azimuth.

RESULTS

Profile Data

Volume change calculated for each successive survey during the study period reveals lateral variation along the spit. Throughout the following discussion profiles 1 and 5 are depicted in figures because profile 1 is representative of trends seen in profiles 1-3 and profile 5 is representative of trends seen in profiles 4-7. During the first year when surveys were taken monthly, profiles 1-3 experienced one to three month shifting trends of accretion or erosion (Figure 4). Profiles 4-7, in contrast, endured one broad annual cycle of erosion during winter months and accretion during the summer months (Figure 4).

Sweep zones, constructed for profile data subdivided into two six month periods to distinguish winter months from summer months (October-March and April-September), depict different envelopes of change between updrift profiles (1-3) and downdrift profiles (4-7). The maximum foreshore position is uniformly displaced vertically and laterally for the profiles 1 through 3 (Figure 5). Sweep zones for profiles 4 through 7 show berm accretion (Figure 5). In general, profiles 1 through 3 maintained similar profile shape while shifting laterally; whereas profiles 4 through 7 exhibited change in shape in the upper foreshore region while the lower foreshore region maintained similar profile shape.

Mean profiles generated for the same six month groupings as the sweep zone analysis (April-September and October-March) also reveal lateral variations along the beach. Mean profiles for summer (April-September) mimic the shape of those from winter (October-March) along profiles 1, 2 and 3 (Figure 6). Summer (April-September) mean profiles 4, 5, 6 and 7 delineate a well defined berm (Figure 6), while winter (October-March) profiles 4, 5, 6 and 7 have an eroded concave up profile (Figure 6).

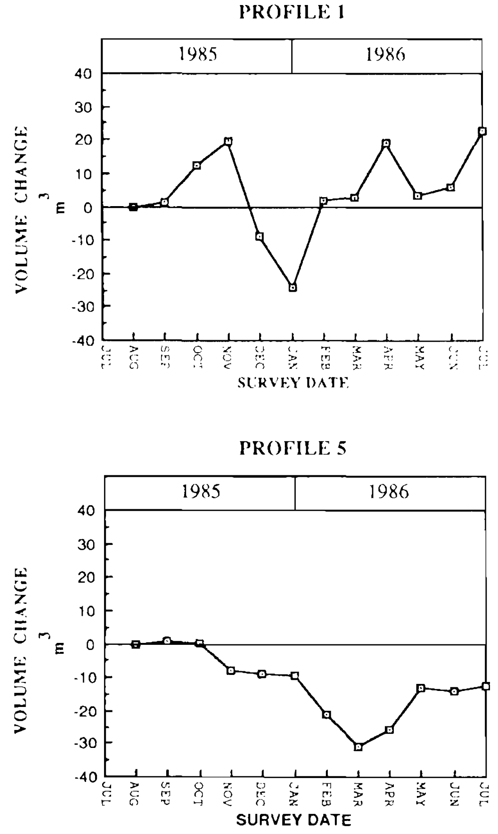

Figure 4. Monthly volume change between surveys taken in 1985 and 1986. The August 1985 volume serves as the starting reference volume. Profile 1 is representative of profiles 1–3 and profile 5 is representative of profiles 4–7.

Wind Data

Wind data collected every 3 hours at the Provincetown Coast Guard Station were analyzed for the study period and compared to historical wind rose data (BEACH EROSION BOARD, 1960; U.S. DEPARTMENT OF COM-

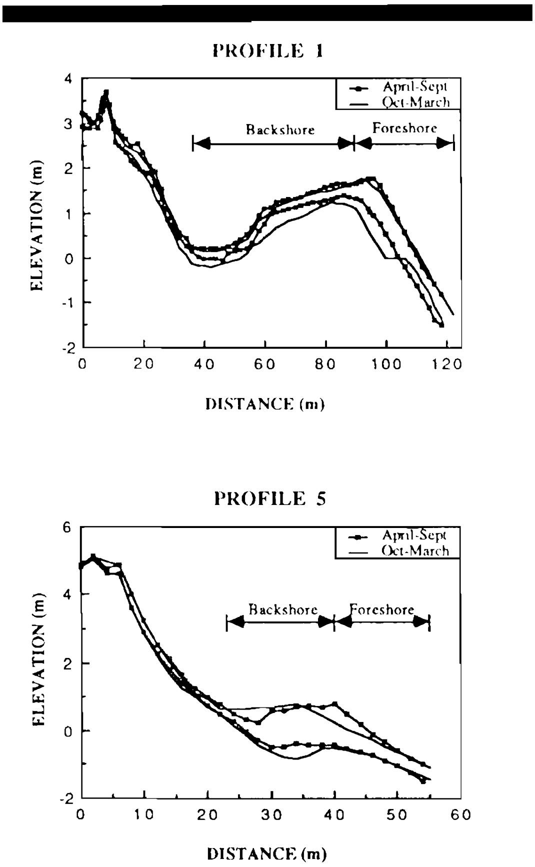

Figure 5. Sweep zone results comparing two 6 month time periods: October-March and April-September (1985-86). Profile 1 is representative of profiles 1–3 and profile 5 is representative of profiles 4–7.

MERCE, 1986). The average daily wind data were 5 knots or below 36% of the time and 65% of the records were less than or equal to 10 knots for the first survey year (1985-1986) (Figure 7). No correlation was found to exist between wind data and profile response.

Wave Refraction

Herring Cove Beach is sheltered from waves approaching from the north, but exposed to northwest through southwest wave approach directions. Waves crossing the spit platform from the northwest experience little attenuation along the bathhouse section of the beach. Northwest orthogonals near profile 3 have higher breaking wave heights than adjacent orthogonals (Figure 8). West wave approach produces a similar change in breaking wave heights alongshore where there is an increase in breaking wave heights for orthogonals near profile 3. Orthogonals near profiles 5 and 6 and Wood End Inlet location experience slightly higher waves. Almost no change in wave height occurs for waves approaching from the southwest. South approaching waves refract and break at low wave heights along the shore between profiles 1 through 6. Orthogonals near profile 7 and Wood End Inlet cross an extremely narrow section of the spit platform resulting in little refraction.

Historical Shoreline Change

Table 1 depicts the magnitude and direction of shoreline change over a 155 year period (1833-1988) for each profile location. Over the 155 year period, the profiles closest to Race Point experienced the largest magnitude and direction of change compared to more distal profiles downdrift. Between 1833 and 1867 the spit shoreline between profiles 1 and 3 eroded while Lancy's Harbor filled in with sediment (Figure 3). Profiles 1 through 3 experienced significant erosion between 1867 and 1909, but profiles 1 and 2 accreted between 1909 and 1988 while profile 3 has eroded at a rate of 0.6 m/year since 1958. Profile 4 steadily eroded since 1867 and profile 5 eroded between 1867 and 1909 and has remained close to the same shoreline position since 1909. Net erosion has occurred at a low steady rate at profile 6. The Long Point section of Herring Cove Beach experienced net accretion over the past 155 years.

DISCUSSION

Wave Refraction

Between 1870 and 1975 half of the reported gales, with wind speeds greater than 15 m/sec, were northeasters (U.S. ARMY CORPS OF ENGINEERS, 1979). Compilation of storm and cyclone activity by CAIN and BOOTHROYD (1983) show storm track centers east of Cape Cod shifting through northeast, north and northwest. When storm centers pass west and northwest of Cape Cod, winds shift from southeast through south and finally west. These storms generate small storm waves because of limited fetch within Cape Cod Bay (30 km).

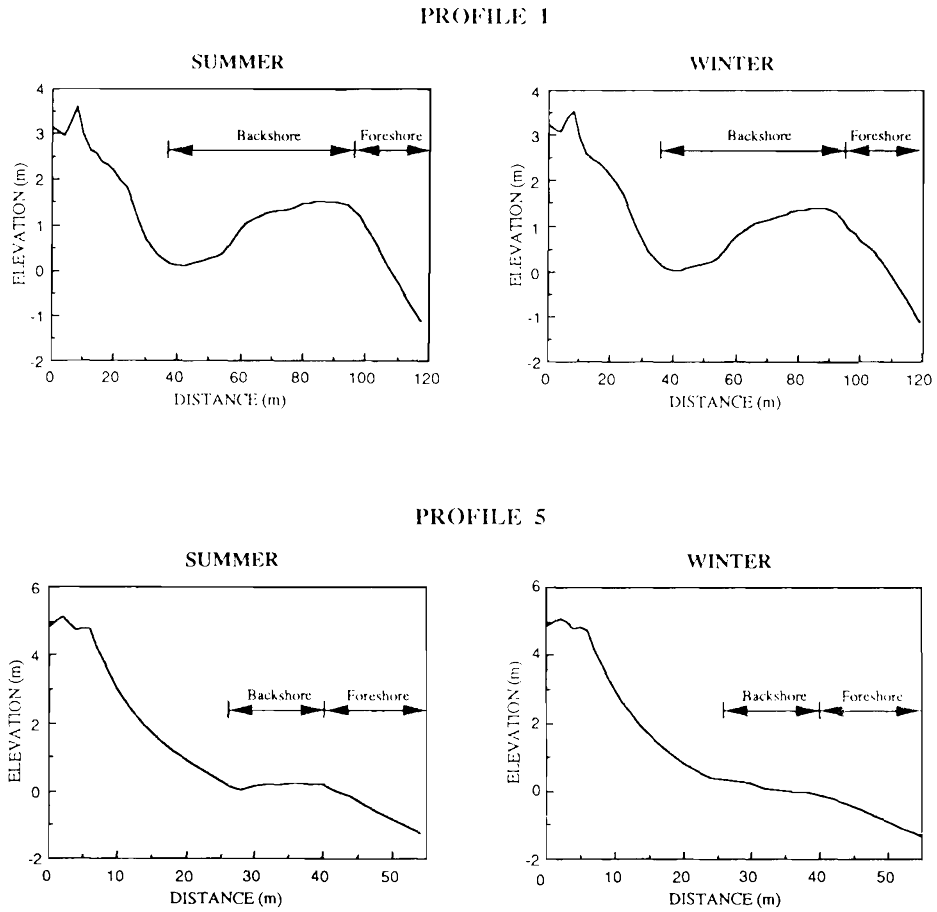

Figure 6. Mean profiles comparing two 6 month time periods: October-March and April-September (1985-86). Profile 1 is representative of profiles 1–3 and profile 5 is representative of profiles 4–7.

Therefore, the west through south wave refraction models, which assume large wave heights, were not considered valid because of the limited fetch distances in those directions. However, the northwest fetch distance is 60 km. The waves with the longest period and highest breaking wave heights observed during this study were those approaching from the northwest, which corroborates the dominant storm track direction (northeast shifting to northwest) for Cape Cod. The northwest wave refraction model is useful for assessing general storm wave impact on Herring Cove Beach. This analysis was necessary because no major storm occurred during the study period (Figure 7) and therefore, direct measurement of storm impacts could not be evaluated.

Waves crossing the spit platform from the northwest have higher breaking wave heights along the bathhouse section of the beach compared to adjacent sections of shoreline (Figure 8). This is probably because the 4 m contour of the spit platform is near the shoreline and waves approaching from the northwest are not significantly attenuated (Figure 3). The 4 m contour also approaches the shore where Wood End Inlet formed during the blizzard of 1978 (Figure 3). Historical records consistently document severe erosion either at the bathhouse section or at the Wood End Inlet section of the beach (U.S. ARMY CORPS, 1876; ZEIGLER *et al.*, 1959; BEACH EROSION BOARD, 1960; GATTO, 1979; and ASHLEY, 1987).

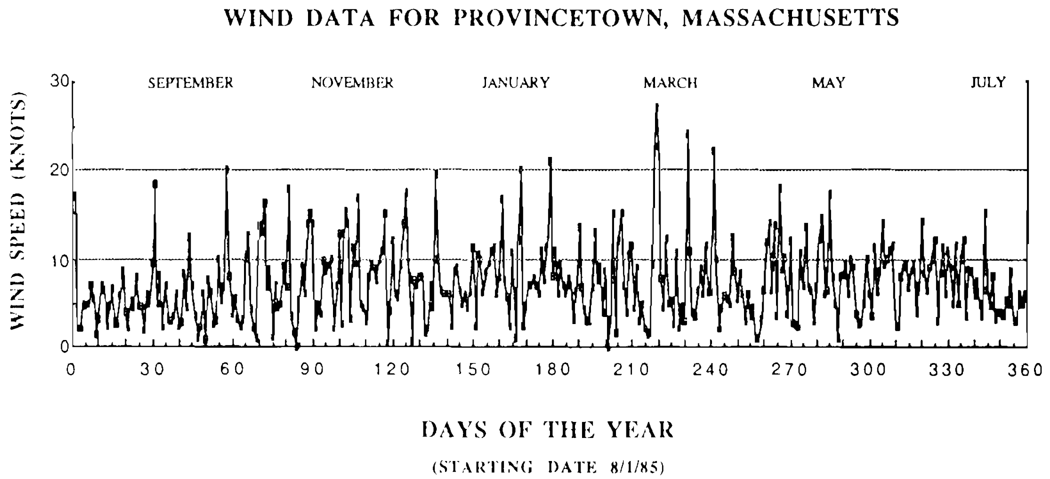

Figure 7. Daily average of wind data collected every three hours at the Provincetown Coast Guard Station for August 1, 1985 through August 1, 1986 (U.S. Department of Commerce, 1986).

Bayside Versus Oceanside Beach Response

Studies of beach profile response on Sandy Hook Spit in New Jersey document a difference between oceanside and bayside beach response (NORDSTROM, 1977; 1980). The bayside beaches on Sandy Hook are protected from Atlantic Ocean storm waves and often exhibit low mobility or small rates of volume change. Therefore, only seasonal trends are conspicuous. The bayside beach winter profiles have less sediment than the summer profiles. In contrast, shorter storm-related cycles of beach response exist on the oceanside beaches of Sandy Hook Spit. The cycle is similar to that documented on other storm dominated coastlines (HAYES and BOOTHROYD, 1969; SONU and VAN BEEK, 1971). In these locations a storm erodes the beach leaving a low, flat profile. Lower wave-energy conditions, following the storm, build a bar that slowly migrates onto the foreshore and restores the beach to its pre-storm profile. Herring Cove Beach is a complex system that exhibits some characteristics typical of both oceanside and bayside beach response.

Herring Cove Beach

Profile surveys recorded in this study (between 1985 and 1989) suggest alongshore differences in beach response. Volume change, mean profile and sweep zone analysis all indicate similar profile response for profiles closest to Race Point (1–3), which differ from downdrift profile response (4–7). For example, updrift profiles have shorter cycles of accretion and erosion than downdrift profiles (Figure 4). Profiles 1–3 have a one to three month accretion or erosion trend before changing. Profiles 4–7, however, have one broad annual cycle of winter erosion and summer accretion. Sweep zones show parallel foreshore positions for profiles 1–3 and in contrast profiles 4–7 exhibit berm development and erosion in the backshore. Mean profiles 1–3 show no seasonal distinctions in profile shape. Profiles 4–7 exhibit seasonal profile response. These mean profiles have persistent berm accretion during the summer months of April to September and erosion during the winter months of October to March.

Shoreline change over the past 155 years (1833-1988) reflects, on a larger scale, the changes recorded in profile response during this short-term study (1985-1989). Updrift profiles closest to Race Point experienced the largest magnitudes of erosion and accretion and more shifts in the direction of shoreline change compared to downdrift profiles (Table 1). Profiles 1 and 2 fluctuated between erosion and accretion,

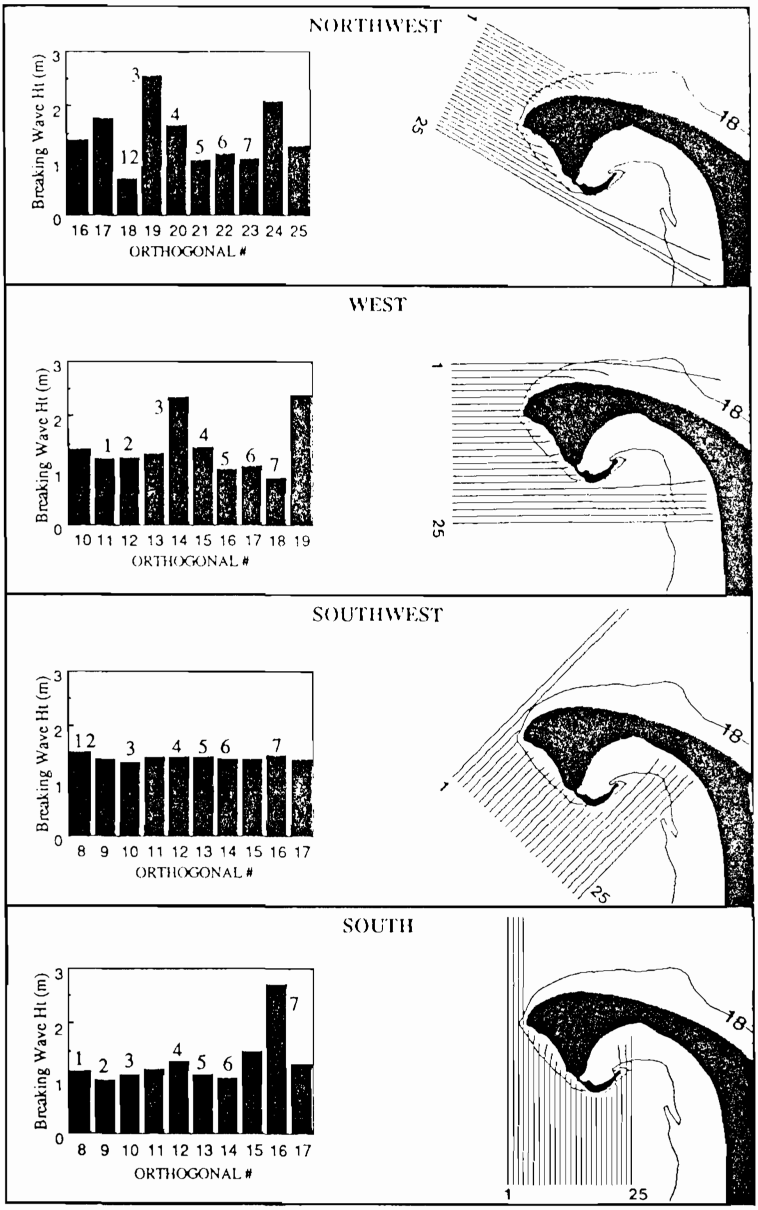

Figure 8. Wave refraction plots for NW, W, SW and S wave approach directions. Each plot represents initial deep water wave height of 1.5 m with a wave period of 5 seconds. Each orthogonal is perpendicular to advancing wave crest. Histograms of each orthogonal's breaking wave height are shown with the survey profiles nearest to each orthogonal marked above the histogram bars. The 18 m offshore contour is also shown.

fpbut experienced net accretion between 1985 and 1989, which is consistent with the accretion trend since 1909 for those profiles. Profiles 3 through 6 remained relatively stable with seasonal fluctuations exhibiting net erosion between 1985 and 1989. The bathhouse section underwent the largest net erosion between 1833 and 1988 (− 181 m or an average of − 1.2 m/year). Profile 7 exhibited slight net accretion between 1985 and 1989 which is similar to his-

Table 1. *Shoreline Change from 1833 to 1988.*

Map Year	Number of Years	*1		*2		*3		4	5	6	7	Wood End Lighthouse
1833												
		Spit	Lancy	Spit	Lancy	Spit	Lancy					
1867	34	-65m -1.9 m/yr	-52m -1.5 m/yr	-78m -2.2 m/yr	+143m +4.2 m/yr	-52m -1.5 m/yr	+26m +0.8 m/yr	+39m +1.1m/yr	-1m -0.03m/yr	+1m +0.03m/yr	-25m -0.7m/yr	+65m +1.9m/yr
1909	42	-91m -2.2m/yr		-117m -2.8m/yr		-137m -3.3m/yr		-40m -1.0m/yr	-28m -0.7m/yr	-12m -0.3m/yr	+13m +0.3m/yr	-39m -0.9m/yr
1958	49	+26m +0.5m/yr		+33m +0.7m/yr		+27m +0.6m/yr		-54m -1.1m/yr	+2m +0.04m/yr	-27m -0.6m/yr	+38m +0.8m/yr	+26m +0.5m/yr
1988	30	+64m +2.1m/yr		+25m +0.8m/yr		-19m -0.6m/yr		-28m -0.9m/yr	-5m -0.2m/yr	-33m -1.1m/yr	+27m +0.9m/yr	— —

Data were collected from historical maps (Beach Erosion Board, 1960). The value at the top of each box represents the net distance and direction the shoreline changed between bracketed dates. The value at the bottom of each box represents the average rate of change per year during the bracketed dates. Positive values indicate seaward accretion and negative values indicate landward erosion. Profiles 1-3 have asterisks because Lancy's Harbor existed only during the 1833 and 1867 map dates. The "Spit" column represents the ocean facing shoreline and the "Lancy" column represents the upland bay shoreline.

torical trends. Herring Cove Beach has maintained a positive sediment budget at profiles 1 and 2 and the Long Point section since 1909 despite rising sea level at a rate of 1 mm/year (REDFIELD and RUBIN, 1962). The middle section between profiles 3 and 6 has experienced slight erosion.

Rising sea level and northeast storm activity have caused erosion to occur on Cape Cod oceanside beaches at a rate of 0.8 m/year (GEISE and GEISE, 1974). GATTO (1979) recorded net erosion (− 36 m) at Race Point oceanside beach between 1938 and 1974. ZEIGLER *et al.*, (1959) found that Cape Cod oceanside beaches exhibit a storm cycle response. Their data also show accretion on the updrift section of Herring Cove Beach after northeast storms eroded oceanside beaches (ZEIGLER *et al.*, 1961).

Herring Cove Beach is dominated by longshore drift processes and not onshore/offshore sediment exchange. Field observations during this and past studies report an absence of offshore bar development (ZEIGLER and TUTTLE, 1961). Thus, there is little offshore storage of sediment eroded from the foreshore. Instead, Herring Cove Beach receives most of its sediment from longshore drift around Race Point (Figure 9).

CONCLUSIONS

Herring Cove Beach can be classified as a bayside beach because it is sheltered from waves generated in the Atlantic Ocean. Unlike other bayside beaches, Herring Cove Beach faces a large water body with over 30 km of fetch. Storm surges generated within Cape Cod Bay, and longshore drift around Race Point from erosion of Cape Cod oceanside beaches, are two important processes which cause Herring Cove Beach to exhibit some characteristics which are not found on other bayside beaches. Historical data and wave refraction show that storm surges, sustained for a sufficient amount of time over 60 km of fetch from the northwest, can generate large waves which have caused significant erosion along the bathhouse section and the section between profiles 6 and 7. Volume change, sweep zone and mean profile data show updrift profiles near Race Point having short cycles of erosion and accretion while downdrift profiles exhibit seasonal trends of winter erosion and summer accretion. Historical shoreline-change data for the past 150 years may also reflect the dynamic response of the section of Herring Cove Beach closest to Race Point to fluctuations in longshore drift around

Figure 9. Aerial view of sediment being transported around Race Point. View looking southeast.

Race Point. Longshore drift from Cape Cod oceanside beaches probably cause increased sediment budgets and beach mobility on the section of the beach closest to Race Point (profiles 1-3). With increased distance from the sediment source, beach mobility decreases and downdrift profiles (4–7) behave more like typical bayside beaches exhibiting seasonal profile response (NORDSTROM, 1980).

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☐ RESUMEN ☐

Herring Cove Beach es una playa en el interior de una bahía, protegida del oleaje del Océano Atlántico, en el municipio de Cape Cod, Massachusetts. Tiene 8 km de longitud y es una playa reflejante formada por una mezcla de arena y grava. Entre los límites de la Bahía y la playa el fetch es de 30 km de longitud. Los vientos reinantes del NW producen una corriente longitudinal neta hacia el SE desde Race Point hacia Long Point. Se ha levantado siete perfiles entre 1985 y 1989 y se ha estudiado los cambios ocurridos en un período de 155 años comparando esta playa con superficie de agua limitada a 30 km, con otras playas similares. La playa presenta algunas características atípicas de este tipo de playas de bahía debido a las mareas meteorológicas generadas en la Bahía y al transporte longitudinal procedente de las playas oceánicas de Cape Cod. Así, mientras que las playas de Bahía *no* son influenciadas por los temporales, Herring Cove Beach ha recibido la acción de varios temporales. El oleaje del Atlántico erosiona las playas exteriorees del Cabo y probablemente controlan la tasa y el volumen de sedimento alrededor de Race Point hacia Herring Cove Beach. Los perfiles 1 y 3 muestran pequeños ciclos de erosión y sedimentación en este estudio y a una escala mayor a través de cambios históricos de la línea de costa; probablemente esto refleja el suministro oceánico arena. Al alejarse de este punto de suministro, la movilidad de la playa decrece y los perfiles 4 a 7 se comportan como perfiles típicos de playa de Bahía, mostrando una respuesta estacional.—*Department of Water Sciences, University of Cantabria, Santander, Spain.*

☐ RÉSUMÉ ☐

Située à l'extrêmité de Cape Cod (Massachussetts), Herring Cove Beach est une plage de flanc de baie abritée des influences de l'Océan Atlantique. Elle s'étend sur 8km, et est constituée de sables et graviers. Elle réfléchit la houle dont le fetch est de plus de 30km. Les vents dominants sont du NW et produisent une dérive littorale dirigée vers le SE depuis Race Point vers Long Point. On a calculé les modifications historiques du rivage sur 155 ans et levé entre 1985 et 1989 des profils sur sept sites. Cela a permis de tester si cette plage de flanc de baie, localisée à 30km du continent était semblable aux autres plages du même type. Les tempêtes générées dans la baie de Cape Cod, et la dérive littorale depuis les plages du côté océan de Cape Cod, font que Herring Cove n'a pas les caractères typiques des plages de flanc de baie. La plupart de ces plages ne sont pas significativement influencées par les tempêtes, car elles sont localisées dans des baies plutôt petites, où le fetch est limité. Ce n'est pas la cas de Herring Cove qui a sérieusement été érodé par les tempêtes. La houle de l'Océan Atlantique érode une partie de Outer Cape. C'est probablement elle qui contrôle l'approvisionnement sédimentaire de Race Point à Herring Cove. Les profils 1 et 3 montrent des cycles courts d'érosion et accrétion, que ce soit pendant l'étude ou pendant l'époque historique. Il est possible d'y voir le reflet de l'influence des apports sédimentaires depuis les plages du côté de l'Océan à Race Point. A mesure qu'augmente la distance à cette source, la mobilité des plages décroît et les profils tendent à se comporter comme des plages de flanc de baie avec une réponse saisonnière.—*Catherine Bressolier, Géomorphologie EPHE, Montrouge, France.*

☐ ZUSAMMENFASSUNG ☐

Herring Cove Beach liegt am Ende von Cape Cod in Massachusetts. Es ist ein 8 km langer Strand aus Sand und Schotter gegenüber der Cape Cod Bay mit über 30 km fetch. Vorherrschende nordwestliche Winde verursachen eine Netto-Sedimentwanderung nach Südosten vom Race Point zum Long Point. 7 Profile wurden zwischen 1985 und 1989 kontrolliert, und die hiesigen Veränderungen über eine Periode von 155 km wurden untersucht, um festzustellen, ob dieser buchtseitige Strand mehr als 30 km vom Festland entfernt sich ähnlich verhält wie andere Strände in gleicher Position. Sturmbrandung aus der Cape Cod Bay und Longshore-Drift von den offenen Ozeanküsten von Cape Cod führen zu Erscheinungen am Herring Cove Beach, die untypisch für Buchtenstrände sind. Die meisten Buchtenstrände werden deshalb von Stürmen kaum beeinflußt, weil sie nur an sehr kleinen Einbuchtungen mit begrenztem Fetch liegen. Im Gegensatz dazu zeigt Herring Cove Beach starke Sturmerosion. Da die Wellen des Atlantischen Ozeans die Strände am äußeren Cape erodieren, kontrollieren sie offensichtlich Sedimentraten und -mengen um den Race Point herum bis Herring Cove Beach. Die Profile 1–3 zeigen kurze Erosions- und Akkumulationszyklen sowohl während der Beobachtungsperiode als auch im größeren Maßstab in historischer Zeit. Dieses ist wahrscheinlich beeinflußt durch eine Sedimentversorgung von den offenen Ozeanstränden um Race Point herum. Mit steigendem Abstand von dieser Sedimentquelle sinkt die Mobilität des Strandes, und die abseits gelegenen Profile 4–7 zeigen typische saisonale Schwankungen wie die übrigen Buchtenstände.—*Dieter Kelletat, Essen/FRG.*