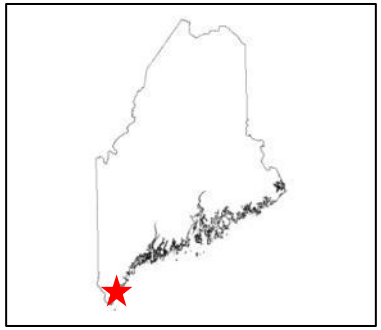
Geologic Site of the Month

May, 2005

Ogunquit Beach and Dunes Over Time



43° 15‘ 19.78“ N, 70° 35‘ 42.55“ W

Text by
Stephen M. Dickson

Introduction

Since Colonial settlement, the beaches and dunes of Ogunquit have been subject to intense use by wildlife, people, and domesticated animals. The beach is backed by coastal sand dunes which, in turn, protect a back-barrier salt marsh from ocean surf. Colonists used the beach as a "highway" for livestock and the marshes were coveted for salt hay. In the 1750's protecting the marsh was as important as it is today.

King George II of England issued a statement in 1757 that recognized that livestock could overgraze and trample the sensitive dune vegetation to the extent that ocean waves could wash beach sand across the dunes and into the salt marsh. In order to protect the marsh, he proclaimed that colonists could not drive cattle or horses along the beach and were to be kept out of the dunes (1757 records of King George II courtesy of Dorothy R. James, Ogunquit, October 30, 1979, 397kb, pdf format).

Penalties were set for people driving or grazing livestock through the dunes and anyone caught mowing beach grass would be fined. In many ways, the King's 1757 beach and dune management plan is similar to that in place today in the Town of Ogunquit. Both have goals to preserve the dunes from foot traffic and domestic animals, to protect endangered species from dune and marsh habitats loss, and to maintain a stable beach for recreation and protection of the upland from storms.

Fifty Years of Dune Change in Ogunquit: 1953

In 1953 the central portion of the Ogunquit dune field was an equal mix of vegetated dunes and open sand surfaces (Figure 1). The open areas appear to be a combination of blowouts created by wind and washouts where surf and coastal flooding washed sand into the dune field. The entire beach and dune system was very dynamic and responsive to the forces of nature.

Figure 1. Aerial photograph of the dunes in 1953

Fifty Years of Dune Change in Ogunquit: 1974

In the 1970s the U.S. Department of Agriculture, Soil Conservation Service led an effort to stabilize the dunes at Ogunquit. In 1974 construction of the OG-1 dike replaced the natural dunes with a linear ridge built of sand scraped from the flood-tidal delta in the Ogunquit River and sand from the beach profile. Close examination of Figure 2 shows a bulldozer at work on the beach. A network of roads to move sand appears in the back dunes along the river. By the summer of 1974 work on OG-1 was complete.

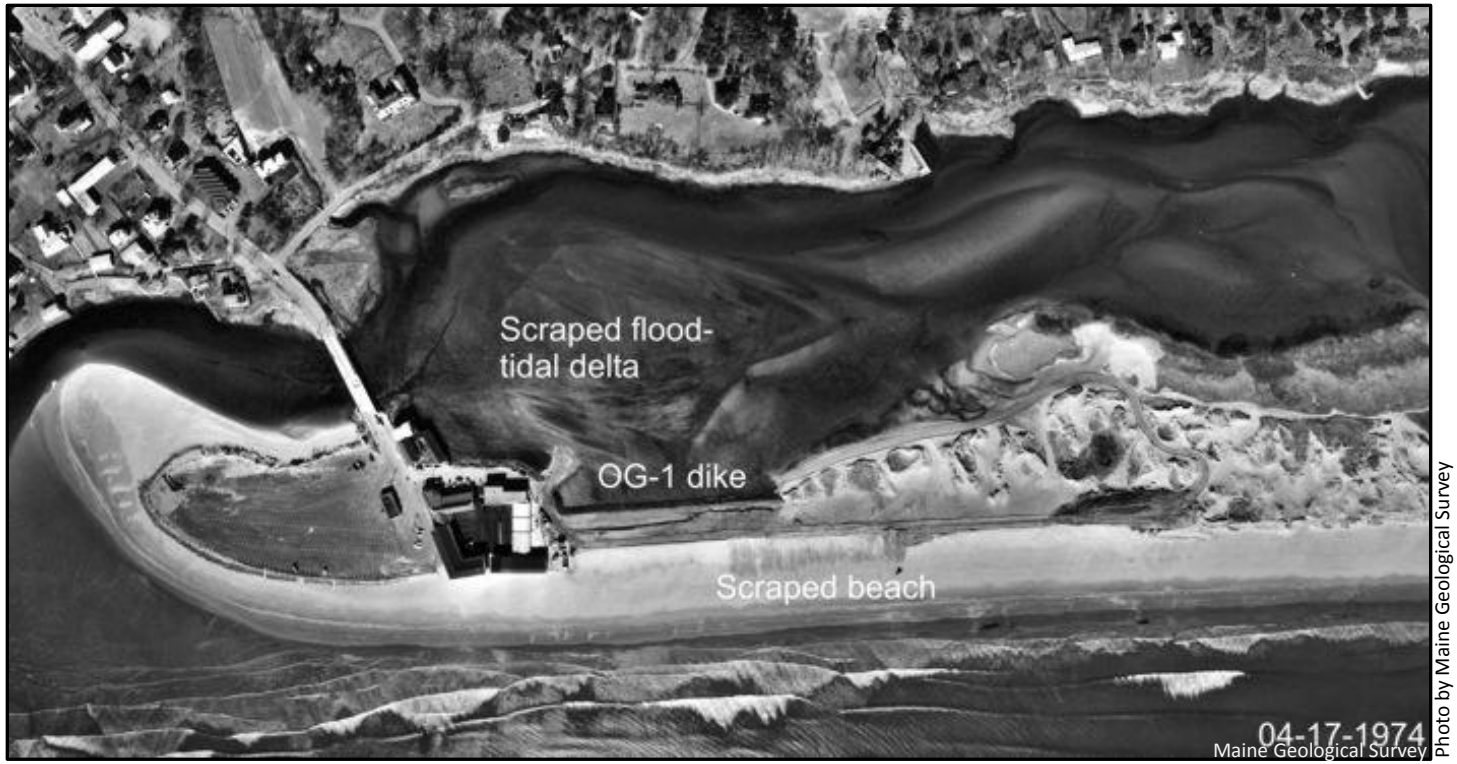


Photo by Maine Geological Survey

Figure 2. Aerial photograph of the dunes in 1974

Fifty Years of Dune Change in Ogunquit: 1974

The central Ogunquit dune field shows signs of sand washing onto the beach from the dunes (Figure 3).

Figure 3. Aerial photograph of the dunes in 1974 showing washover fans.

Fifty Years of Dune Change in Ogunquit: 1974

High water levels in the Ogunquit River during a storm can cause flooding in the dunes and, as shown here, sand can be transported seaward and back to the beach. The washover fans form small delta-like aprons on the upper beach profile just seaward of the dune vegetation line. If a breach of the dunes is extensive, a new tidal inlet can form. Such occurrences are rare since waves and tides tend to seal the opening with sand from the beach soon after a storm has passed. There are historical accounts of the Ogunquit River having its tidal inlet at the northern end of the beach in 1760. By 1879 the inlet was charted to the south in the vicinity of where it is today.

Fifty Years of Dune Change in Ogunquit: 1974

The northern segment of Ogunquit Beach (Figure 4) is the location of the Ogunquit Sewer District treatment plant. This facility was built in the back dunes. Close examination of the 1953 air photo (Figure 1) shows the alteration of the dunes in preparation for plant construction. The treatment facility once discharged into the Ogunquit River. Since 1993, the discharge has been through a pipe that is buried under the frontal dune and beach and extends offshore to an ocean outfall. Over time the plant's capacity has been expanded within the existing footprint in the dunes to accommodate a growing coastal population. The natural beach and dunes end at the Wells town line at Moody Beach.

Figure 4. Aerial photograph of the dunes in 1974 showing the Ogunquit sewer treatment plan.

Fifty Years of Dune Change in Ogunquit: 1977

In a 1977 photo (Figure 5) the completed OG-1 dike is visible. It is a uniformly linear ridge covered with vegetation. A footpath on the Ogunquit River side of the dike can be seen. The flood-tidal delta in the river has grown in height since 1974 with sand most likely transported into the inlet from the beach and ebb-tidal delta (shoal) at the river mouth.

Figure 5. Aerial photograph of the dunes in 1977.

Fifty Years of Dune Change in Ogunquit: 1977

The second phase of construction in the dunes at Ogunquit was the much longer OG-2 dike. This linear ridge was built with a core of glacial gravel brought in from an upland gravel pit between December 1974 and March 1975 (Figure 6). The ridge is also higher than the previous frontal dune ridge crest and higher than waves can runup in a 100-year storm. The ridge is a strong and rigid barrier to breaching in storms from both the ocean and river, but it also impedes the natural movement of sand that once existed between the frontal dune and back dunes. To protect the Ogunquit sewer treatment plant from extreme erosion events, a metal sheet-pile wall was driven into the frontal dune seaward of the plant. This engineering structure has remained buried in the frontal dune over the years because the beach has not been eroding significantly.

Photo by Maine Geological Survey

Figure 6. Aerial photograph of the dunes in 1977 showing the OG-2 dike.

Fifty Years of Dune Change in Ogunquit: 1991

The Halloween Storm of 1991 became known as the Perfect Storm as a result of Sebastian Junger's 1977 book of the same name. The storm affected all of Maine's beaches and dunes. Many dunes were eroded and lost sand on the upper portion of the beach profile. This seaward shift of sand during storms helps lower the beach slope and causes surf to break farther offshore. This natural response lowers the storm wave energy reaching the remaining dunes and helps preserve the lower and more fragile back dunes. Over time, sand lost to the offshore returns to the frontal dune.

Fifty Years of Dune Change in Ogunquit: 1991

In Figure 7 and Figure 8 the ragged edge of the frontal dune can be seen 18 days after the Perfect Storm. It appears that there was very little overwash or flooding over the top of the OG-1 or OG-2 dikes. Large blocks of dune vegetation are visible on the beach profile. Erosion did not reach the seawall at the sewer treatment plant (Figure 8).

Figure 7. Aerial photograph of the dunes in 1991 after the Perfect Storm.

Fifty Years of Dune Change in Ogunquit: 1991

A vehicle is visible on the beach in each photo, perhaps in an effort to repair a damaged sand fence that was along the edge of the frontal dune or involved in work at the plant. The parking lot next to Moody Beach has sand in it, probably a result of washover through the pedestrian path (Figure 8).

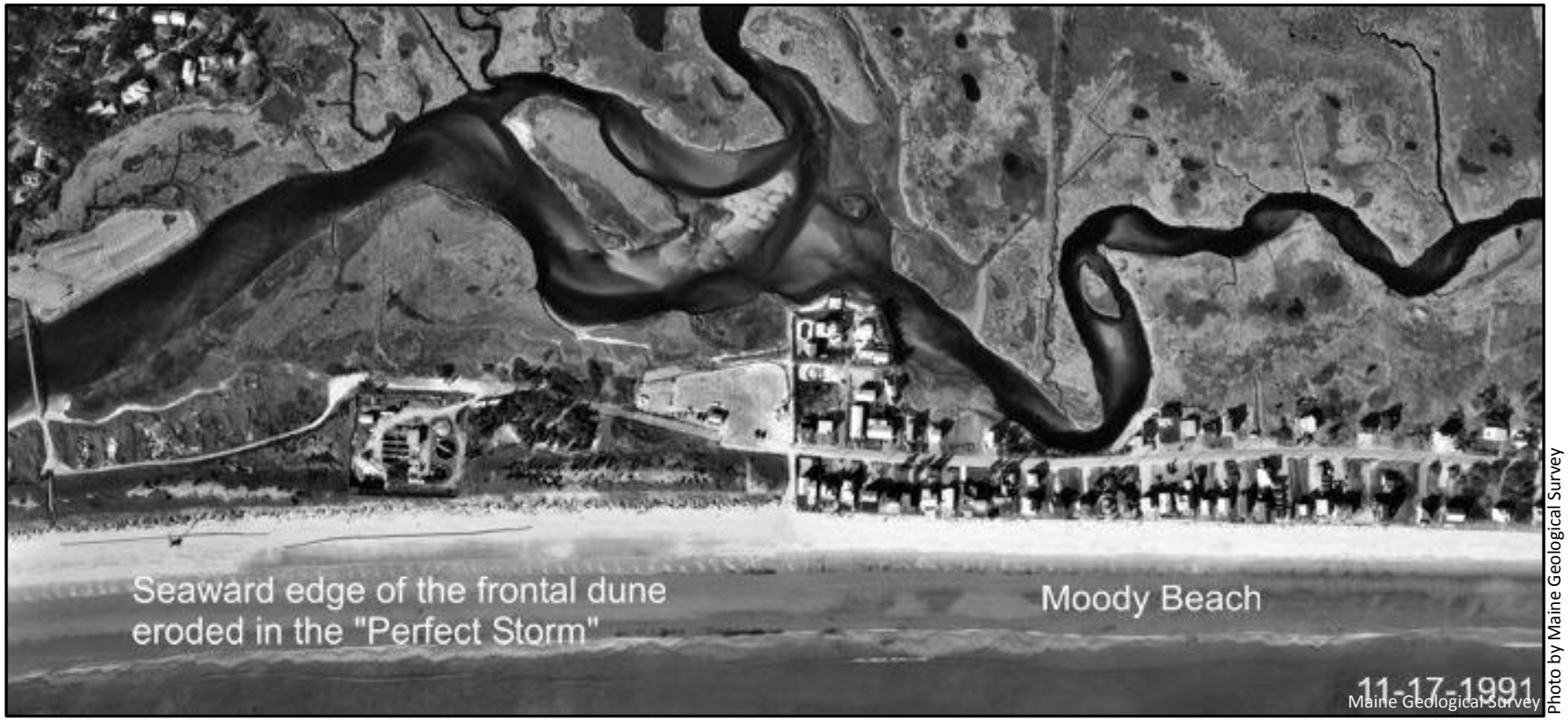


Photo by Maine Geological Survey

Figure 8. Aerial photograph of the seaward edge of the dunes in 1991 after the Perfect Storm.

Beach Profiles

A team of volunteers has been measuring profiles of Ogunquit Beach (Figure 9) for several years as part of a larger Maine Beach Profiling Project. Results of profiling efforts around the state are presented at the Maine Beaches Conference. The profiles are measurements of elevation of the beach and they are taken monthly at low tide. Over time, comparison of the profiles allows a better understanding of erosion or accretion trends on the beach and at the seaward edge of the frontal dune.

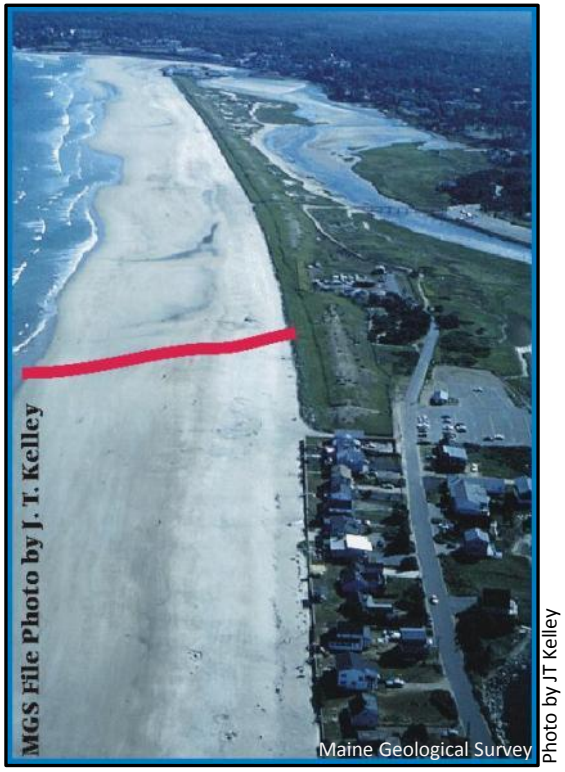


Photo by JT Kelley

Figure 9. Approximate location of the beach profile line shown in Figure 10.

Beach Profiles

The graph in Figure 10 illustrates how stable the Ogunquit Beach profile has been between 2000 and 2004. This graph shows the profile at the end of each winter storm season and before much of the summer sand has moved ashore from deeper water. The exception to this is in the May 2004 profile which already shows the additional vertical accumulation of sand in the form of a berm or relatively flat and dry part of the beach that is ideal for sunbathing.

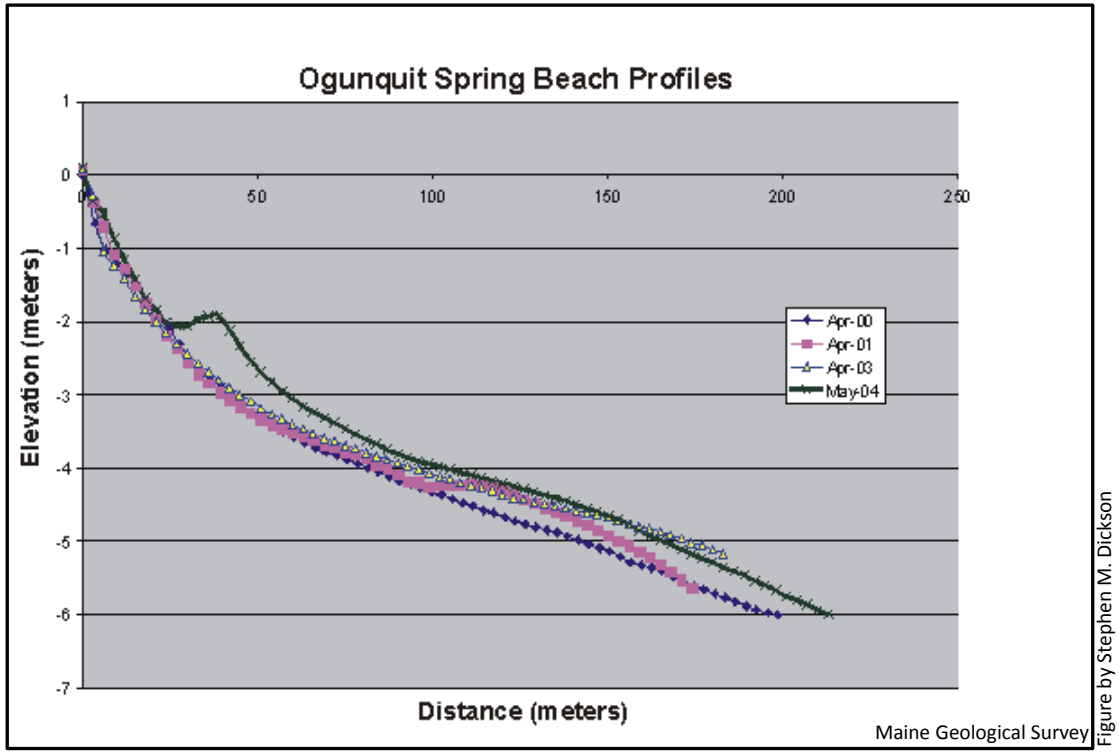


Figure 10. Comparison of spring beach profiles at the Ogunquit 2 station from April 2000 to May 2004.

Conclusions

The results shown here are good news. The beach and dune do not show signs of eroding over this four-year period of time. Perhaps of more importance to most people, sand comes back ashore in time for summer recreation.

The overall stability is also good news for preserving essential nesting and foraging habitat for endangered piping plovers. The Town of Ogunquit, the Maine Department of Inland Fisheries and Wildlife, the Maine Audubon Society, and local volunteers help actively protect bird habitats on this beach each spring and summer.

Dune management by the Town of Ogunquit has kept the dunes healthy and resilient in the face of decades of storms and intensive recreational use of the beach. The artificial construction of the OG-1 and OG-2 dikes has made the Ogunquit dunes less natural than they once were, but the seaward edge of the frontal dune is currently as dynamic as many others in Maine that do not have seawalls. Proper management of the dynamic frontal dune helps insure both essential habitat and a wide beach berm for summer recreation. As King George II realized about 250 years ago, protection of the natural dune system can pay both short- and long-term benefits.

References and Additional Information

FitzGerald, Duncan M., Lincoln, Jonathan M., Fink, L. Kenneth, Jr., and Caldwell, Dabney W., 1989, Morphodynamics of tidal inlet systems in Maine in Tucker, Robert D., and Marvinney, Robert G. (editors), Studies in Maine geology: Volume 5 - Quaternary geology: Maine Geological Survey (Department of Conservation), p. 67-96.

FitzGerald, D. M., Fink, L. K., Jr., and Lincoln, J. M., 1984, A flood-dominated mesotidal inlet: Geo-Marine Letters, v. 3, no. 1, p. 17-22.

Van Heteren, Sytze, FitzGerald, Duncan M., McKinlay, Paul A., and Buynevich, Ilya V., 1998, Radar facies of paraglacial barrier systems; coastal New England, USA: Sedimentology, v. 45, no. 1, p. 181-200.

MGS Maps of Ogunquit Geology:

MGS has available four color air photos that overlap slightly and cover all of the Ogunquit Beach and dunes. The photos were taken in 1986 and are annotated with the geologic environments such as the frontal dune, back dune, beach, high salt marsh, low salt marsh, and tidal channels. Each publication comes with a legend and additional information about coastal sand dunes. These publications can be purchased for $1.00 each. Ordering information is available on the Publications section of the MGS web site.

Dickson, S. M, 2001, Beach and Dune Geology, Ogunquit Beach, Ogunquit River, Ogunquit, Maine: Maine Geological Survey Open-File No. 01-442, 4 p. (includes the Ogunquit River mouth, Beach Street, and the parking lot at the spit).

Dickson, S. M, 2001, Beach and Dune Geology, Ogunquit Beach, Beach Street, Ogunquit, Maine: Maine Geological Survey Open-File No. 01-443, 4 p. (includes the flood-tidal delta, OG-1 and southern portion of OG-2).

Dickson, S. M, 2001, Beach and Dune Geology, Ogunquit Beach, Ogunquit, Maine: Maine Geological Survey Open-File No. 01-444, 4 p. (includes the central narrow dunes, Ogunquit River, footbridge, and part of the treatment plant).

Dickson, S. M, 2001, Beach and Dune Geology, Ogunquit Beach, Ogunquit River, Ogunquit, Maine: Maine Geological Survey Open-File No. 01-438, 4 p. (includes the treatment plant, Ocean Ave. parking lot, river marshes and part of Moody Beach).

Additional Links

- How to Order Copies of Air Photos
- Kennebunk and Wells Beaches
- Kittery Point Beach
- Ogunquit's Marginal Way geology
- Pebble Beach on an offshore island
- Reid State Park Beaches, Georgetown
- Songo Beach, Sebago Lake State Park
- Surveying beach erosion
- Laudholm and Drakes Island Beaches