

THE BARRIER BEACHES OF CHATHAM

Graham S. Giese, Provincetown

As other articles in this issue of Bird Observer make clear, the Monomoy "system" is in a state of constant flux: fishing villages and tern colonies come and go. Monomoy is first an island, then a peninsula, yet again an island, then two islands. This article will provide the geological underpinnings for an understanding of the Monomoy process.

S.Z.

The Chatham coast consists of two basically different types of land forms: a relatively stable inner coast formed chiefly by submergence of Pleistocene glacial deposits but modified in part by wave action; and an extremely dynamic outer coast consisting of unconsolidated deposits formed and continually modified by wave, tidal and wind action.

Most of the outer coastline features formed in this way are technically known as "barrier beaches." A barrier beach is an elongate coastal feature generally consisting of beaches, dunes, and tidal flats, together forming a narrow low-lying strip of land composed of unconsolidated sediment and extending roughly parallel to the trend of the coast. It is separated from the mainland by a body of fresh, brackish or saline water, or a marsh system. A barrier beach may be joined to the mainland at both ends, or at one end, in which case it is known as a "barrier spit," or, as in the case of a "barrier island," it may not be attached at all.

The eastern outer coast of Chatham--Nauset Beach and Monomoy--comprises the southern part of a series of barrier beaches, islands, and spits which are formed of sediments eroded by wave action from the sea cliffs of Eastham and Wellfleet and carried southward by littoral drifting. The southern outer coast of Chatham--Forest Beach, Ridgevale Beach and Harding Beach--is similarly made up of barrier beaches, islands and spits which consist of materials eroded and carried eastward from the exposed glacial deposits of the Nantucket Sound coast west of Chatham.

During the past 200 years, a large amount of information has been gathered concerning the form and changes of form of the Chatham barrier beaches. A study of this information was undertaken for the Conservation Commission of Chatham, with the following objectives: first, to determine the patterns of change undergone by the Chatham barrier beaches over the past 200 years; second, to deduce the processes controlling the observed patterns of change; and third, to predict the patterns of change which may be expected in the future. The

results of this study are summarized below.

Patterns of Past Changes

Once the primary data sources (reports, historical accounts, studies, maps and charts) for the 200-year study period (1770-1970) had been collected, pertinent information was divided chronologically into 20-year periods. For each 20-year period a generalized diagram representing the major shoreline features of that time period was prepared. The ten resulting shoreline diagrams are the first of the thirteen diagrams shown together in this article. It should be emphasized that each of these ten diagrams represents a composite of all the data available for that time period and therefore may differ from the coastal form at any one time during that period. Furthermore, diagrams are not maps--that is, they were not constructed according to a constant-scale relationship with the actual land forms. Therefore, while they are useful in indicating relative shoreline changes, they cannot be used to determine absolute changes or rates of changes.

Some portions of the barrier beach complex have changed relatively little over the entire 200-year period. On the south coast, Harding Beach, which joins the mainland at West Chatham and extends southeastward, forcing a right-angle bend in the Oyster River, has maintained a fairly constant form. It has slowly increased in width and in length. On the east coast, the part of Nauset Beach north of Strong Island has maintained a fairly constant form without permanent breaks (most of this part of Nauset Beach lies above the diagrams). Also, the part of Monomoy from Inward Point south to Monomoy Point has been stable over the entire period. The northern end of this part of Monomoy has narrowed somewhat due to erosion along the eastern coast, but the southern end has widened, growing southeastward approximately one-half mile between 1887 and 1964.

However, the barrier beaches on the east coast between Strong Island and Inward Point have undergone major changes. Two centuries ago the barrier beach extending southward from Nauset Inlet was a barrier spit which ended approximately opposite the present location of Tern Island. The Chatham coast southward was not protected. The barrier began again at Morris Island and continued without interruption to Monomoy Point. The northern barrier gradually grew southward, until by 1820 it reached south of Morris Island and overlapped the southern barrier, which then separated from the island. After this separation, the south end of the northern barrier continued to grow southward and the north end of the southern barrier continued to retreat southward.

In 1846 a new inlet formed through the northern barrier opposite Ministers Point (Allen Point). As this inlet rapidly grew wider, the barrier beach south of it gradually disintegrated, and migrated in remnants westward into the Chatham

mainland. The barrier beach north of the inlet grew gradually southward once more, and the barrier south of Morris Island regained a continuous form and became reattached to the island, so that by about 1940 the general form of 1800 had returned.

After 1940, the post-1800 pattern was repeated: continued southward growth of the northern barrier until it reached south of Morris Island; separation of the southern barrier from the island; continued southward growth of the northern barrier and southward retreat of the north end of the southern barrier. In summary, the east-coast barrier beaches between Strong Island and Inward Point undergo a cyclical pattern of changes with a period of approximately 150 years.

Processes Controlling Change

The Chatham barrier beaches owe their existence to, and change form in response to, processes driven by a number of different natural forces, including coastal erosion, wave energy, tidal flow, winds and storms. Coastal erosion west of Chatham provides sand for Chatham's south coast barrier beaches, while coastal erosion north of Chatham provides sand for Chatham's east coast barrier beaches. Along the south coast, eastward-directed net wave energy transports sand to the barriers on that coast. Along the east coast, southward-directed net wave energy transports sand to the east coast barriers.

Easterly winds, storm waves and storm tides transport sand westward across the east coast barrier beaches in the form of dune movement, overwash and overwash fans, and breakthroughs and flood-tidal deltas. As a result, the barrier moves westward at a rate of between 5 and 10 feet per year. In doing so, it causes the inner channel to become ever more constricting to tidal flow from Pleasant Bay and Chatham Harbor to the Atlantic Ocean. Eventually, the constriction becomes so great that when, as a result of storm-elevated sea levels, a breakthrough occurs through the northern part of the barrier, Pleasant Bay tidal water flows through the breakthrough instead of through the inner channel, and the breakthrough becomes an inlet.

The southward moving sand supplied by littoral drifting is intercepted at the new inlet. Some sediment is carried in and added to the flood-tidal delta, and some is carried out and added to the ebb-tidal delta. Because of the reduction in the volume of sand supplied to it, the barrier south of the new inlet is "starved." It gradually breaks down and is moved landward.

Eventually, the inlet is no longer an inlet but rather marks the southern end of a barrier spit which grows southward with the addition of sediment supplied by littoral drifting. The previous barrier, south of the "new" spit, moves onto the Chatham mainland, forming the "peninsula" of Monomoy. At this stage, the attachment of Monomoy to the southern Chatham main-

land is secured by rapid littoral drifting along this shoreline resulting from its open exposure to waves.

When the "new" barrier spit grows far enough southward to overlap the southern barrier, and when this southern barrier becomes breached in the ordinary manner, the breach remains open because the littoral drifting required to close it is no longer available. Thus the northern end of the southern barrier retreats as the southern end of the northern barrier advances. The cycle is reinitiated when the northern barrier is once again squeezed against the mainland of southern Chatham.

Patterns of Future Changes

Assuming that the cyclical changes continue without interruption, the future form of the shoreline can be predicted. The last three diagrams shown in this article represent present and future shoreline development for the periods indicated.

However, the 150-year cycles of change are superimposed upon a very long-term trend toward a different pattern. Eventually, after two or three more cycles have run their course, the northern portion of the barrier will be sufficiently westward of its present location that it will no longer overlap the mainland of Chatham. Rather, the barrier beach system will stop at North Chatham, the coast from North Chatham to Morris Island will be exposed to ocean waves, and an ever-widening Monomoy spit will extend southward from Morris Island.

GRAHAM GIESE, of North Truro, is a coastal oceanographer and director of the Provincetown Center for Coastal Studies. The present article is based on his report, The Barrier Beaches of Chatham, Massachusetts, prepared for the Chatham Conservation Commission and published as a special supplement to the Cape Cod Chronicle, June 1, 1978.

ANNOUNCEMENT: PARKER RIVER REFUGE PLANNING

Alternatives for the management of the Parker River National Wildlife Refuge, Newburyport, will be the subject of a number of workshops to be held in August. The alternatives have been formed in part from ideas and comments received from the public last fall. If you would like to learn of the date and location of the workshops and receive advance information, call Parker River at 465-5753 or the Regional Refuge Planning Team at 965-5100, extension 278. Persons and groups on the mailing list for The Refuge Planner will automatically receive this information.