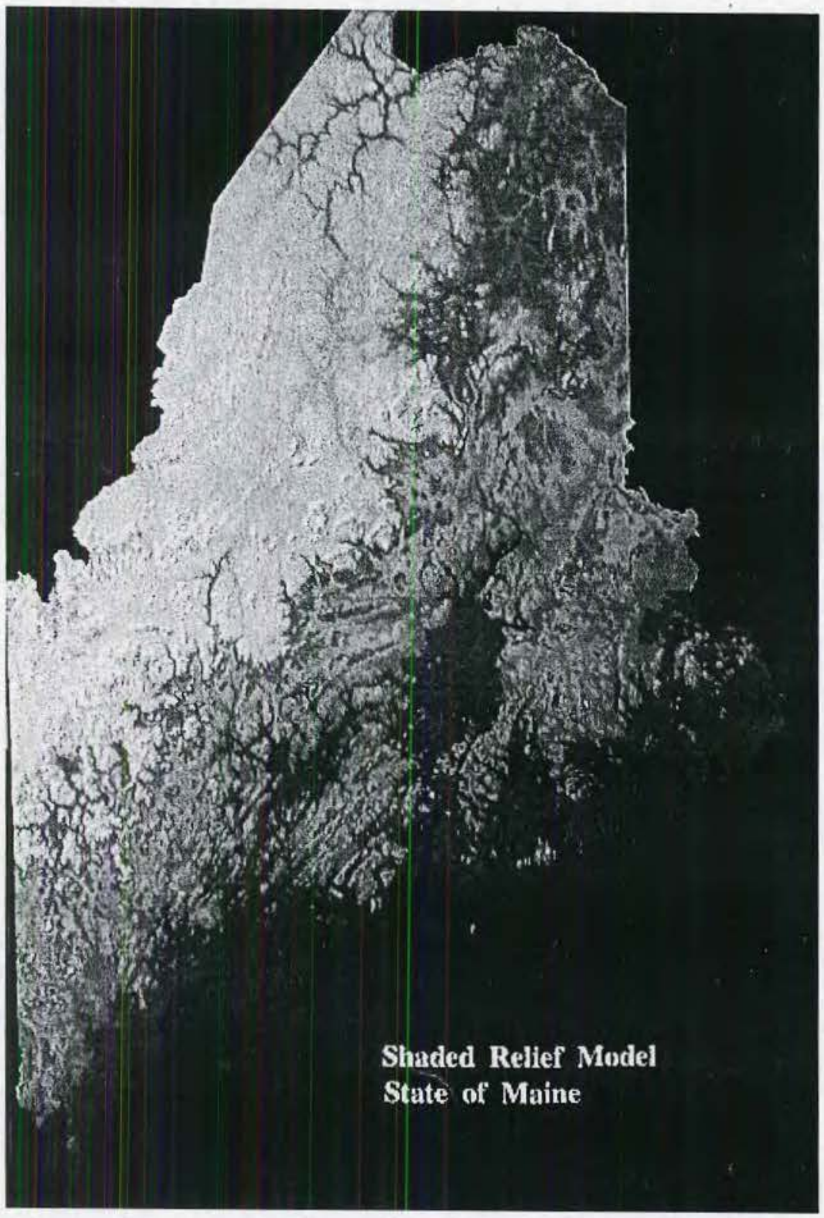

Maine's Beaches and Dunes and their Changes through Time

Presentation to the Maine Legislature

Joint Standing Committee on

Natural Resources

March 25, 2003

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DEPARTMENT OF CONSERVATION
MAINE

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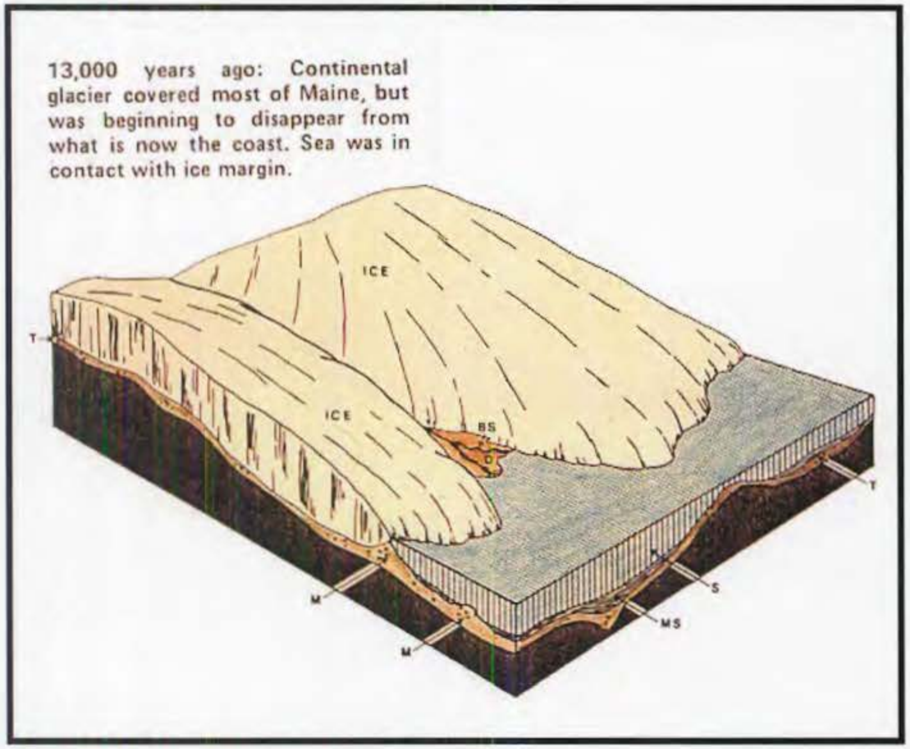
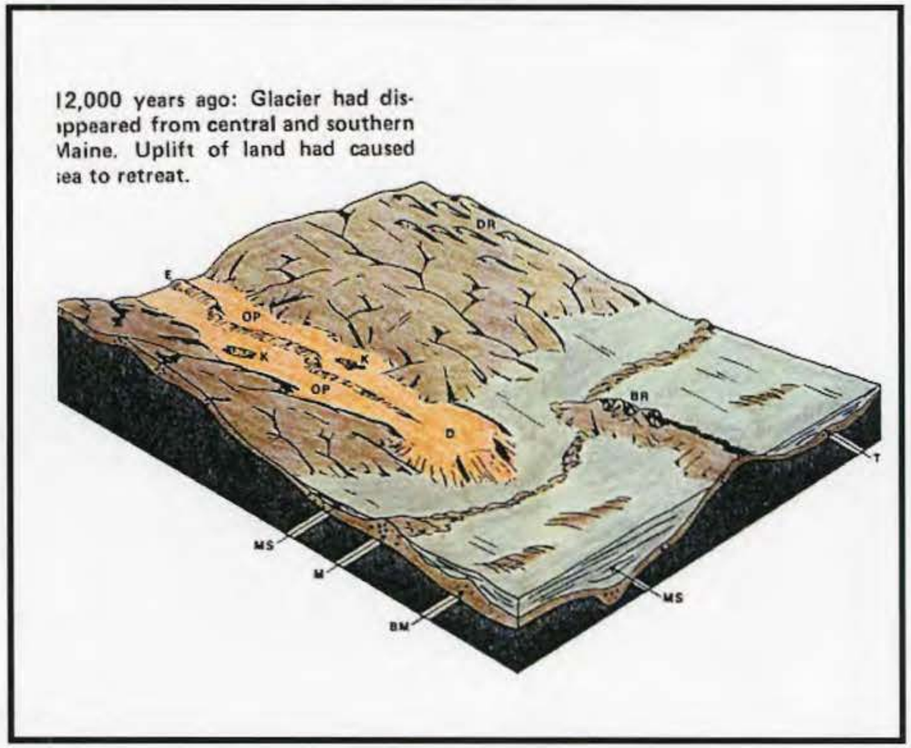
Sea-level rise
Dune geology
Beach processes
Coastal flooding/storms
Seawalls and jetties
Sand management
Property damage
Recreation

Glacial Retreat and Land Uplift



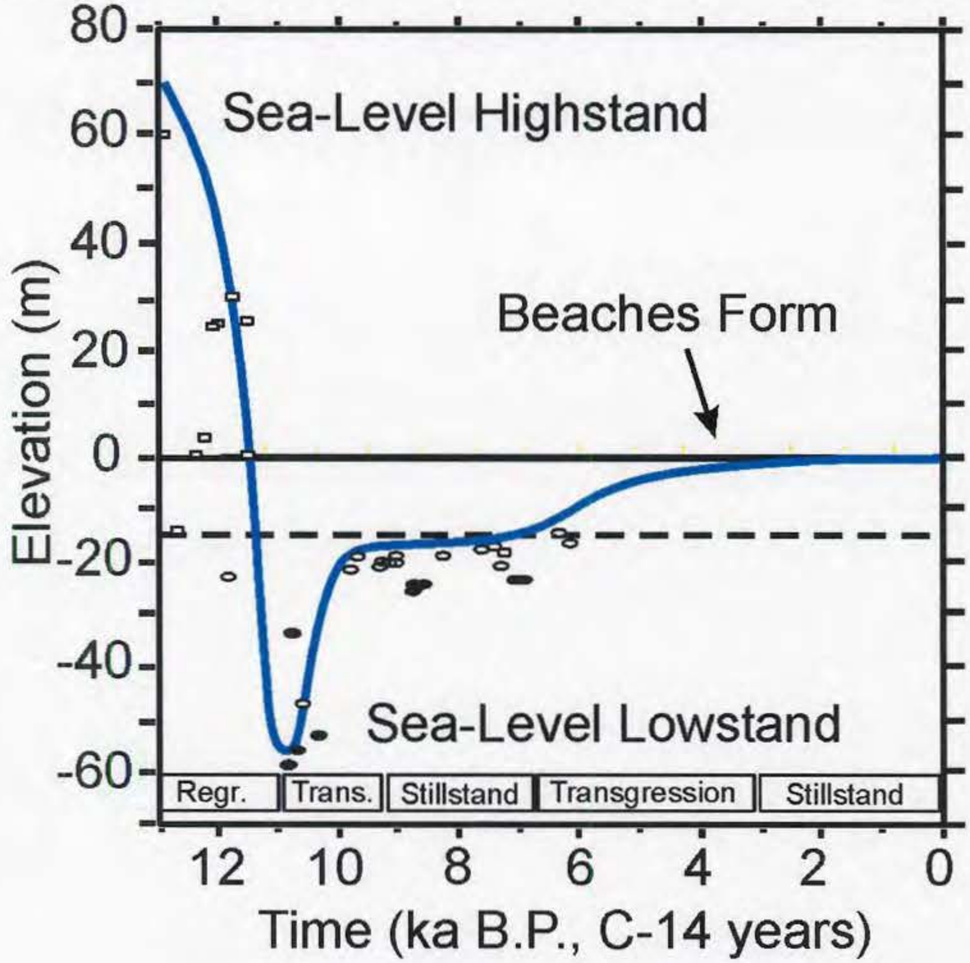


About 13,000 years ago a continental glacier melted and produced gravelly marine deltas and shelly marine mud offshore (left). Ice melt unloaded the earth and the land rose until about 12,000 years ago and resulted river deltas and beaches offshore (right). These offshore deposits are now over 100 feet below sea level. MGS graphic from Thompson and Borns (1985).

Pineo Ridge Delta, Columbia

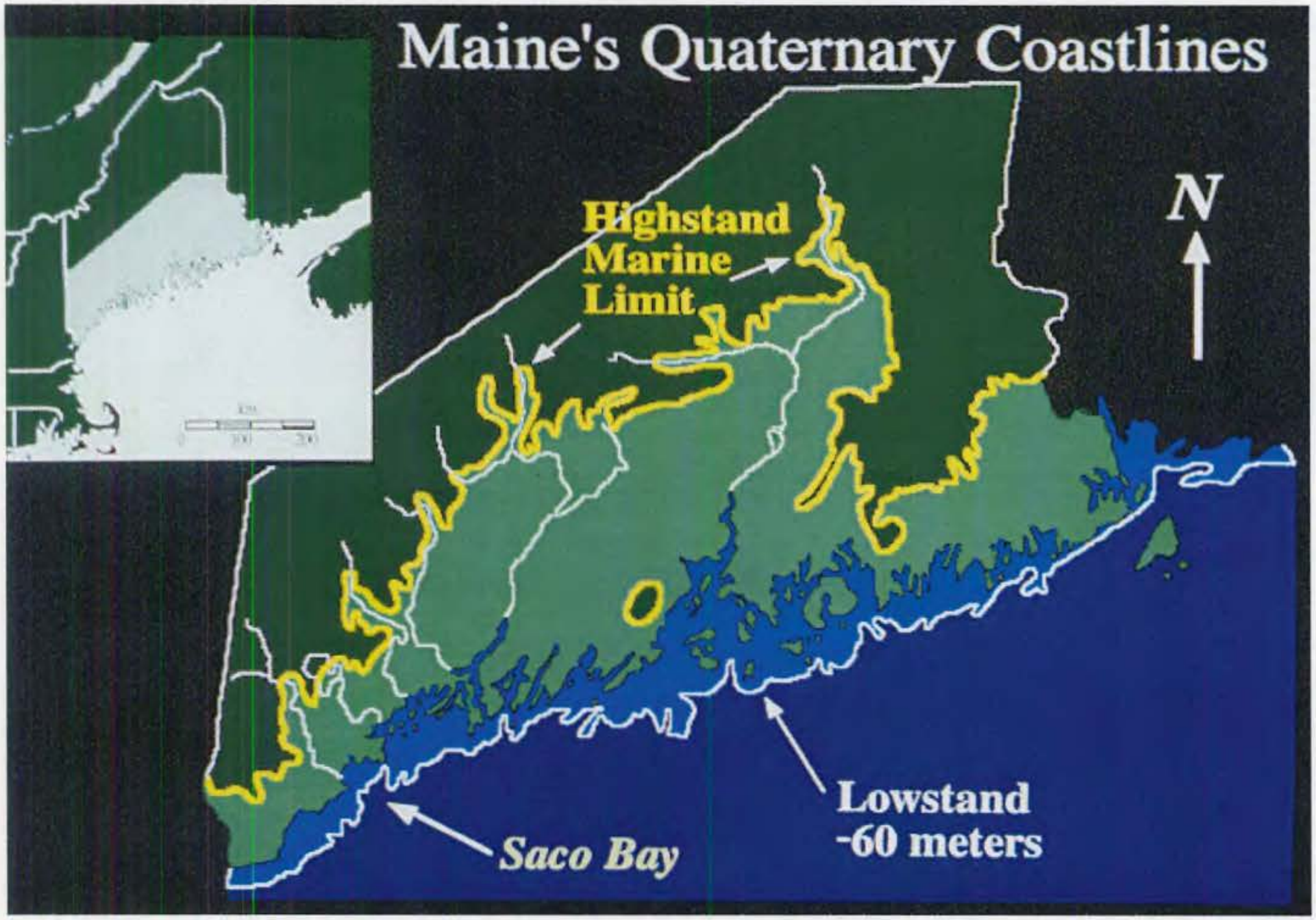
Aerial view of a sand and gravel delta in Washington County. The delta formed in the the ocean at a high stand of sea level as glaciers left Maine. MGS File Photo.

13,000 Years of Sea-Level



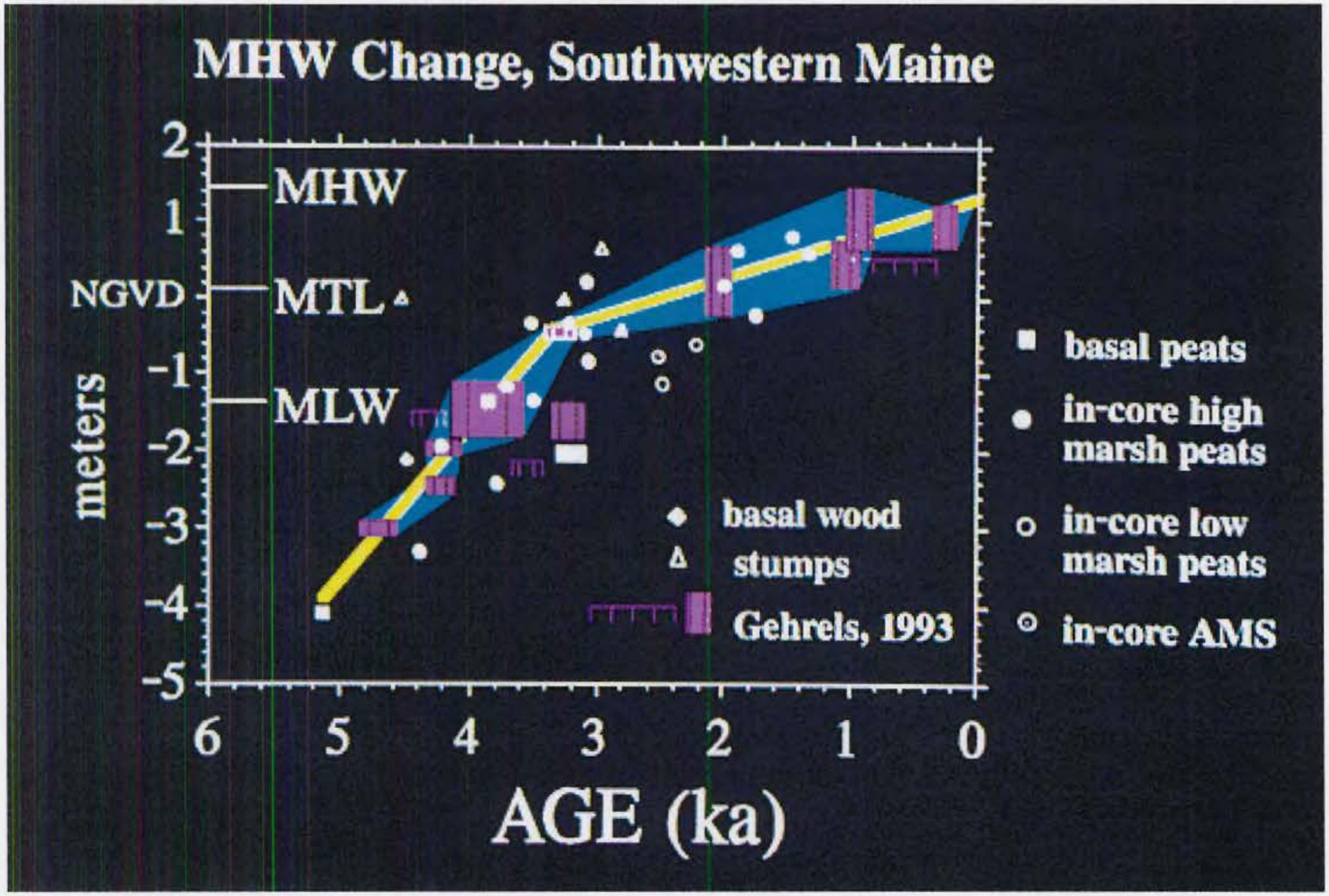
The curve shows the fall and rise in the ocean over the last 13,000 years. In the last 3,000 years sea level has been relatively stable (a stillstand). From Dickson (1999) and based on Barnhardt (1994) and Belknap et al., (1987).

Ocean Shorelines in Maine



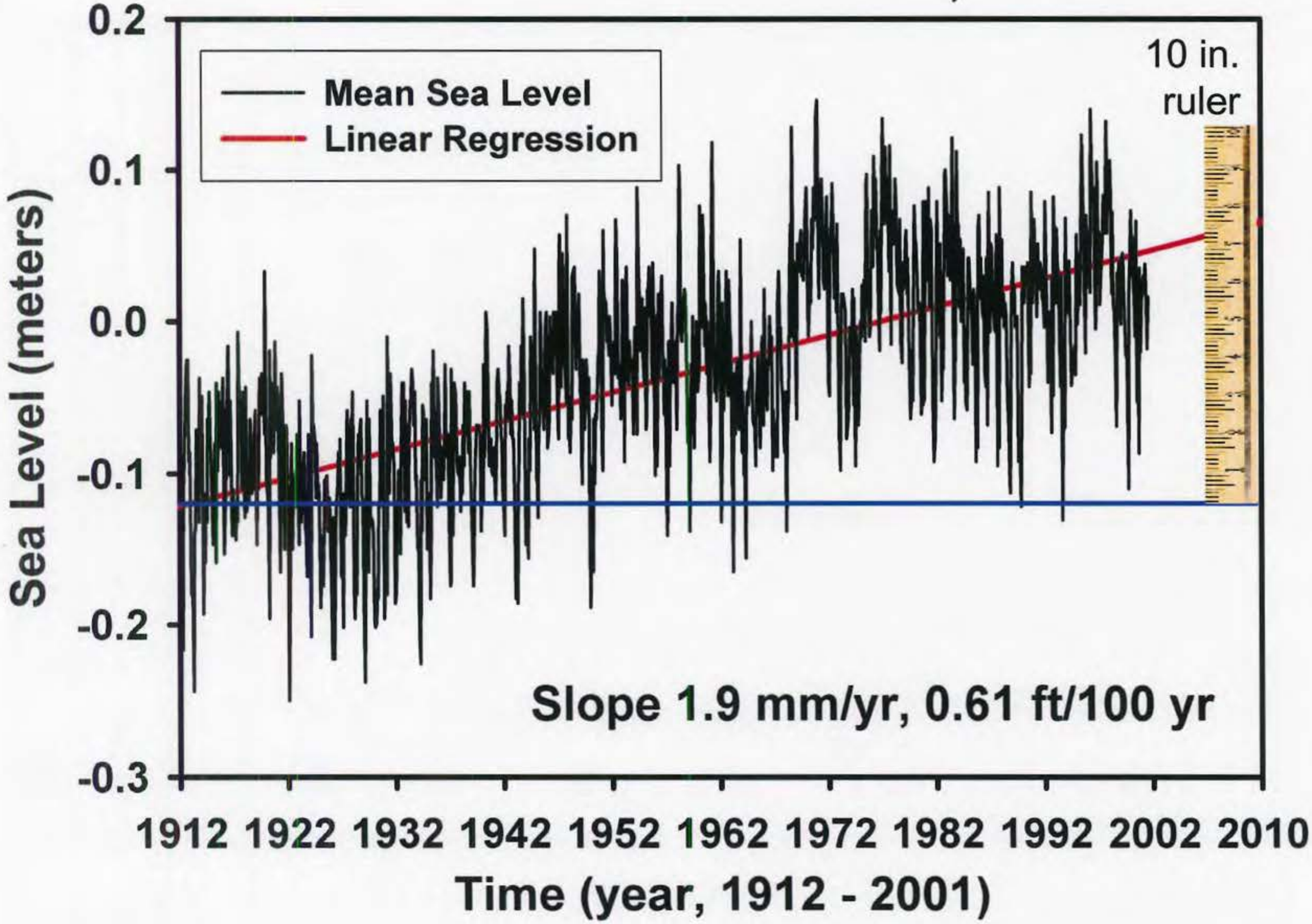
Map showing the inland-most shoreline about 14,000 years ago, based on marine deltas and shelly marine sediment. The offshore shoreline position was about 11,000 years ago and defined by sediments in cores, radiocarbon age dates, and geophysical surveys of submerged strata. MGS/UMaine graphic based on Barnhardt (1994).

5,000 Years of Sea-Level Rise



Sea level over the last 5,000 years measured from submerged peat, tree stumps, and salt marsh deposits. The curve shows the rise in mean high water (MHW). In the last 3,000 years high tide has risen 6 feet (1.8 m) in southern Maine or 0.2 feet/century. Based on Gehrels (1994).

Sea Level at Portland



Summary of Sea Level

13,000 to 11,000 years ago sea level fell 400 feet (20 ft/century).

11,000 years ago sea level was at its lowest, 175 feet below present.

10,000 years ago to present sea level has risen 175 feet.

5,000 years ago sea level was 13 feet below present.

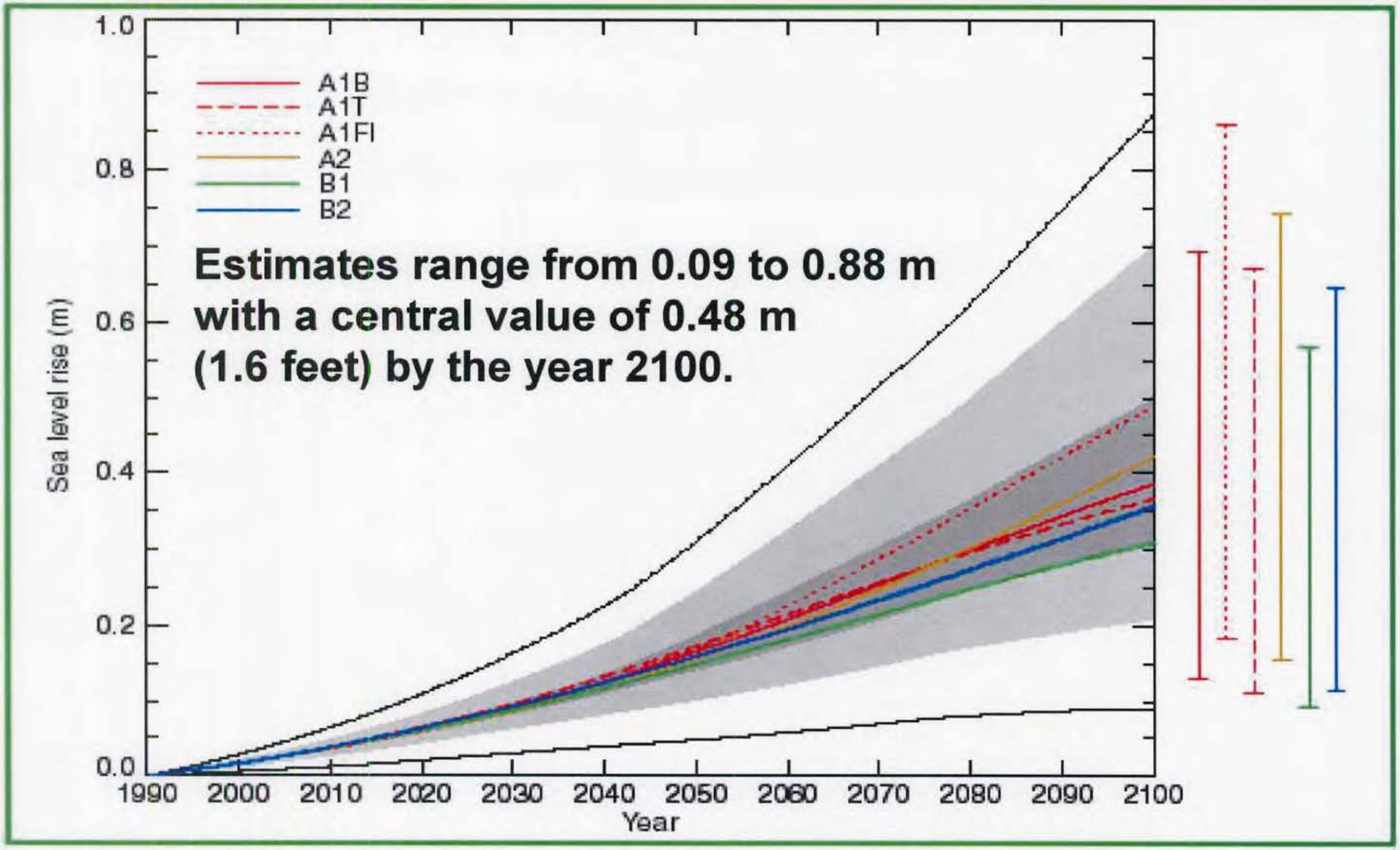
3,000 years ago sea level was 6 feet below present.

3,000 years ago the rate of sea-level rise slowed to 0.2 ft/century.

Since 1912 sea level has risen at a rate of 0.6 ft/century.

The current rate of sea-level rise is the fastest in the last 3000 years.

IPCC Sea Level Forecast

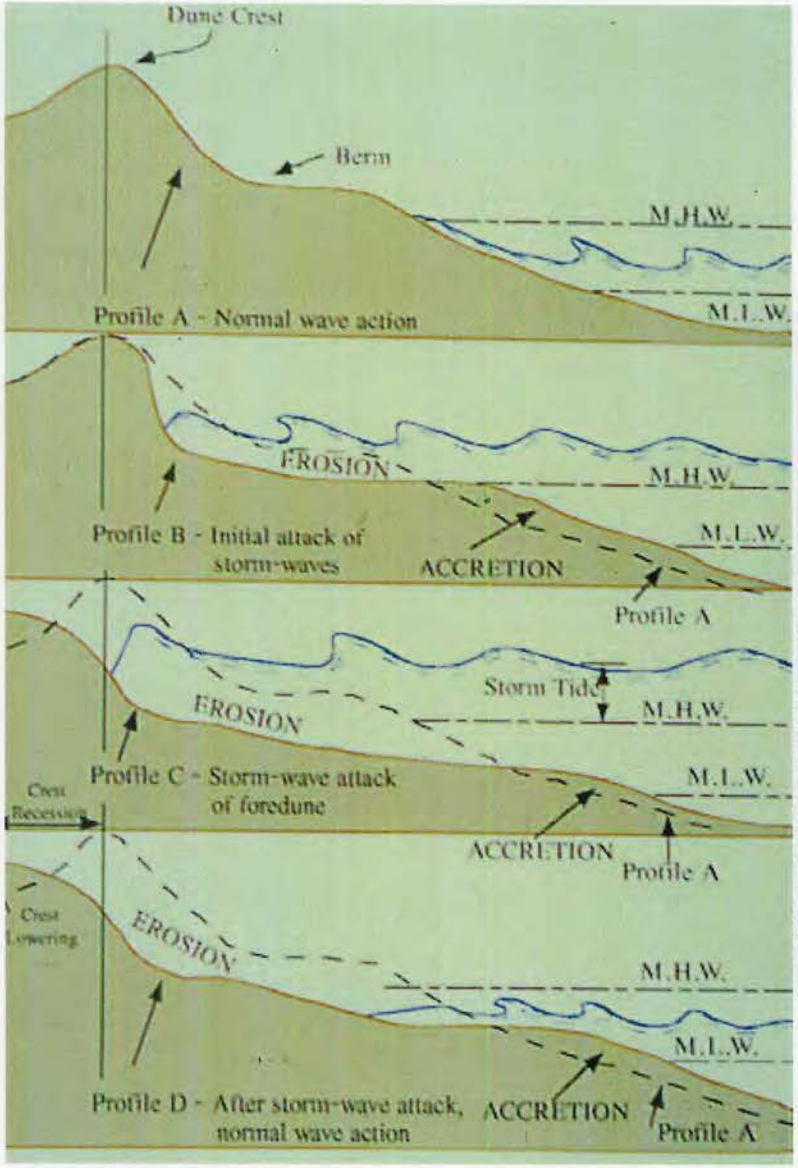


Source: IPCC Technical Summary of Working Group I Report, Fig. 24, p. 74.

Maine's Coastal Sand Dune System

Coastal sand dunes are variable in size along the coast. The frontal dune is generally 125 to 150 feet in width (shore perpendicular) while back dune width varies. MGS has mapped about 2000 acres of large dune systems along about 30 miles of the Maine coast. About 1/3 of the dune acreage is frontal dune; 2/3 is back dunes. MGS File Photo of Seawall Beach by S. M. Dickson, 2002.

Frontal Dune Processes



US Army Corps of Engineers (1984)

Frontal dune ridge in Cape Elizabeth. About half of the ridge was eroded and subsequently rebuilt with American beach grass and sand. MGS File Photo by S. M. Dickson, 1986.

Dune Scarp Formation

December 1992 Northeaster, Seawall Beach, Phippsburg

A 4-day northeaster in December 1992 resulted in a coastal storm surge (left) of less than 2 feet produced an erosional cut in the dunes. Northeasters commonly produce frontal dune erosion and scarp formation (right). Dune scarps from major storms can take years to return to the pre-storm condition. MGS File Photo by S. M. Dickson, 12/13/1992 (left) and 1/24/1992 (right)

Frontal Dune Overwash

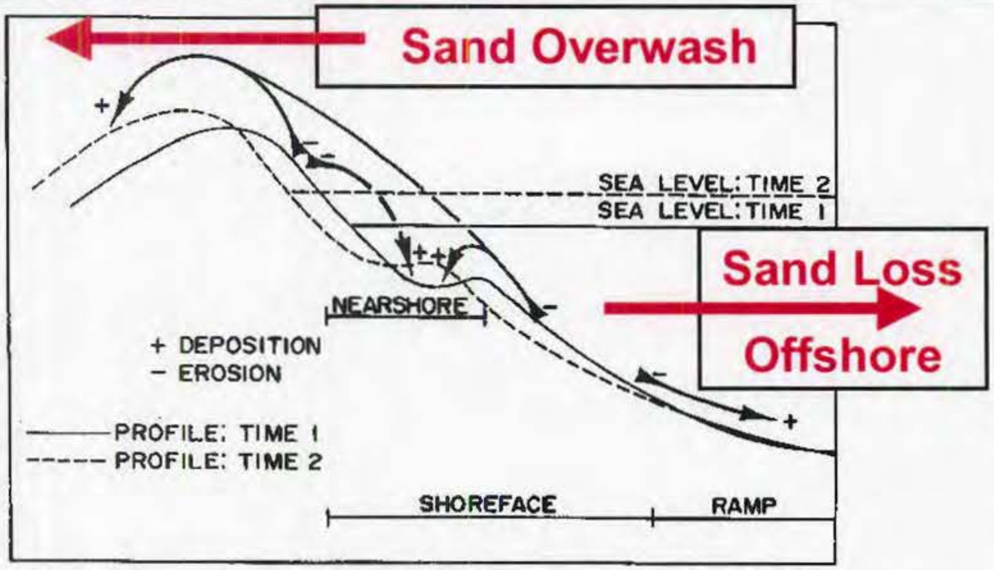
October 1991 "Perfect Storm," Saco Bay Beaches

The fontal dune ridge is built primarily from wave action. In storms, waves deposit sand on the crest of the dune ridge. Most frontal dune ridges are built by the process of overwash to the elevation of active wave run-up and sand transport in a 100-year storm. Lesser storms add sand to low dune areas where wind and foot traffic have lowered the ground elevation. American beach grass grows through the new sand and helps hold it in place. MGS File Photos of Pine Point in Scarborough (left) and Ferry Beach State Park, Saco (right) by S. M. Dickson, 1991.

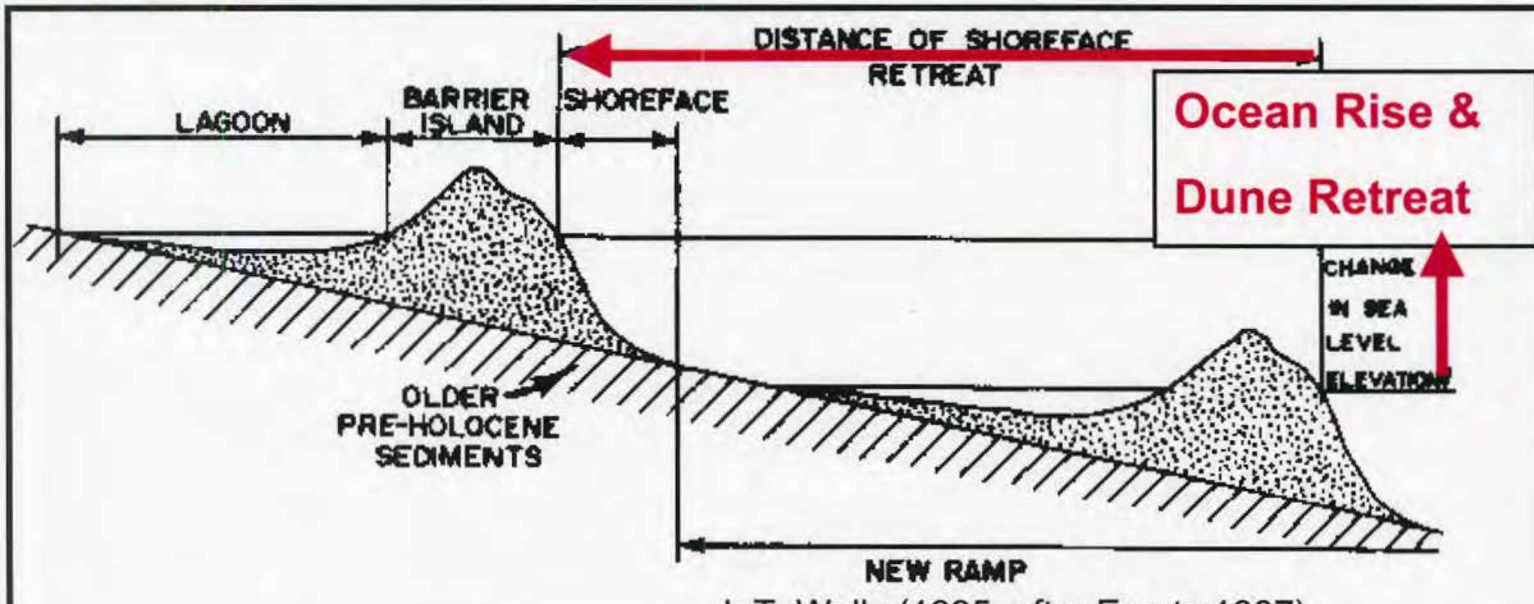
Back Dune, Saco

The back dune environment has low-relief dunes with patchy vegetation and wind-blown sand. Some back dunes have a pitch pine forest. About one-third of the back dunes are in the 100-year floodplain. MGS File Photo by S. M. Dickson, 2002.

Barrier Beach Migration with Rising Sea Level



J. T. Wells (1995, after Dubois,1992).

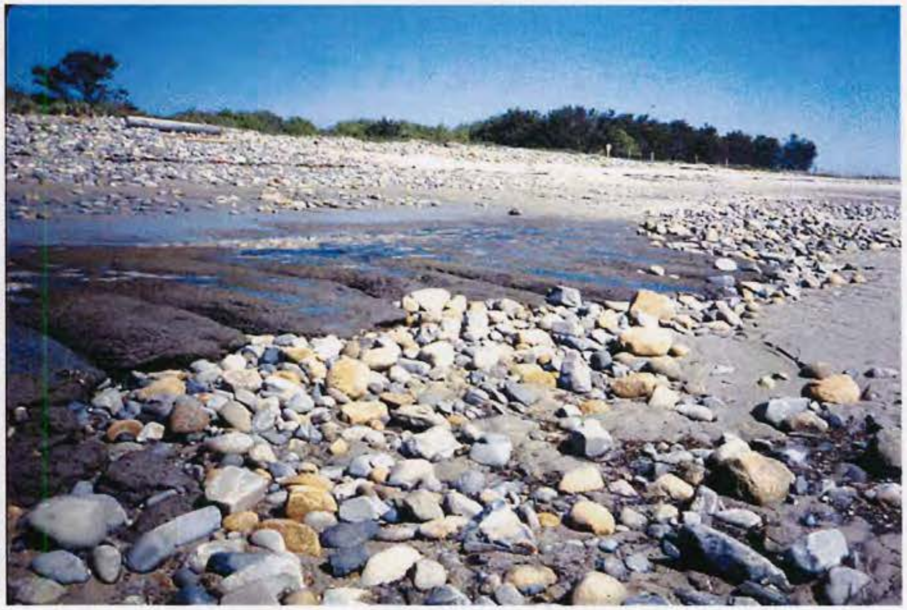


J. T. Wells (1995, after Everts,1987).

Signs of Dune Migration

Drowned Forest, Kennebunk

Drowned Salt Marsh, Wells



Tree stumps (in situ) on a beach in Kennebunk were drowned by the rising sea (left). Salt marsh peat from the back barrier marsh is exposed on Laudholm Beach in Wells (right). In both locations, the barrier beach and dunes have migrated inland over forest and marsh environments due to sea-level rise of about 6 feet in the last 3,000 years. MGS File Photos by S. M. Dickson.

February 8, 1978 Storm

A special pullout section

The Boston Globe

Four full pages of storm pictures

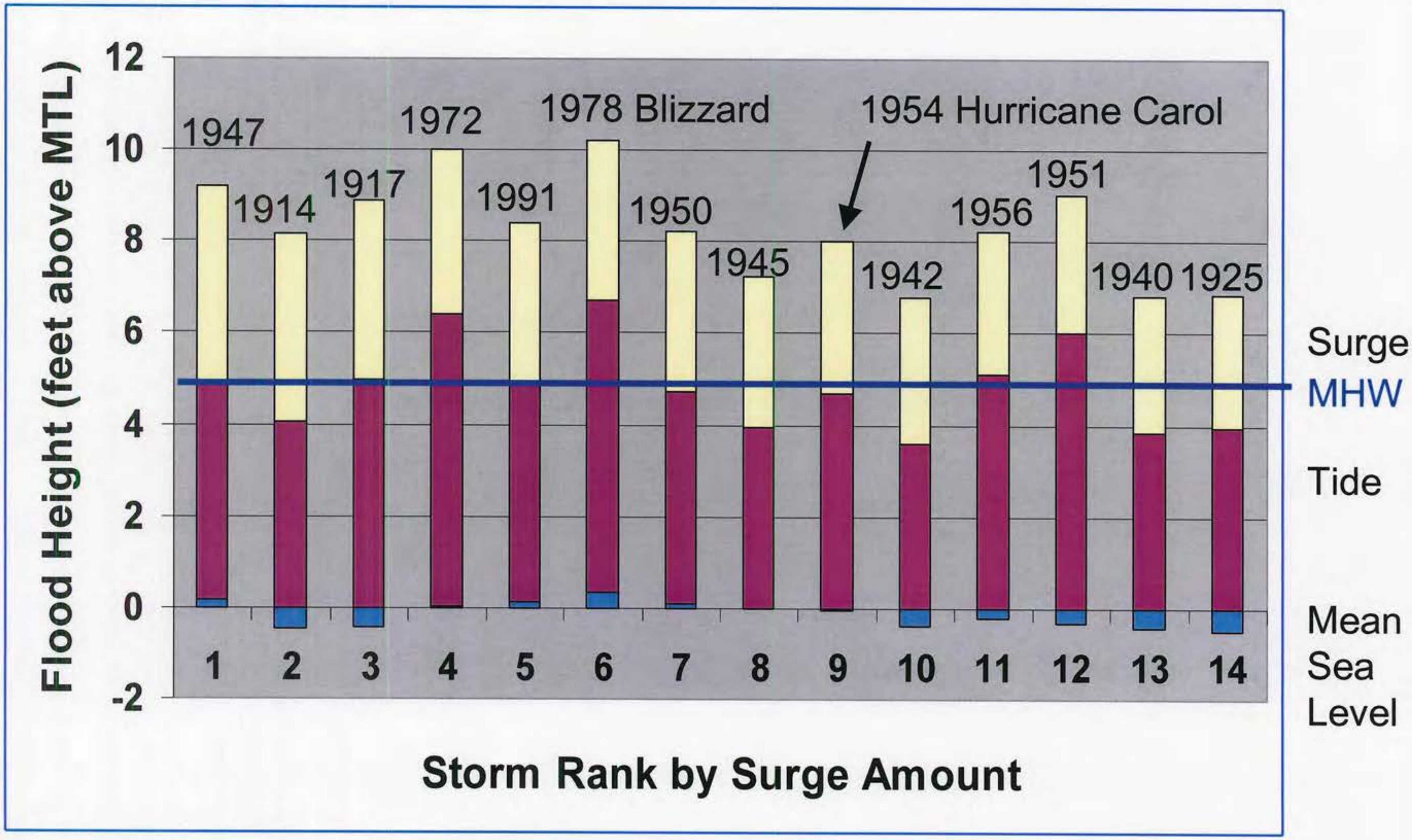
STORM ONE

'Awesome'

GOV. MICHAEL S. DUKAKIS, returning from helicopter survey

Peggotty Beach, Scituate. Globe photo by Dan Sheehan, v. 213, n. 40, 2/9/78.

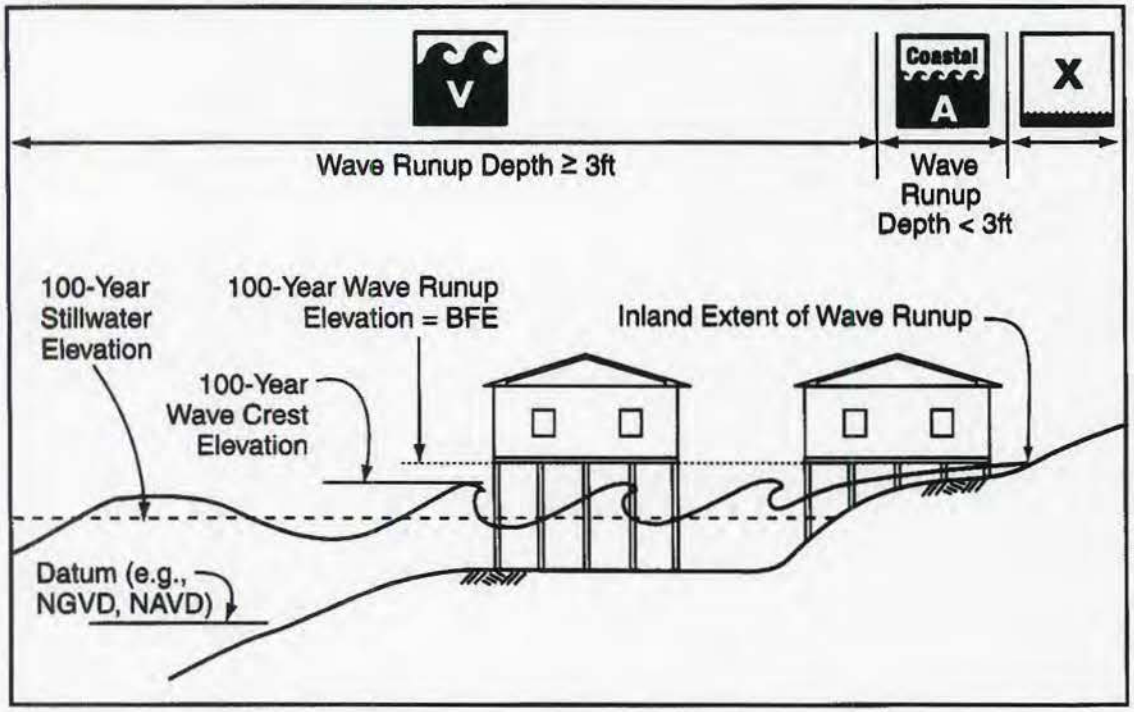
Coastal Storm Flooding



Flood Zones and Waves

Figure 3-9

Where wave runup elevations exceed wave crest elevations, the BFE is equal to the runup elevation.



DEFINITION

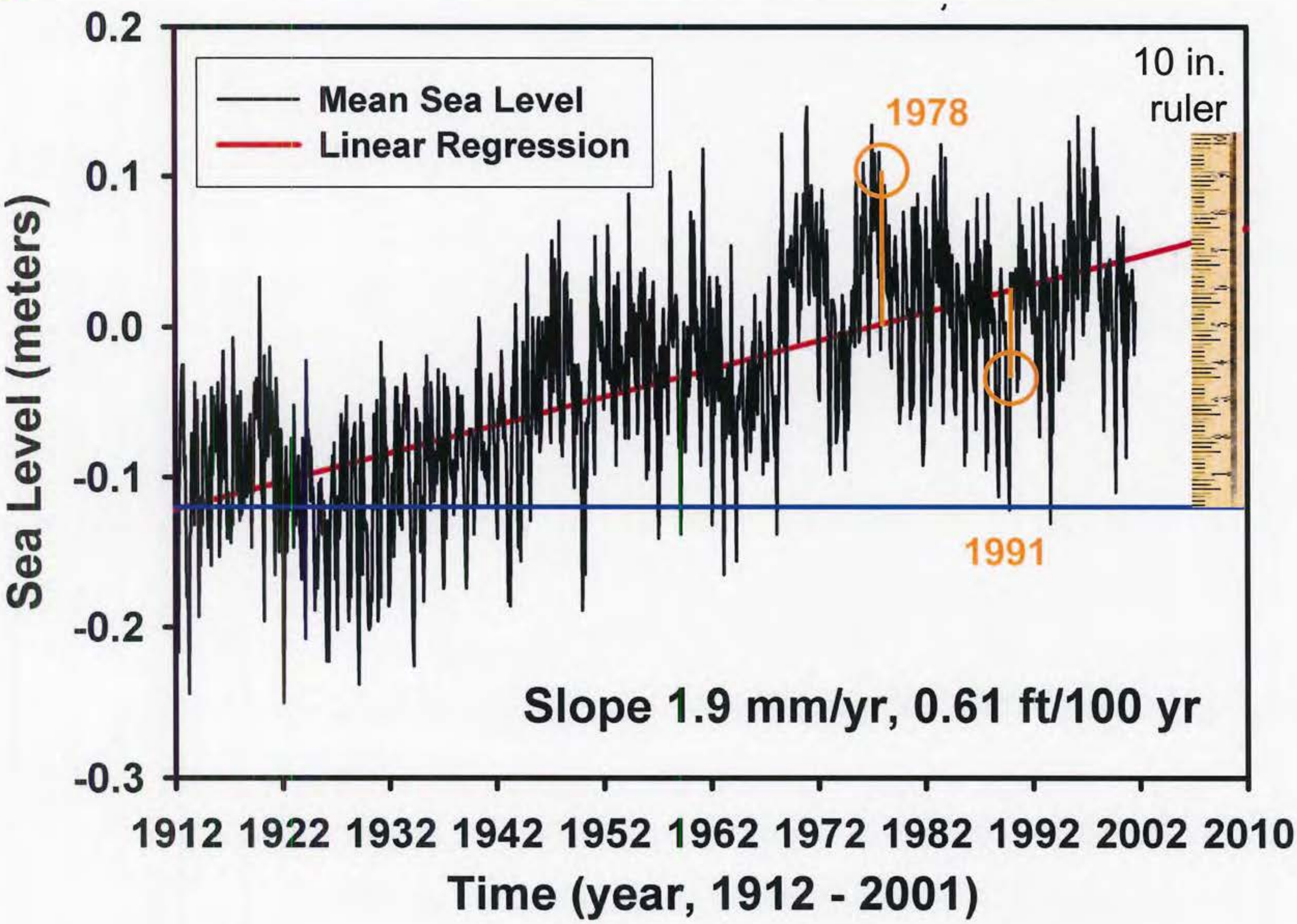
Wave runup elevation is the elevation reached by wave runup, referenced to the National Geodetic Vertical Datum of 1929 (NGVD) or other datum.

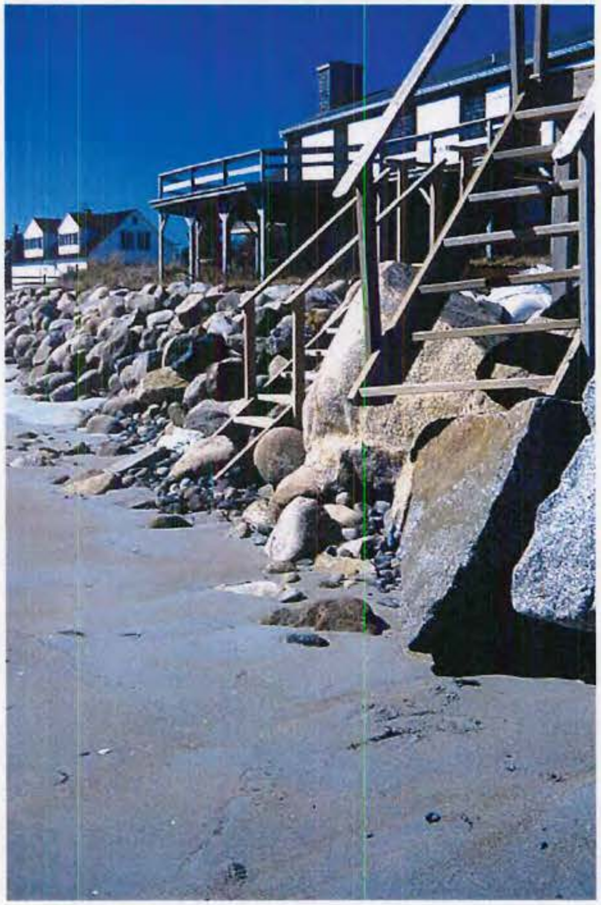
Wave runup depth at any point is equal to the maximum wave runup elevation minus the lowest eroded ground elevation at that point.

Source: FEMA Publication 55, p. 3-11.

Coastal floodplains are dynamic and change with erosion and sea-level rise. A rise of 1 foot in southern Maine changes the 100-yr floodplain to a 10-yr floodplain. A rise of 6 inches in the sea makes the 100-yr flood a 500-yr flood.

Sea Level at Portland





Seawalls and Wave Reflection

Seawalls result in wave reflection that causes enhanced beach scour in front of the wall. Over time the beach will lower and expose more of the wall. Continued erosion in front of the wall leads to a narrower beach and the need to reinforce or enlarge the wall to increase its resistance to wave action. MGS File Photos (Goose Rocks Beach, Kennebunk, 1990 (left) and Saco, 1986) by S. M. Dickson.

Seawall Damage

Seawall Collapse and Rapid Beach Profile Adjustment

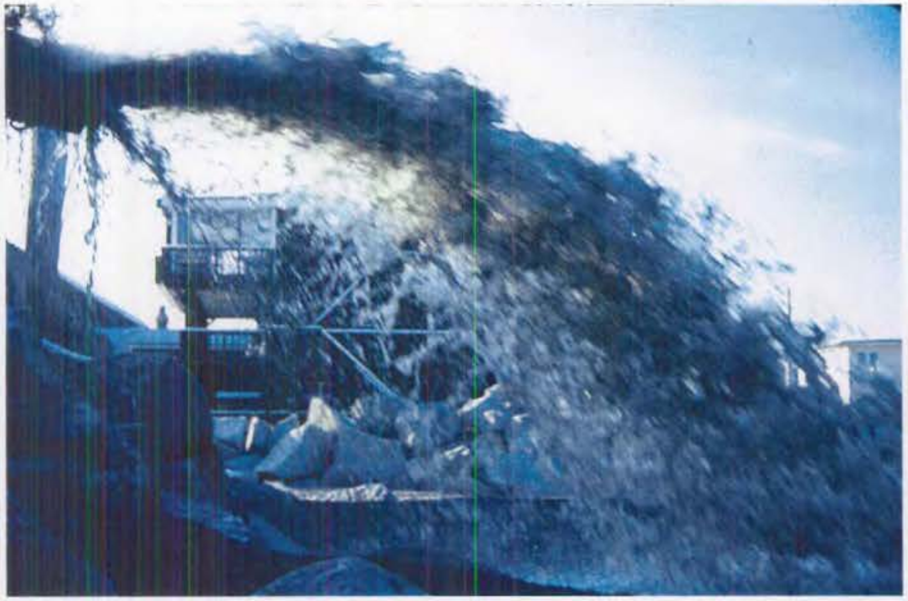
Seawall failure results in rapid release of dune sand and fill from behind the wall. Foundations can be undermined before a storm ends and result in structural damage behind seawalls. MGS File Photos (Wells, 1987 and Saco, 1991) by S. M. Dickson.

North Jetty and Breakwater, Saco

Coastal engineering at tidal inlets alter the natural movement of sand. In Saco, the jetty prevents Saco River sand from reaching the beach and wave reflection causes accelerated beach erosion and longshore drift. There are other federal jetties in Wells, Kennebunk, and Scarborough adjacent to beaches. MGS File Photo by S. M. Dickson, 2002.

Beach Nourishment and Sand Bags

Sand pumped onto the beach and placed in bags on the beach



Beach nourishment places additional sand on the beach profile to reduce the sand deficit. Sand bags were placed on the beach to attempt to slow the erosion rate in Saco. MGS File Photos by S. M. Dickson, 1992 left and J. T. Kelley, 1992, right.

Sand Movement

Overwash sand replaced on the beach by Saco Public Works

Storms repeatedly wash sand from the beach into the dune (road) at the intersection of North and Main Streets in Saco. The City of Saco regularly returns the sand to the beach. MGS File Photos by S. M. Dickson, 1990 left and P. A. Slovinsky, 2002, right.

Fortification of Seawalls

Seawall reinforcement and expansion

Sheet pile for reinforcement of seawalls along Beach Avenue in Kennebunk.
Riprap in Saco slumps on the beach over the upper part of the beach profile.
MGS File Photos by S. M. Dickson, 1999, left and 2002, right.

Old Orchard Beach

Development located landward of a natural frontal dune ridge

Ideal dune development is in the back dunes behind a wide frontal dune ridge.
MGS File Photo by S. M. Dickson, 1986.

Laudholm Beach, Wells

Development located landward of a natural frontal dune ridge

Back dune development behind a wide frontal dune ridge and elevated on posts in Wells. MGS File Photo by S. M. Dickson, 1986.

Popham Beach Property Damage

Erosion undermines homes at Hunnewell Beach, Phippsburg

1976 beach erosion at Hunnewell Beach, Phippsubrg

J. T. Kelley, 1976

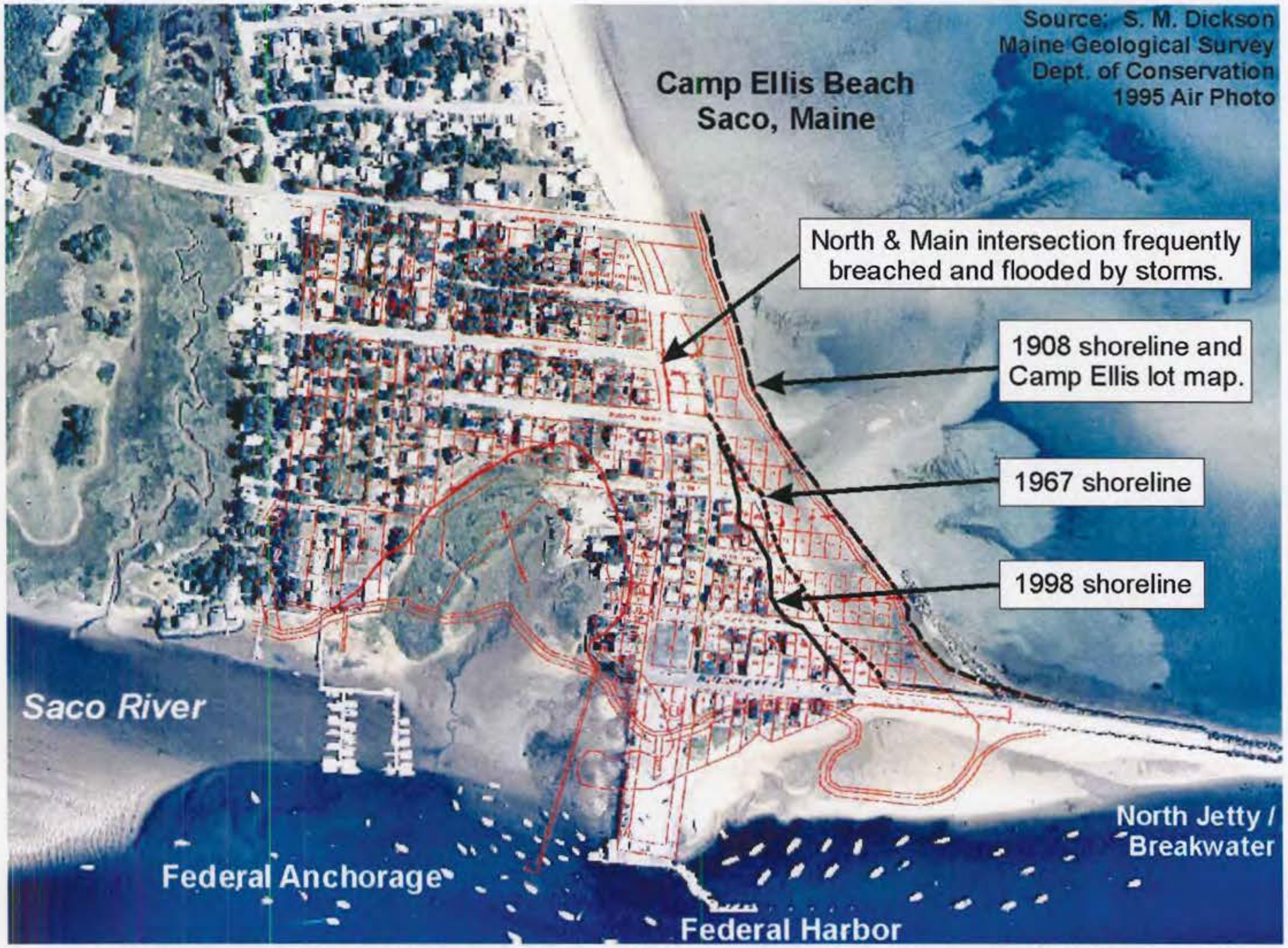
L. K. Fink, 1976

Popham Beach, Phippsburg

Undermined and threatened by erosion, 2 homes retreat and elevate

A damaged home at Hunnewell Beach in Phippsburg (left) and the neighboring home were moved landward and raised on posts after erosion in 1983. MGS File Photos by J. T. Kelley, left, 1983 and by S. M. Dickson, right, 1989.

Camp Ellis Property Loss



Over 30 properties have been lost in less than 100 years. Historical lot map modified from Appendix E of the Saco Bay Regional Beach Management Plan, 2000. Shorelines mapped in 1998 by the Saco Bay Beach Erosion Committee.

Camp Ellis, Saco

Erosion undermines a home at Camp Ellis Beach prior to collapse

Despite the threat of imminent collapse and a long-term erosion rate of 2 to 3 feet per year, this Saco property was enlarged prior to being destroyed in 1991. MGS File Photos by S. M. Dickson, left 1986 and right, 1990.

Camp Ellis Property Damage

Erosion undermines homes at Camp Ellis Beach in Saco

Surf and chronic erosion threaten the Camp Ellis neighborhood. The two homes in the left photo were destroyed by different storms. The house on the left was behind a seawall; the one on the right was not. MGS File Photos by S. M. Dickson, left 1986 and right 1990.

Beach Erosion and Recreation

Continued beach erosion reduces the recreational beach width when dunes are fixed in place beneath frontal dune homes and do not migrate inland. Erosion in Wells (above) has limited the optimal time for recreation to about half of the tidal cycle. MGS File Photo by S. M. Dickson, 1990.