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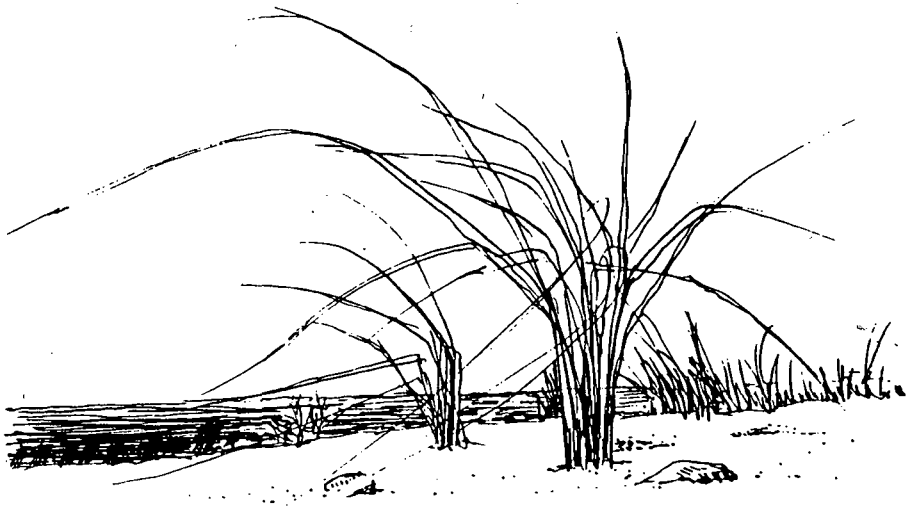

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The Eroding Shores of Outer Cape Cod

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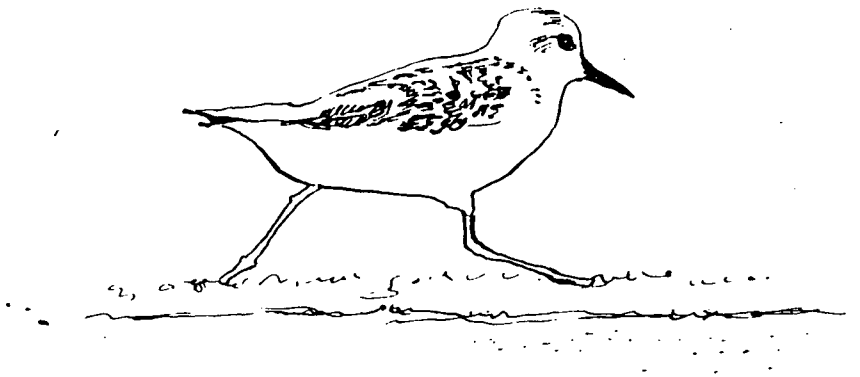

The Eroding Shores of Outer Cape Cod

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THE ERODING SHORES OF OUTER CAPE COD

Reminisce a bit: a summer visit to Truro's Coast Guard Beach, a town-owned beach just north of Highland Light. There the cliffs towered high behind the beach, providing good shelter from the prevailing offshore summer winds which blow from the southwest, across the continent to the sea. The backshore of the beach (the flat upper beach above the reach of the tide) was broad as it usually is in summer. The foreshore (the sloping front of the beach which is alternately submerged and exposed by the waves and the tides) was steep. A gentle swell was coming in. The small waves broke lazily against the steep foreshore, but after breaking they sent a sudden rush of foam and water (the swash) up the slope. The more tranquil return flow downslope (the backwash) left the foreshore wet with water draining seaward.

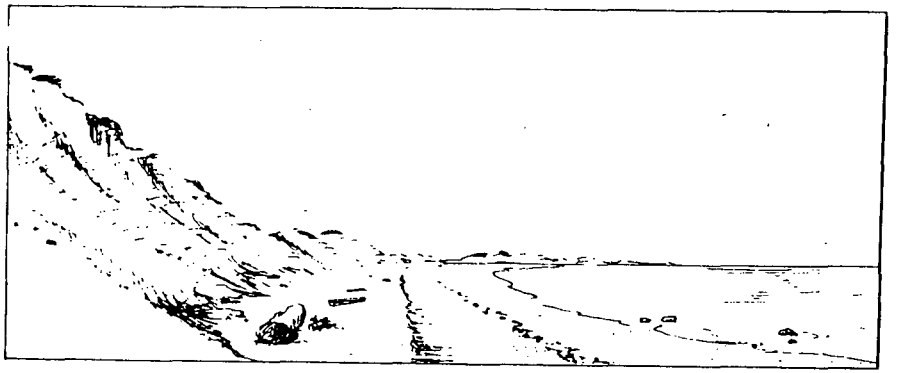
All the while, the sand of the foreshore was in motion. The waves, when they broke, disturbed the sand beneath them. This sand was lifted from the bottom, mixed with the turbulent breakers, and carried up the foreshore by the swash, down the foreshore by the backwash.

And so it was last summer and the summer before. A continuously pulsing movement of beach sand on the steep foreshore of a wide beach responding to the breaking of long low waves. The summer visitor may think that each year he finds the same wide sandy beaches lying at the foot of the same cliffs, but that is an illusion.

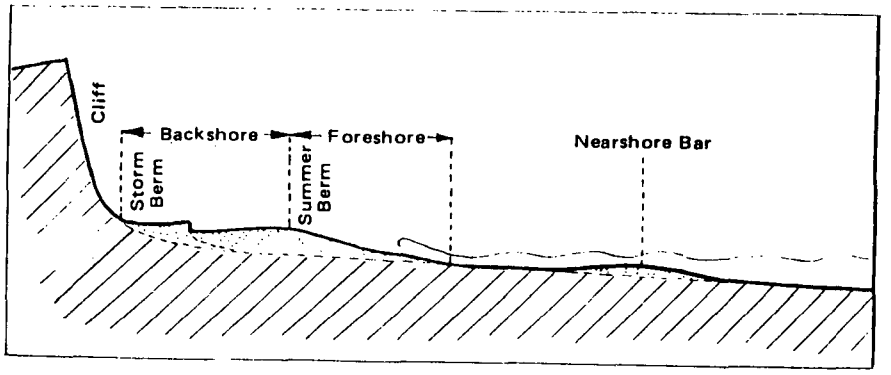
Summer is not forever, and beneath the placid surface of the summer beach lie the sands of the starker scene of winter storms. For during winter, the summer mask of harmony between sea and land is dropped, and the eternal conflict of the elements resumes.

Even during that summer visit scars of the winter ravages were visible on the backshore of the beach and in the face of the cliff. The backshore consisted of two nearly horizontal terraces—or berms. The higher berm which lay just in front of the cliff was the so-called "storm berm." Among the driftwood on its surface were huge timbers which had been left by winter storm waves. And across the face of the cliff was a faint, nearly horizontal line some fifteen feet above the storm berm. This marked the level to which the cliff had been wave cut during the preceding winter. Except for the line, all evidence of the winter cut was now hidden by the sand and gravel which had slid down the slope from above.

Severe winter storms are a fact of life for the New England coast. Over a seventy-five year period the Weather Bureau at Boston reported 160 gales—that is, storms with continuous winds over 32 miles per hour. Of those 160 gales, eighty blew from the northeast, and as a look at the map will verify, a northeast wind is onshore along the outer coast of Cape Cod and directly onshore at Highland Light.



Typical Summer Beach Profile of Outer Cape Cod



The slashed region represents the eroding shore face of the glacial deposits of Cape Cod. The erosion is accomplished chiefly by wave action.

The stippled region represents the beach and the nearshore sediments which have been sorted out from the glacial deposits by wave action and which are in the process of being transported along the shore by the waves.

The waves which are formed by the northeasterly gales striking the outer Cape are huge and furious, but before reaching the beach they break on the bars, the submerged sand ridges which parallel the shoreline. Along the outer coast there are generally two lines of bars: the outer (offshore) bar which lies several thousand feet from the shore and the inner (nearshore) bar which is usually several hundred feet or less from the beach.

During a gale the biggest waves break on the offshore bar, and these breakers sometimes reach heights of twenty feet or more. Moving shoreward over the deeper water between the outer and inner bars, the waves re-form and then, at the inner bar, break again. These inner breakers may be eight feet high. Inshore of the inner bar the sea is a frothy confusion of breakers tumbling together and roaring incessantly up the beach. Because the strong onshore winds and low atmospheric pressure have raised the sea level, perhaps as much as three feet above what it would have been otherwise, the turbulent surf reaches high onto the shore.

These storm waves move the beach sands much more rapidly and violently than did the mild summer swells. The beach sand is cut away and carried offshore by the turbulence of the surf. Where during summer a steep foreshore rose to a high berm, in winter a low flat beach extends unchanged to the furthermost reach of the waves. Although the tide by itself is not responsible for the beach changes, the rising and falling of the tide distributes the erosive action of the storm surf over a wide stretch of beach. The height of the beach may be reduced by as much as ten feet at a single spot when a high tide brings the storm surf up the beach. Where once stood a lofty berm, one lowtide later may be found a hard flat plane. Finally, after the protective skin of beach sands is removed, the storm seas cut away at the loose sands and gravels which form the body of Cape Cod.

The erosion of the outer arm of Cape Cod takes place every winter. More some winters than others. More at one place than another at any one time. But every winter storm waves cut away at the Cape.

"LANDSLIDE ERODES CLIFFS AT CAPE COD LIGHT" announced the Provincetown Advocate, September 21, 1972. The article told of the loss of a two hundred square foot section of the backyard of the Coast Guard Cape Cod Light (Highland Light) Station, and the deposition of 10,000 cubic feet of cliff debris on the beach below the Light. Again in December and January other slides occurred and looking up from the beach, the foundations of a building could be seen exposed in the face of the cliff.

On July 6 and again on October 12, 1972, the Advocate reported speculation as to the possibility of the sea breaking through the greatly

diminished barrier dune at Ballston Beach in Truro and damaging the upper part of the fresh water marsh of the Pamet River. There followed official and unofficial meetings and discussions involving the Truro Selectmen, the Truro Conservation Commission, the National Seashore Superintendent and erosion experts. Despite all the meetings and discussions, in March the Advocate reported that gale force winds had driven a few waves over the dunes and road into the marsh.

At Beach Point on the bayside of Truro, motel owners feared for their businesses when fall storms sent breakers pounding against the bulkheads only a few feet from their motels. The Advocate quoted one owner as saying his motel was "on the brink of disaster," and bulldozers were kept busy on the beach moving sand up against the bulkheads. Voters at the Town Meeting in March agreed to appropriate $10,000 as the town's share of the first phase of a groin construction project to check the erosion.

So it went that winter and so it has gone every winter. Just how rapidly the erosion is proceeding is a question that has long been discussed. Thoreau noted that at one place opposite the Highland Light the cliff had lost about forty feet between October, 1849, and June of the following year. However, he "judged that generally it was not wearing away . . .at the rate of more than six feet annually" adding—what many fail to realize—that "any conclusion drawn from the observations of a few years, or one generation only, are likely to prove false . . ."

The first careful determination of Cape Cod's east coast erosion rate was provided by the surveys of Henry Marindin of the U.S. Coast and Geodetic Survey during the period 1887 through 1889. Comparing his results with those of a survey forty years earlier, Marindin estimated the rate of retreat of the cliffs between Highland Light and Nauset Light to have been 3.2 feet per year.

A determination based on an even greater time span, seventy years, was provided by the survey made in 1958 and 1959 by the Woods Hole Oceanographic Institution's coastal studies group headed by Dr. John M. Zeigler. Their results compared with those of Marindin indicate an erosion rate of 2.6 feet per year for the same section during the period between the surveys.

The differences between the rates are not the result of a reduction in the long term rates of erosion. Rather, the differences result from the fact that although we make use of the convenient measure "annual rate of erosion," its use conceals the reality that the cliff erosion proceeds in jumps. At any one place there will be little erosion for a long period of time followed by much erosion over a short period of time.

A strikingly clear demonstration of the erosion rate at a single location is provided by the Cape Cod National Seashore's exhibit at the

site of the former Marconi station in South Wellfleet. There, at the edge of the cliff where once stood the high antenna towers which first sent telegraphic messages across the Atlantic, is a small sign which reads: "At this point the sea has carved its way inland more than 170 feet since Marconi built his wireless station in 1902."

We do not wish to give the impression that outer Cape Cod's coastal changes are entirely erosive. The sea has built the entire end of the Cape west of High Head, North Truro, including all of Provincetown and part of Truro, as it has also built Nauset Beach and Monomoy Island. These latter features are examples of barrier beaches. Such forms make possible the existence of salt marshes. (For a discussion of the high productivity and importance of salt marshes to the coastal ecosystem, see APCC Informational Bulletin Number 6, "Cape Cod Salt Marshes".) But the amount of land which has been built is small compared to the amount of land which has been removed.

Outer Cape Cod is eroding. We have discussed primarily the erosion of the ocean shore, but the bay shore also is eroding although at a somewhat slower rate. We often hear the question: What can be done to control the erosion? The concern is understandable. Population is increasing. Land value is increasing. But the amount of land is decreasing.

Well, what can be done? There are many temporary and partial answers of varying complexity and practicality, but the single final answer is very simple: nothing. Nothing can be done to prevent the erosion of the shores of Cape Cod.

To the person whose house sits imperiled at the edge of the sea, this may be a distressing state of affairs. He is unlikely to realize that Cape Cod is merely a temporary deposit of glacial sediment, pausing briefly (in the geological sense) on its way to inevitably being washed into the sea. Viewed broadly, coastal erosion is a single but important part of the basic earth processes. But the scale and long time periods of these processes make it difficult to see shoreline erosion as a fundamental part of the evolution of the earth's surface. We see too little of the world for too short a period of time and as a result man is accustomed to viewing erosion as purely destructive, a feared misfortune. We speak of it as a wasting disease.

The cycle of earth dynamics that includes erosion involves mountain building, erosion, sediment transportation and deposition of sediment in the seas followed by renewed mountain building. This cyclical process is as fundamental as the cycle of evaporation and precipitation.

The appearance of ancient marine fossils embedded in the strata of mountain tops is vivid evidence of the earth-sea continuum. But to understand the dynamic processes that bring the remains of sea creatures to the tops of mountains, let us begin below the sea floor.

The earth's crust consists of plates that move relative to each other.

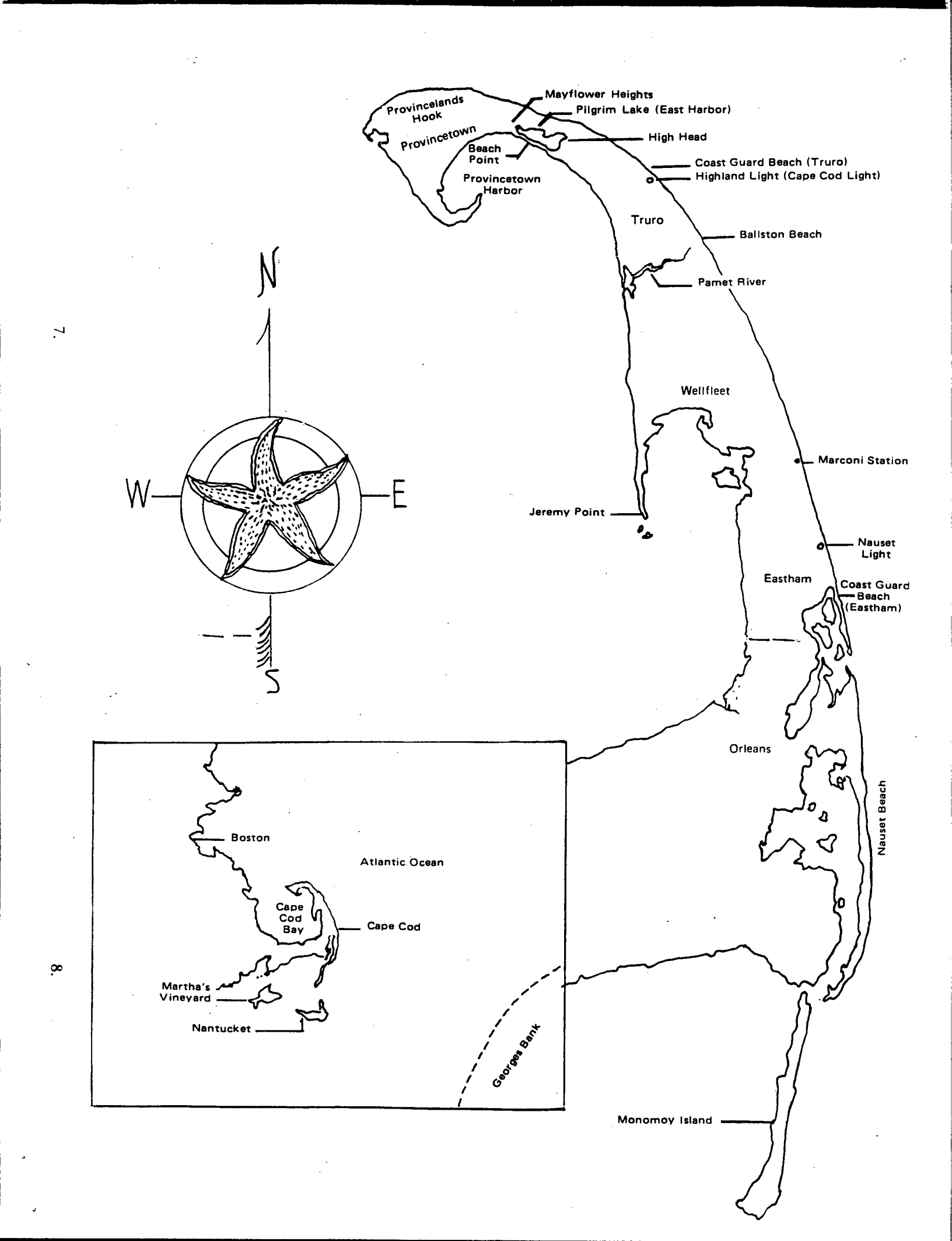
Some move away from each other forming seas; some are moving together forming mountain ranges. During this mountain building process great compressive forces fold, squeeze and thrust the thick sediment apron which makes up the coastal plain and the continental shelf. As a result, the sediments derived both from the earth and the sea are pushed upwards. Earthquakes, faulting and volcanism are some of the cataclysmic effects which accompany mountain building. Molten rock rises from the depths of the earth's crust forming granites and lavas which mix with the uplifting sediments and the whole is transformed into deep-rooted, high-peaked mountains. This process is today continuing to form the Andes Mountains of South America.

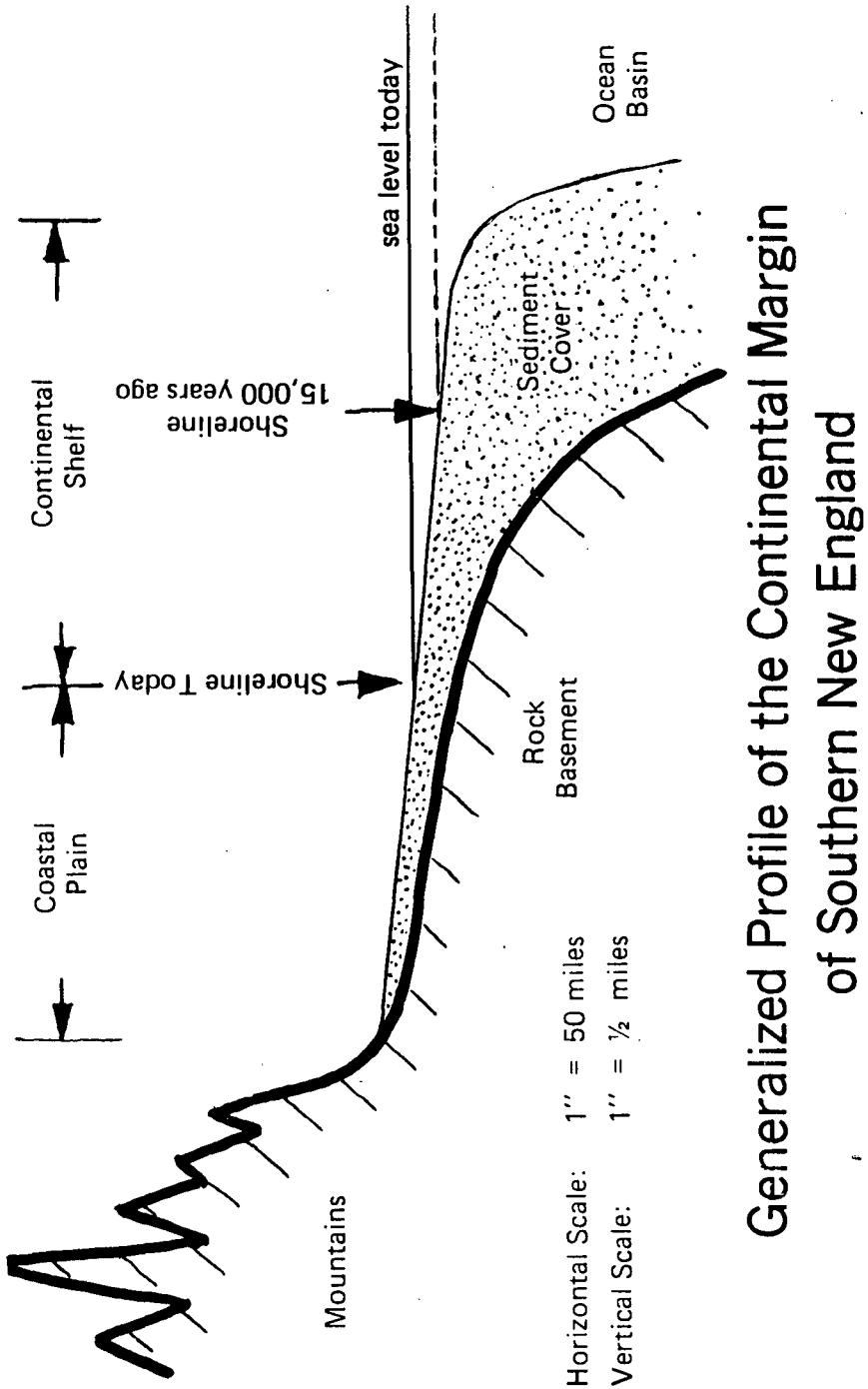
All the while, air, water and sun are acting together to wear the mountains down and return them to the sea. The winds, in constant motion generated by the heat of the sun, blow fine sediments from the mountain sides. Winds blowing upon the surface of the sea produce waves which wear away the rugged coastal margins of the land. The winds carry water vapor evaporated by the sun from the sea surface over the land. There, as rain, it beats upon the mountains and washes them, piece by piece, from rivulet to stream to river and finally to the sea. In some cases the water comes down upon the land as snow which, when deep enough, flows as glaciers. The glaciers quarry the earth rock and carry the pieces along. When finally the glaciers melt, the rock pieces—gravels, sand, mud, and clay—are released either directly into the sea or in land deposits which are later carried to the sea.

At the edge of the sea, waves and currents redistribute those deposits into ribbons along the shores. As sea level rises and falls hundreds of feet over the millenia, the sea lays down blanket upon blanket of sediment along the edge of the continent. These sediment layers form a continuous apron from the mountains to the underwater edge of the continent. The expanse from the foot of the mountains to the seashore is called the coastal plain. The submerged land from the seashore to the continent's edge is the continental shelf. The location of the shoreline, which divides and unites the land and sea, depends upon the sea level at any given time. It is here that the major sea forces act upon the land. With the passage of hundreds of millions of years, the sediments which form this apron become miles thick and the cycle resumes when mountain building takes place and these sediments re-emerge as lofty peaks.

Our own coastal plain and continental shelf extending along the entire east coast of North America owes its existence to the Appalachian Mountain Range. This mighty range rose into being about 250 million years ago and there are indications that peaks over three miles high were formed. Since that time the Appalachians have undergone erosion interspersed with minor renewed uplift.

Among the many types of erosion which have slowly worn the


Provincelands Hook
Provincetown
Mayflower Heights
Pilgrim Lake (East Harbor)
High Head
Beach Point
Coast Guard Beach (Truro)
Highland Light (Cape Cod Light)
Provincetown Harbor
Truro
Ballston Beach
Pamet River
N
W
E
S
Wellfleet
Marconi Station
Jeremy Point
Nauset Light
Eastham
Coast Guard Beach (Eastham)
Orleans
Nauset Beach
Boston
Atlantic Ocean
Cape Cod Bay
Cape Cod
Martha's Vineyard
Nantucket
Georges Bank
Monomoy Island



Appalachian crags into gently rounded hills were the spreading glacial ice sheets which advanced and retreated over North America during the Pleistocene Epoch, which began about two and a half million years ago. Cape Cod owes its origin to the last ice advance, known as the Wisconsin Stage. This great glacial sheet first carved its way south 50,000 to 70,000 years ago. Stalling here for several thousand years before a warming climate caused final retreat, the glacial lobes which brought the material of which Cape Cod is made conveyed their lode into deposits hundreds of feet high.

Since their deposition by the melt water streams from the glacial ice some 15,000 years ago, the temporary deposits forming Cape Cod have continued their progress toward ultimate deposition in the sea and incorporation into the Atlantic coastal plain and continental shelf system.

The most significant erosional agent at work is the worldwide rise in sea level which necessarily accompanies the retreat of continental glaciers. For it is at that very point where sea meets land, the shoreline, that most erosion takes place. The position of the shoreline is determined by the sea level. That thin, inarguable line has been creeping inland since glacial retreat began. The rate of sea level rise at Cape Cod was about 10 feet per 1,000 years following the Cape's deposition until about 2,000 years ago. Since that time the level of the sea has continued to rise but at about one third of the former rate, a little more than 3 feet per 1,000 years. Although such a rate may seen very slow, particularly when regarded over such a short period of time as a year, its importance becomes clear in view of the very slight inclination of the sediment layers making up the Atlantic coastal plain and continental shelf system. The average slope of this continental border is approximately one vertical foot for each 1,000 horizontal feet. This means for every foot the sea level rises (vertically), it would spread 1,000 feet over the land (horizontally) if the inclining continental border were perfectly smooth without islands, valleys, hills and other configurations such as Cape Cod. At a sea level rise rate of 3 feet per 1,000 years, the sea would be encroaching upon the land, if it were a smooth plain, at the rate of about 3 horizontal feet per year.

In fact, the encroachment of the sea has been so rapid since the ice retreat that only during the past several thousand years have the deposits been sufficiently submerged to produce a form that we would recognize as Cape Cod. For example, 7,000 years ago Cape Cod, Martha's Vineyard, and Nantucket were all part of the same land mass which extended some 25 miles eastward from the present east coast of Nantucket. Part of the fishing shoal which is known as Georges Bank and which lies 100 miles east of Cape Cod was then an island. And the sandy Provincelands Hook—Provincetown—had not yet begun its growth outward from the glacial deposits of Truro which end at High Head.

The mechanism by which shoreline forms are developed involves the breaking of waves along the shoreline. Sand is moved along the shore as the result of waves breaking obliquely to the coast. It is this wave action that accounts for most of the alongshore movement of beach sand (littoral drifting, in technical terms) and not tidal action as is often supposed. The larger the waves and the greater the angle of attack, the more the sand is moved along the shore.

As long as Georges Bank existed as an island it offered the outer Cape shores considerable protection from the fury of the easterly and southeasterly open ocean waves. The littoral drifting was then principally from north to south, Truro to Orleans. With the gradual submergence of Georges Bank due to rising sea level, this protection diminished and the intensified waves angling in from the east and southeast began moving material from Truro to the north and west. This change began about 6,000 years ago. The creation of the Provincelands Hook was underway, its substance coming from the sorting out of glacial material washed out of the cliffs of Truro.

To the south of Truro, however, the predominating direction of littoral drifting remained southerly and a corresponding buildup of sand occurred to the south, resulting in the formation of Nauset Beach and Monomoy Island.

The bayside was to feel the effects of the submergence of Georges Bank as well, for the growing Provincelands Hook now offered protection from the northerly and northwesterly waves. Then, along the bayside shore of Truro, the direction of littoral drifting became south to north. Sand washed along the inside curve of the Cape finally came to rest in North Truro and formed the long sand spit known as Beach Point, while to the south of bayside Truro sand was washed south and deposited to form Jeremy Point off Wellfleet.

But while these features have been slowly growing, the parent body has been rapidly disappearing. As discussed earlier the ocean shore cliffs are retreating at a rate of 2.6 feet per year. The bayshore cliffs are also retreating at the lesser but still significant rate of about 1 foot per year.

What of the future? What will the Cape's fate be? William Morris Davis, Professor of Geology of Harvard and founder of modern geomorphology, wrote in his study of the outline of Cape Cod, published in 1896:

"The Provincetown peninsula may be expected to outlast the Truro mainland; for as long as the latter exists, the former must receive contributions from it. But when the mainland is washed away—ten thousand years hence, at the present rate of wearing—then Provinceland must rapidly disappear . . . .All these changes are rapid, as changes go on the earth's surface. The Truro mainland will soon be destroyed, and the sands of Provinceland will be swept away as the oceanic curtain falls on this little one-act geographical drama."

Just as the earth's water is continually recycled through evaporation and rainfall, so it is with the land: the sands which wash into the sea today will be a part of future mountains.

Although this is an apt analogy, we have difficulty in relating it to the matter of our eroding shores because of the awesome scale of earth changes. Unmindful of the cyclical processes of earth dynamics (mountain building, erosion, sediment deposition in the seas followed by uplift and mountain building) we single out and think of erosion as a calamity, addressing ourselves to "the erosion problem."

At least since the time of Moses we have thought of the land as "ours." The Book of Genesis bids ". . .let them have dominion over . . .all the earth . . .fill the earth and subdue it." Failure to protect "our" land from the encroachment of the seas constituted neglect of scriptural duty. Man's obvious successes at stabilizing river banks (for example, Rome's Tiber, Paris' Seine and London's Thames) have led him to believe that ocean shores can be stabilized in a similar way. But, despite the millions of dollars spent annually in the United States since the Second World War on attempts at beach erosion control, we have only succeeded in compounding and increasing "the erosion problem."

The Panel on Oceanography established under President Johnson reported: "The Panel was distressed to find a high failure rate of construction projects in the surf zone and on beaches." The report goes on to describe the destruction of beaches by structures designed to protect or extend them and various other follies committed at the expense of the taxpayer.

A study of Cape Cod's ocean shores by the Army Corps of Engineers began in 1973 when funds were authorized for an erosion control study of the outer arm of Cape Cod extending from Provincetown to the southern extremity of Nauset Beach. The study, completed in 1979, finally concluded that, for economic and environmental reasons, "no beach erosion control project be adopted by the United States for providing protection against erosion and storm damage along the easterly shore of Cape Cod."

Let us take a brief look at some of the ways man has already affected the shores of Cape Cod, either by intentional effort at control or through unintended disturbance of natural shoreline balance.

An attempt to control shoreline changes of the ocean shores of Cape Cod was undertaken by the Cape Cod National Seashore in 1966 at Eastham's Coast Guard Beach in an effort to protect the access road to a new parking lot. Winter storms, especially those in 1965-1966, had swallowed up much of the ten foot cliff on which were situated the vestiges of a town-built parking lot and the access road. In a desperate attempt to hold the bank and thereby preserve the access road, 3,000 cubic yards of rubble consisting largely of huge chunks of broken concrete were dumped over the bank and onto the beach.

The principal effect of this action has been the aesthetic defilement of this beach. In 1973, the then Seashore Superintendent, Leslie Arnberger, summed up the results by saying, "We may have gained a few years, but in turn a hazardous and unsightly situation has resulted."

Mr. Arnberger's previously stated position of "learning to live with erosion as a fact of life" has become the accepted policy of the National Park Service. It was announced in September 1973 that the National Park Service would no longer try to control shoreline processes anywhere along the coastline within its jurisdiction. This policy came as the result of detailed scientific studies combined with a history of costly failure at controlling eroding shorelines.

Succeeding Seashore Superintendent, Lawrence C. Hadley, said at that time,"We have reached the conclusion that what we have been doing is not the way to go at all. It is time to set out on a different course that would allow those coastal landscapes to shift with the natural forces."

The threat to man-made structures such as parking lots and lighthouses usually provides dramatic witness to erosive forces at work. In the case of Ballston Beach at the head of Truro's Pamet River, striking evidence of the sea's advance upon the land was given in the winters of 1972 and 1978 during severe easterly storms. Waves washed over the dwindling barrier dune onto the paved road connecting North and South Pamet Roads and threatened the fresh waters of Pamet River. This has happened before and one such washover in 1896 led the Provincetown Advocate to predict that the outer Cape would one day "be made an island." In November of 1933 Boston Globe headlines portended "Cape Cod an Island Ten Years from Now." Under the inept headline the subheading followed,"sea threatens to break across Pamet River unless Uncle Sam intervenes."

But Man's unintentional intervention was already too great. The advent of the automobile had led to the stabilization by hard-surfacing, and later paving, of this road running behind the barrier dune. The shoreline here is naturally receding inland. Left to its normal movement, the dune would have migrated inland, all the while maintaining its size and form. The road would have likewise moved inland, always running between the foot of the dune and the head of the Pamet. Once paved, the road was fixed, but the dune was not and its encroachments upon the road were necessarily removed. Thus the sustenance, natural movement and protective qualities of this barrier dune were upset. As a result, this important natural protection has deteriorated and washovers occur with greater frequency.

The bayside of the Outer Cape has a longer history of attempts at manipulating natural shoreline processes. The uses of the rivers, harbors, beaches, marshes, flats, and other features have been manifold. Man's interest in their condition has always been keen, ever since the Pamet and Nauset Indians fished and farmed this region.

Left alone, of course, these features take care of themselves and adjust to the natural forces acting upon them. Certain forms evolve in response to the forces of winds, waves and currents and exist in a state of equilibrium until the forces change. A new balance is then achieved. Tampering with any of the elements in this balance of forces is bound to have troublesome effects.

To keep the mouth of Pamet River a viable harbor, rock jetties extending out into the bay were built in 1918-1919. At first this appeared to be a successful venture. But these jetties interrupted the normal flow of sand along the shore from south to north. Thus, the sand accumulated behind the south jetty, starving the beaches on the north side and eventually spilling around the jetty's end and into the river channel that the jetty was built to protect. Keeping the channel open now requires periodic dredging.

Without the jetties, Pamet River would have maintained an opening itself as it had done through the ages. Through natural processes, the inlet would migrate from south to north. Once reaching the northern extremity of the river valley a new opening would break through at the southern end. This recurring pattern of inlet migration in the direction of littoral drifting is common to estuaries. But the vagaries of location and depth of the natural Pamet inlet did not suit man's practical sense.

Another example of the unhappy results of man's interference in natural shoreline processes is occurring in Truro. Because of the cheek-by-jowl commercial development of North Truro's Beach Point, the shoreline changes taking place there are the cause of extremes of feeling among the property owners. Beach Point, as described earlier, was a growing sand spit sheltering behind it a tranquil harbor which mariners for centuries used as a refuge from storms and a resting place. It became known as East Harbor and is still called that by some although since 1869 it has been a lake—Pilgrim Lake.

The denuding of the land by the early settlers led to the gradual filling of East Harbor with blown sand. To quote Kittredge's "Cape Cod: Its People and Their History," published by Houghton Mifflin Company, the sand "washed down through its (East Harbor's) entrance into Provincetown Harbor which was being gradually silted up by this constant deposit." To halt the flow of sand into Provincetown Harbor, a dike was built joining the end of Beach Point to Provincetown at Mayflower Heights. The dike was completed in 1869.

The building of this dike, for however good reasons, brought mischief to the balance of forces. As stated earlier, shoreline forms change in response to changed forces acting on them. Tidal flow surging in and out of the mouth of East Harbor had interrupted the alongshore currents and influenced wave action on the shore. The closing of the harbor entrance ended that tidal effect on the area and made the shoreline continuous. It also left a concavity in the shoreline at that point. The response of the beach to the new conditions has been to

form a clean regular curve. This natural smoothing out of the shoreline is today being produced by a filling of the concavity with material eroded from the southeastern portion of Beach Point. To the glee of the property owners to the north, their shoreline is building out at the rate of 6 to 10 feet per year, while to the distress of their brethren to the south, the beaches are disappearing and cottages and motels are threatened.

The construction of substantial buildings on a frail and very mobile sand spit such as Beach Point seems almost unbelievable in hindsight. The history of development was insidious: dike, road, little cottages, big cottages, little motels, big motels. To arrest the erosion presently taking place and thereby protect the heavy private investment made there, town monies were allocated in 1973 for the construction of two groins at Beach Point.

If these groins were constructed they would prevent the establishment of equilibrium conditions along this section of the shoreline. By preventing change in one section of the evolving shoreline the entire shoreline would be thrown increasingly out of equilibrium. This defiance of natural order would result in the "protected" section requiring increasingly greater commitments to be maintained. Therefore, the construction of groins along Beach Point would be merely another link in the burdensome chain of coastal problems and misfortunes initiated by our unwitting forebears when they stripped the land of vegetation over 200 years ago.

EPILOGUE

Cape Cod is a temporary, steadily diminishing glacial deposit whose shores have been subject to submergence by a rising sea level since its creation some 15,000 years ago. Nothing that man can ever do, intentionally or unintentionally, will change the fact that Cape Cod is slowly submerging. The erosion of our shores is but a tiny part of the great cycle of earth dynamics.

Many generations will live here and there is plenty of room and time, if we make wise use of our resources, to fill our needs for life here. But let us make no mistake; the shoreline cannot be adjusted to suit short term needs without affecting the lives of others, often for a long time. Costly and often futile shoreline control efforts are made to protect unwisely placed roads and buildings. It would make greater sense to build according to the conditions imposed by nature—adjust ourselves to the changing shoreline rather than trying to adjust the shoreline to ourselves.

What we have to enjoy is the magnificence of ever changing natural shoreline forms: towering cliffs, long sweeping beaches, reaches that change from hour to hour with the changing tides and winds. New forms will be born of the old and will themselves generate change within the delicate balance of forces. As part of nature's continuum it behooves us to live within it harmoniously.

AFTERWORD

This booklet was first published by the Association for the Preservation of Cape Cod in October, 1974, and some minor changes were made in the text in the late 1970s. Despite the many developments that have occurred in coastal science and coastal management over the intervening years, it is re-issued in its original form because we believe that the essential message it presents is as valid now as it was then.

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