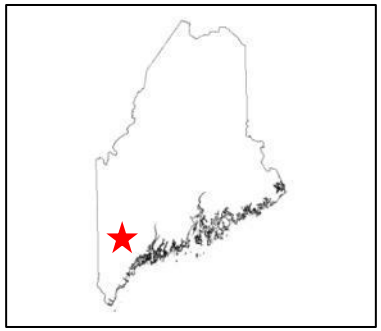
Maine Geologic Facts and Localities

August, 1997

Summary of Sebago Lake Shoreline Change Studies, 1990-1997



43° 54‘ 42.86“ N, 70° 34‘ 32.16“ W

Text by
Robert A. Johnston, MGS
And
Martha N. Mixon, F.M. Beck, Inc.

Introduction

Shoreline changes at Sebago Lake from 1990 to spring 1997 are discussed in this new report prepared for the Portland Water District (PWD). A previous study (Dickson and Johnston, 1994) reported on beach profiling at the north end of Sebago Lake from 1990 to 1993. The authors of that study documented transient seasonal beach changes and identified processes that caused those changes at 12 sites established at several beaches at the north end of Sebago Lake. Ten of those sites were south-facing and 2 were southwest-facing.

The present study follows 6 of those sites for 3 more years and reports on an additional 12 sites around the perimeter of the lake, with sites facing in all directions. In addition to beach profiling, a shoreline classification and mapping project was completed to determine the types and extents of different shoreline environments around the lake; and a monitoring program for eroding bluffs was initiated.

Background

Sebago Lake, Maine's second largest lake, is located approximately 20 miles (30 km) northwest of Portland (Figure 1). The lake covers a surface area of approximately 47.5 square miles (123 square kilometers) and is 316 feet deep (97 m).

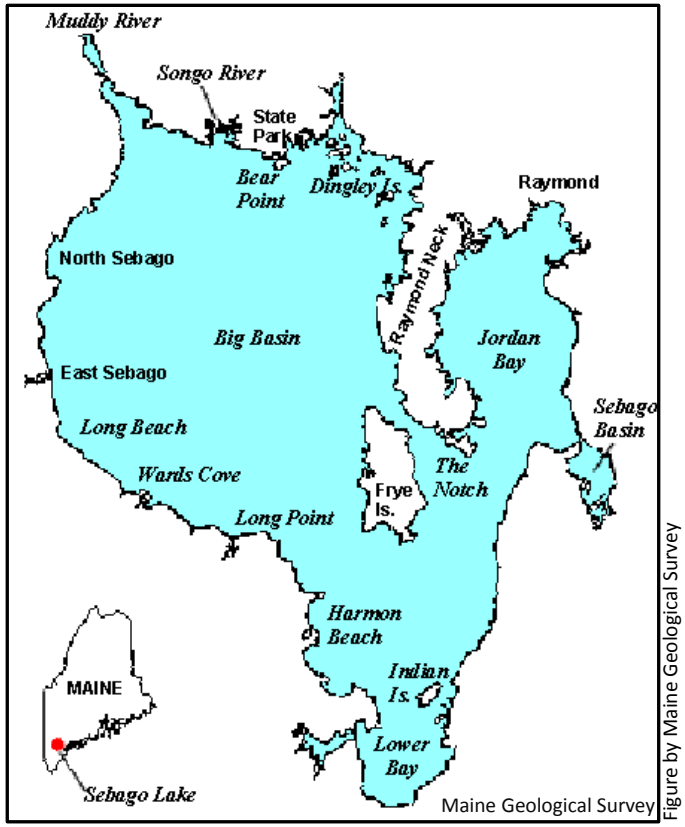


Figure by Maine Geological Survey

Figure 1. Locations around Sebago Lake.

Background

Lake levels at Sebago Lake have been managed artificially since 1830 when the Basin Dam was first built by the Cumberland and Oxford Canal Company (Wheeler, 1994). The dam was originally constructed to provide for better navigation and to divert water to a newly constructed canal. The present full pool elevation is 266.65 feet above mean sea level. At the present time the water levels in the lake are governed by a water level management plan developed by S. D. Warren, the Federal Energy Regulatory Commission (FERC), the PWD, various state agencies and local citizen groups (FERC, 1997b).

Shoreline erosion became a concern at Sebago Lake in the mid 1980's when the S. D. Warren Paper Company, the current owner of the dam, changed its water level management plan. Before 1986 there was no specific water level plan for the lake. In 1986, CMP implemented seasonal electric rates, with winter rates approximately 40 percent higher than summer rates. In 1987, S. D. Warren, began to hold more water in the lake during the fall and winter months in order to generate more of its own power and purchase less from CMP at the higher winter rates (FERC, 1997a). This raising of the water levels brought an increase in the number of complaints on their management of the water levels. At a number of places around the lake, erosion of the sand beaches was reported due to the higher water levels.

Background

The Maine Department of Conservation, Bureau of Parks and Recreation (BPR), became involved in the water level when beach erosion exposed tree roots at Songo Beach in Sebago Lake State Park (Figure 2). The Maine Geological Survey (MGS) was asked by the BPR to look at the erosion problem. Those efforts resulted in the initial study by Dickson and Johnston cited earlier.

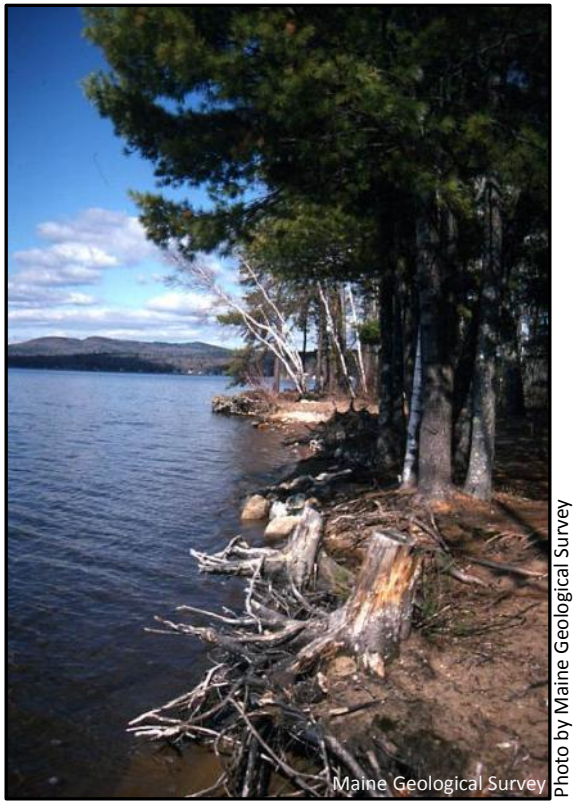


Figure 2. Roots exposed by erosion on Songo Beach, May 13, 1996.

Background

Due to continuing controversy and concerns about shoreline erosion, the MGS and PWD, with assistance from the Friends of Sebago Lake, a local citizens group, initiated additional beach profiling sites covering most of the sand beaches around the lake, bringing the total to 50 sites. The present study is based on a subset of 18 of those sites, including some of the sites from the Dickson and Johnston study.

Since 1991, S. D. Warren has been managing lake levels in accordance with a plan developed by the Maine Department of Environmental Protection (DEP). In 1994, FERC issued an order (FERC, 1994) requiring S. D. Warren to file with the Commission a water level management plan that addressed the competing interests and issues surrounding lake water levels. Draft and Final Environmental Impact Studies were prepared by FERC (FERC, 1996 and 1997a). In April 1997 FERC issued an order amending S. D. Warren's license to operate the Eel Weir Dam to include a water level management plan which substantially reverses the late 1980's and early 1990's practice of maintaining high water levels in the fall.

This shoreline study, therefore, covers a transitional time period in the water level management on Sebago Lake. No similar studies are available to document beach conditions and dynamics prior to the high fall water levels of the late 1980's and early 1990's. Any future studies may document the impact of the new water level management curve on shorelines.

Results: Shoreline Classification

Results of the shoreline classification project are presented on a map at a scale of 1:24,000 (PDF format) which is available as a separate publication (Johnston, 1998). The shoreline classification project found the following types and amounts of surficial materials around the perimeter of the lake: glacial till (a mixture of sand, silt and clay), glacial outwash (sand and gravel), silt, clay, and wetland deposits (silt and decaying plant material). The types and lineal distances of the shoreline environments mapped are:

Shoreline type	Distance (meters)
Marsh	6,622
Sand beach	23,805
Seawall behind beach	7,649
Groins with sand in between	4,285
Bluff behind sand beach	6,833
Sand beach with boulders	3,491
Glacial till (sand, silt, and clay)	92,123
Artificial fill	9,239
Bedrock	6,326
Total meters of shoreline	160,373

Table by Maine Geological Survey

Maine Geological Survey

Table 1. Shoreline types and lineal distances at Sebago Lake.

Results: Shoreline Classification

Glacial till is the dominant shoreline environment mapped, followed by sand beaches. Shorelines modified by human action (including seawall behind beach, groins with sand in between, and artificial fill) total 21,173 meters, or approximately 12.5 percent of the Sebago shoreline.

A shoreline stability and classification study of the Songo River from the Songo Lock to Sebago Lake identified marsh, floodplain, upland, beach, and water as the modern geologic environments of the Songo River. A stability index (actively accreting, stable, moderately stable, moderately eroding or actively eroding) was assigned to each stretch of shoreline and human modifications (artificial fill, retaining wall, rip rap, and stabilization project) were mapped. Most of the river bank is presently classified as stable or moderately stable, with marsh and floodplain dominating the geologic environments. These results are available as a separately published map at a scale of 1:4,000 (Lewis and Johnston, 1998).

Results: Beach Erosion Study

The bluff erosion monitoring program was established in the summer of 1996, on six eroding bluffs (Smith, 1997). Data was collected through spring of 1997. Limited conclusions can be drawn from this study because of its short duration, but minor erosion was documented over this short time period. Beaches were stable over the study period, showing seasonal sand oscillations as documented by Dickson and Johnston (1994), until the Songo, Frye Island, and Halls beaches and the Barton Residence at Harmons Beach experienced catastrophic changes in the fall of 1996 (Figure 3). The Songo and Frye Island Beaches face south; Hall Beach faces southwest; and the Barton Residence faces east. These changes resulted from a rare combination of weather events and not from a lake-level management plan.

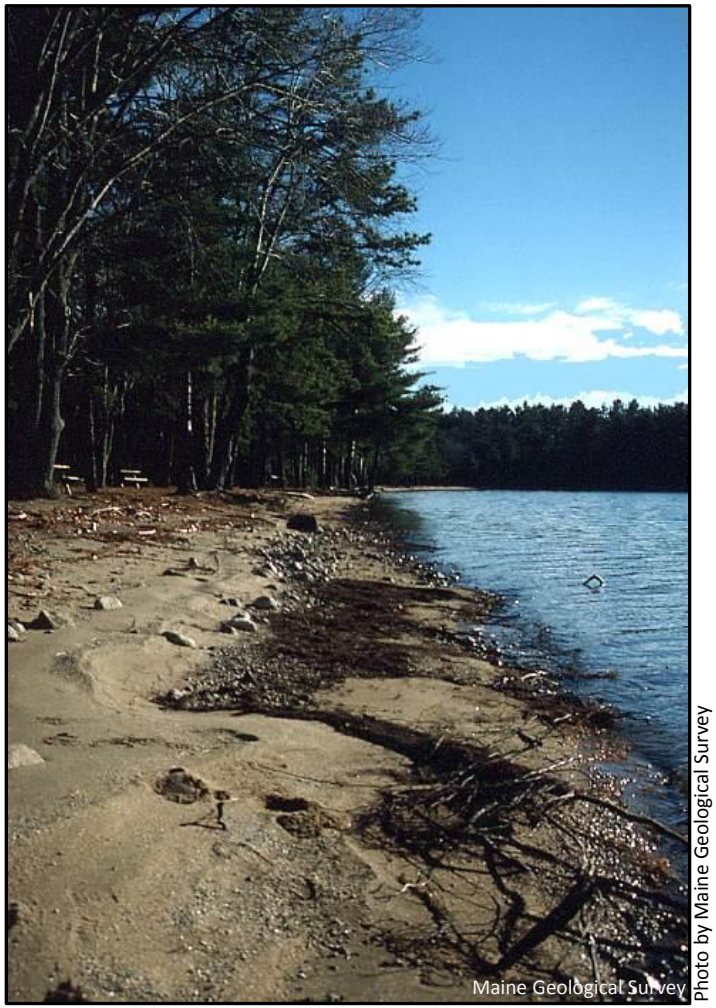


Figure 3. Erosion at Songo Beach, November 22, 1996.

Results: Beach Erosion Study

The Songo and Frye Island Beaches face south; Hall Beach faces southwest; and the Barton Residence faces east. These changes resulted from a rare combination of weather events and not from a lake-level management plan. On October 20-22, 1996 a major rain storm occurred in southern Maine, with rain in excess of 8 inches in the Sebago Lake basin over a period of about 12 hours (FEMA, 1996). This record-breaking storm resulted from a blocked "Northeaster" over the southern Maine region which was being fed tropical moisture from hurricane Lili, located 900 miles southeast of Portland. A strong high pressure system over Labrador kept the low pressure system from moving. As a result of this storm the Sebago Lake level rose 2 feet in just a few days. The overall rise in lake level during the following week was approximately 3.6 feet.

While lake levels were at or near this full pond level, a low pressure system tracking up the St. Lawrence River valley brought strong southerly winds to the lake on November 8th and 9th (NOAA, 1996). The combination of strong winds and high lake level allowed waves to reach and erode the upper beach areas, exposing tree roots and toppling trees along the shoreline at the Songo and Frye Island sites.

Halls Beach was affected more by the heavy rains than by the strong winds in November. Large gullies, approximately 4 feet deep, and as wide, developed across the beach in two locations, eroding the beach and forming deltas out into the lake.

The Barton Residence at Harmon's Beach is located near the north end of Harmon's beach. This site, although east-facing, suffered severe erosion, apparently a result of wave refraction.

Results: Beach Erosion Study

The steepening of upper portions of profiles that occurred at the Songo Beach sites in the fall of 1996 continued into the spring of 1997, when further erosion occurred at those beaches. Exposure of tree roots at Songo and Frye Island beaches, and loss of the front line of trees along Songo beach, suggest that further changes in the profiles are likely before a new equilibrium profile is reached. Because the erosion occurred so high up on the beaches, it is not likely that sand will be returned to the eroded upper profile. Continued profiling at these sites will show the extent of change that eventually will result from the weather events of October and November 1996.

While not the result of any lake level management plan, these events sharply illustrate the role of high lake levels in shoreline erosion, by providing storm waves access to new ground. Although this event took place in the fall, comparable damage could occur at any time lake levels are high, and on any beach where the combination of wind direction, speed, and fetch allow development of storm waves.

Minor erosion events were also documented during the spring of 1994, and the late spring/early summer of 1995, at times of high water and winds.

Results: Beach Erosion Study

Erosion was also documented during low lake levels. At low lake levels, however, erosion was not observed to result in permanent changes to the beach profiles, even when the volume of material removed from the beach profile was large. Significant erosion occurred in the fall of 1992 and late summer/fall of 1995, at low lake levels with high winds. Among the largest changes documented in the six years of beach profiling was an erosion event at the Songo site 3 between September 1 and October 3, 1995. The sand lost there was restored naturally over the following year. Low lake levels, therefore, do not appear to pose a risk of long-term change to beaches.

While the events of the fall of 1996 caused major erosion that is expected to be long- lasting, this type of change appears to occur relatively infrequently. Most of the beach changes documented were transient accumulations and losses of sand between different areas of the profile, as reported by Dickson and Johnston (1994), resulting in onshore and offshore beach profile shifts with rising and falling water levels; and ice-related accumulations of sand in the early spring, and their subsequent reworking.

Overall, the beach profile data present an emerging picture of beach dynamics in which long term stability is punctuated by sudden large, long-lasting and irreversible changes which result from storms during high water. This study included sites facing all compass directions. The south-facing beaches experienced the most change during the study period, but a longer period of data collection at the other beaches could alter this. The potential for a "Northeaster" during spring high lake levels is high. Such a storm could cause major and long-lasting changes at north to east-facing beaches.

Recommendations

A number of recommendations follow from the results of this study, and from our experience in data collection and analysis (Figure 4).

Figure 4. Beach profiling on Songo Beach, April 6, 1996.

Recommendations

- Continued data collection at selected profile sites around the lake is a high priority. The conclusions drawn in this report are very preliminary since at some sites they are based on only three years of data, sometimes with a single profile in one or more years. At the Songo and Halls beach sites, where data collection has been in progress for six years, only in the fall of the sixth year was a major shoreline-changing event documented. Profiling should be continued to verify or modify some of the conclusions of this study, and to provide a more complete data set for analysis. Beaches representing all compass directions should be included. Future profiling should include many of the existing sites because of the value of the long-term data sets.
- Immediately activate a couple of the abandoned beach profiling sites at Long Beach in Standish to collect baseline data. Currently, there is no data from these sites. Long Beach appears to be at risk of large-scale shoreline changes in the event of a "Northeaster," a common type of storm in the Sebago Lake area. Several sites can be abandoned, especially where there are multiple sites at a beach, but at least two sites per beach should be maintained so that longshore currents and intra-beach variation can be evaluated. It does not appear necessary or cost-effective to continue monitoring all 50 sites.

Recommendations

- Continue periodic surveys of eroding bluffs. A frequency of once per year is adequate, with budget flexibility to increase the frequency following any storm or other events that warrant closer monitoring.
- Data from all sites should be collected and analyzed whenever possible by the same individuals. Familiarity with the sites is crucial to profile interpretation and developing an understanding of beach dynamics at a site.
- All beach profile data should be maintained in a database that is easily accessible to any potential users and members of the public.
- Since high lake levels expose the shoreline to the potential for major storm-generated erosional events, maximum lake levels should be restricted in elevation and duration in seasons when large storms can be expected.
- The elevations of clay lenses with erosion potential around the perimeter of the lake should be surveyed, or determined from boring logs, so that the impact of different water levels can be evaluated. Clay exposed to wave erosion can add nutrients to the lake and impact overall water quality. Elevation data on potential clay erosional sites will assist in overall shoreline protection and planning.

References and Additional Information

Dickson, S. M. and Johnston, R. A., 1994, Sebago Lake State Park Beach Dynamics: A Report on the Results of Beach Profiling: Maine Geological Survey, Open File Report 94-4, 189 p.

Federal Emergency Management Agency, 1996, Interagency Hazard Mitigation Report, Covering the Counties of Cumberland, Oxford and York; FEMA-DR-1143-ME. 12 p.

Federal Energy Regulatory Commission, 1994, Order on Complaints, Eel Weir Project No. 2984, issued August 4, 1994.

Federal Energy Regulatory Commission, 1996, Eel Weir Hydroelectric Project, Draft Environmental Impact Statement; FERC No. 2984-025, Maine. Washington, D. C.

Federal Energy Regulatory Commission, 1997a, Eel Weir Hydroelectric Project, Final Environmental Impact Statement; FERC No. 2984-025, Maine. Washington, D. C.

Federal Energy Regulatory Commission, 1997b, Order Approving Settlement and Amending License, S. D. Warren Company, Project No. 2984-025, issued April 21, 1997 and amended May 6, 1997.

Johnston, R. A., 1998, Shoreline Classification of Sebago Lake: Maine Geological Survey, Open File Map 98-123, scale 1:24,000.

Lewis, E. B., and Johnston, R. A., 1998, Songo River; Slope Stability/Shoreline Classification Map: Maine Geological Survey, Open File Map 98-124, scale 1:4,000.

NOAA, National Climatic Data Center, 1993-1996, Monthly Summaries of Local Climatological Data, Portland International Jetport, Portland, Maine.

Smith, C. L., 1997, Bluff Recession Rates and Processes at Sebago Lake, Maine. Bowdoin College Senior Thesis, Brunswick, Maine.

Wheeler, R., 1994, The Great Basin Dam War. Friends of Sebago Lake, Sebago Lake, Maine. 13 p.

Additional Links

Sebago Lake State Park
Portland Water District