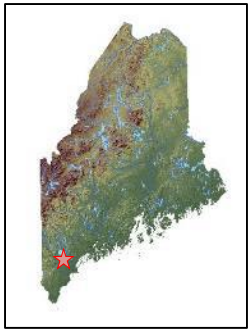
Maine Geologic Facts and Localities

December, 2017

Surficial Geology of the Sebago Lake Land Reserve, Standish, Maine



43° 46’ 20.68” N, 70° 29’ 39.25” W

Text by
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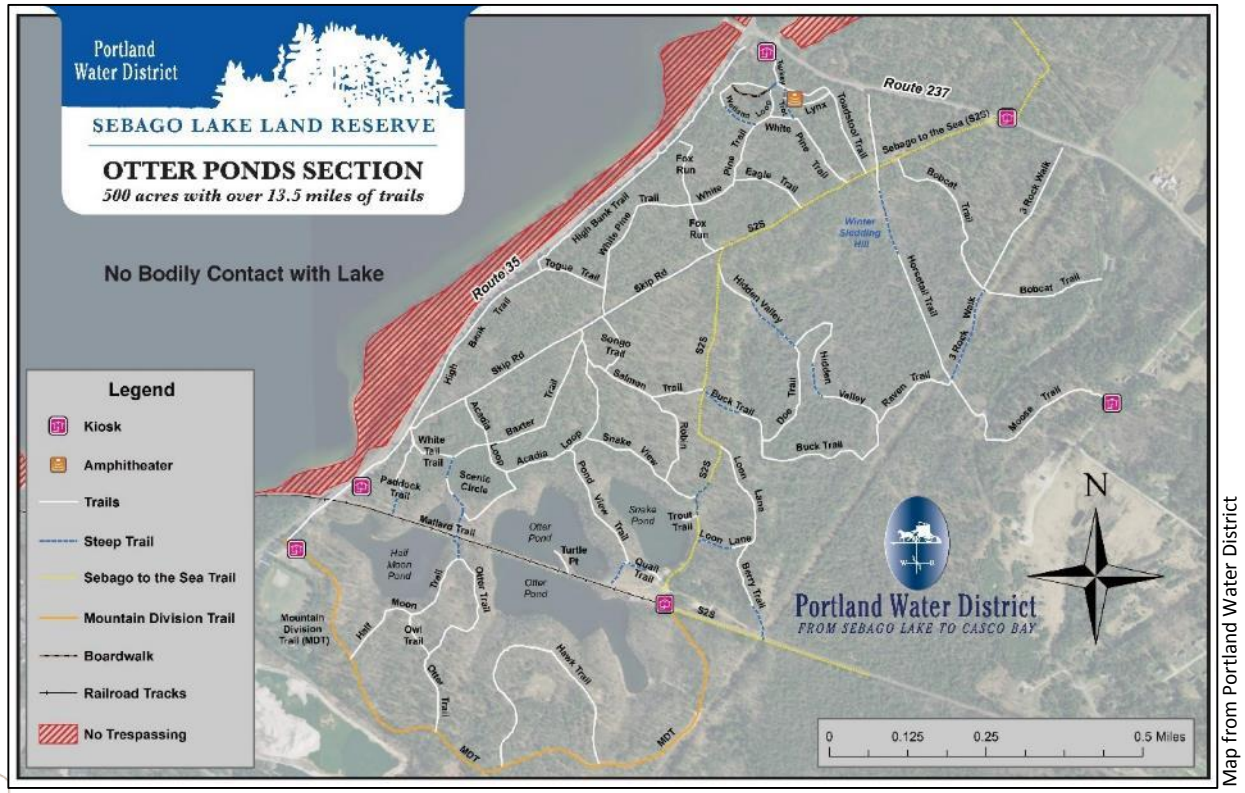
Introduction

The Sebago Lake Land Reserve is a 1,700 acre tract located south of Sebago Lake in Standish, Maine. The property is owned by the Portland Water District, but is open to the public with many well-maintained trails that are perfect for activities such as hiking, biking, horseback riding, snowshoeing, and cross-country skiing (Figure 1). The Sebago to Sea Trail also passes through the property, linking visitors to areas farther south. In addition to the recreational opportunities, there are also some great examples of surficial geology in the Reserve. This publication provides an overview of some surficial geologic features that can be viewed from an easy-moderate loop hike through the Reserve.

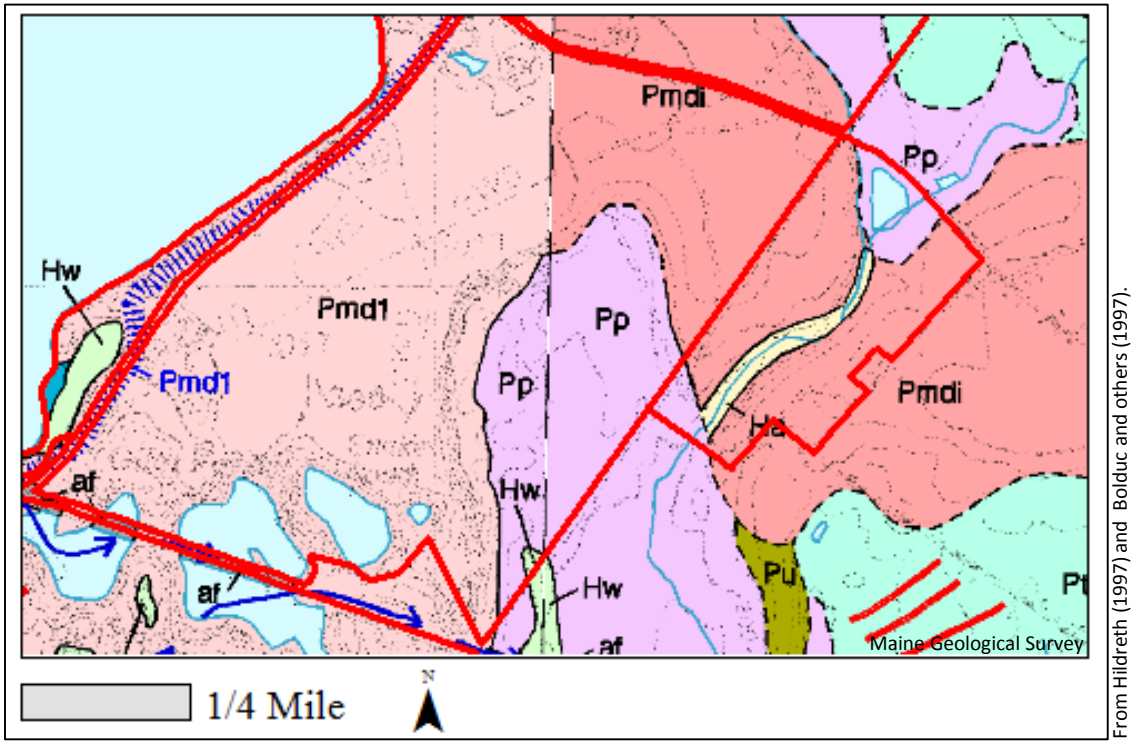


Map from Portland Water District

Figure 1. Map of the Otter Ponds Section of the Sebago Lake Land Reserve in Standish, ME. Copies of this map are available at trailhead kiosks, and can be downloaded from the Reserve website.

Surficial Geology Overview

At the end of the last Ice Age, the Laurentide Ice Sheet retreated across Maine to the northwest leaving extensive sediment deposits that cover much of the state's bedrock. The weight of the massive glacier depressed the earth's crust, allowing the ocean to inundate areas of southern Maine during late-glacial times and adding to the complexity of this region's surficial geology. The two most common surficial deposit units in the Otter Ponds Section of the Sebago Lake Land Reserve are the Presumpscot Formation (Pp) and the Sebago Lake Glaciomarine Delta (Pmd1 or Pmdl) (Figure 2) (Hildreth, 1997; Bolduc and others, 1997). Both units were deposited in a glaciomarine environment, meaning an area where the retreating glacier was in contact with the ocean.



From Hildreth (1997) and Bolduc and others (1997).

Figure 2. Surficial geologic maps of the Otter Ponds Section of the Sebago Lake Land Reserve (Sebago Lake and North Windham quadrangles). Red boxes indicate Reserve boundaries.

Surficial Geology Overview: Presumpscot Formation

The Presumpscot Formation is made up of finer sediments such as silt, clay, and sand that were transported to the ocean by glacial meltwater streams, and deposited in calm waters beyond the edge of the ice sheet (Figure 3). The unit is typically found at lower elevations, such as stream valleys. It may overlie other glacial materials such as till, and underlie coarser meltwater stream or marine deposits. Many Mainers simply refer to the Presumpscot Formation as "blue clay". This deposit can be rock hard or soft, wet, sticky, and slippery. See Weddle (2000) and Thompson (2015) for more photos of and details about the Presumpscot Formation.

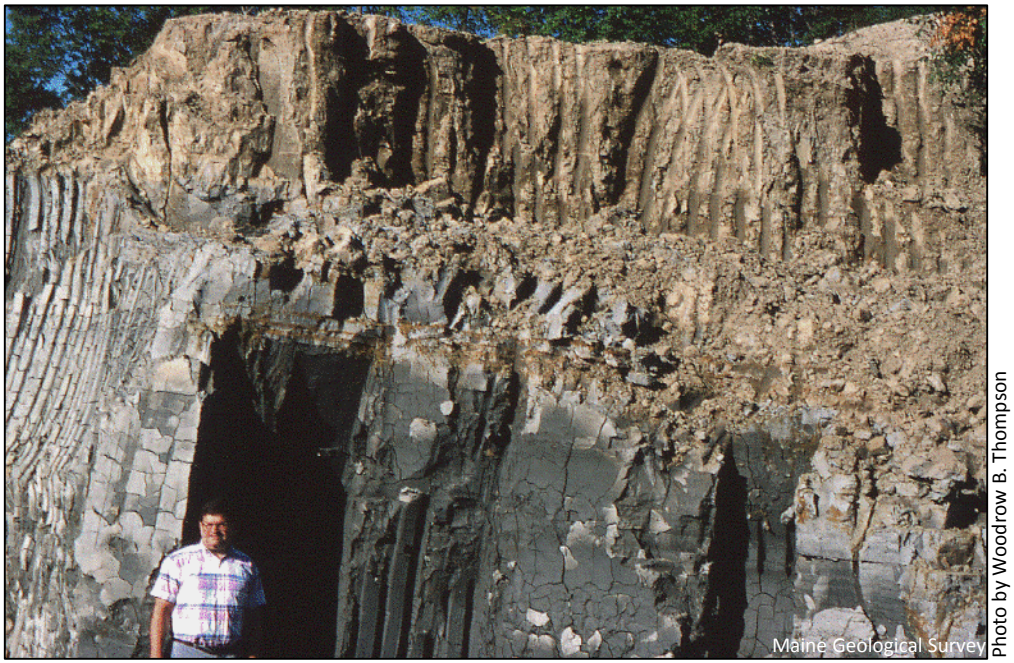


Figure 3. An excavation showing both weathered, hard Presumpscot (top tan layer) and bluish-grey soft Presumpscot (bottom layer).

Surficial Geology Overview: Sebago Lake Glaciomarine Delta

The Sebago Lake Glaciomarine Delta consists of sand and gravel that were transported to the edge of the ice sheet by glacial meltwater streams. If the position of the retreating glacier remained stationary for long enough, sediments being deposited into the ocean at the glacier's edge would form a sub-marine fan. The fan could be built up into a delta over an extended period of glacial stand-still (Figure 4). The flat, sandy area just south of Sebago Lake was identified as a delta because of local gravel pit exposures that revealed the typical gently sloping foreset beds and gravelly topset beds beneath the surface (similar to Figure 5). The delta deposit probably overlies the Presumpscot Formation in much of the area. See Thompson (2003) and Thompson (2015) for more information about Maine's many glaciomarine deltas.

Figure 4. Example of a modern glaciomarine delta from above. Meltwater is moving from top left to bottom right. If we were to dig a pit in this delta, it might look like Figure 3.

Figure 5. Side-view excavation of a glaciomarine delta in central Maine with examples of the typical foreset and topset beds. Water was flowing from left to right in this photo.

Surficial Geology Overview: Kettles

Kettles form when blocks of the retreating glacier break off and become buried in glacial meltwater deposits. The depression that is left after the block of ice melts is known as a kettle – some are dry, while some hold water (Figure 6). The Otter Ponds and other small depressions in the delta surface on the west side of the Reserve are kettles (Figure 7).

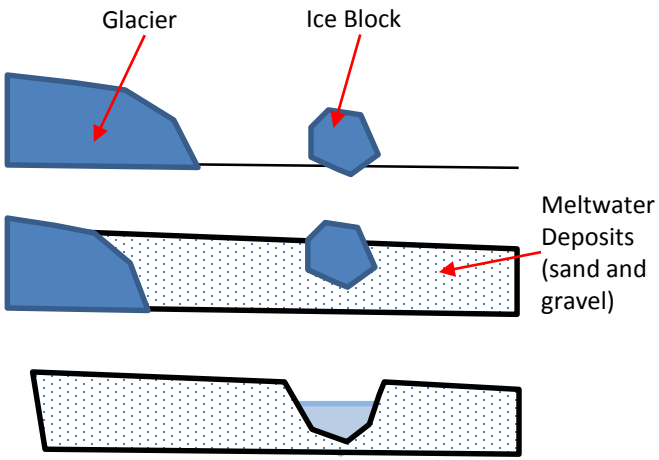


Figure 6. Side view of kettle formation. Top: Glacier retreats to left and ice chunk breaks off. Middle: Ice chunk is buried in meltwater sand and gravel. Bottom: Ice chunk melts and depression forms a kettle lake.

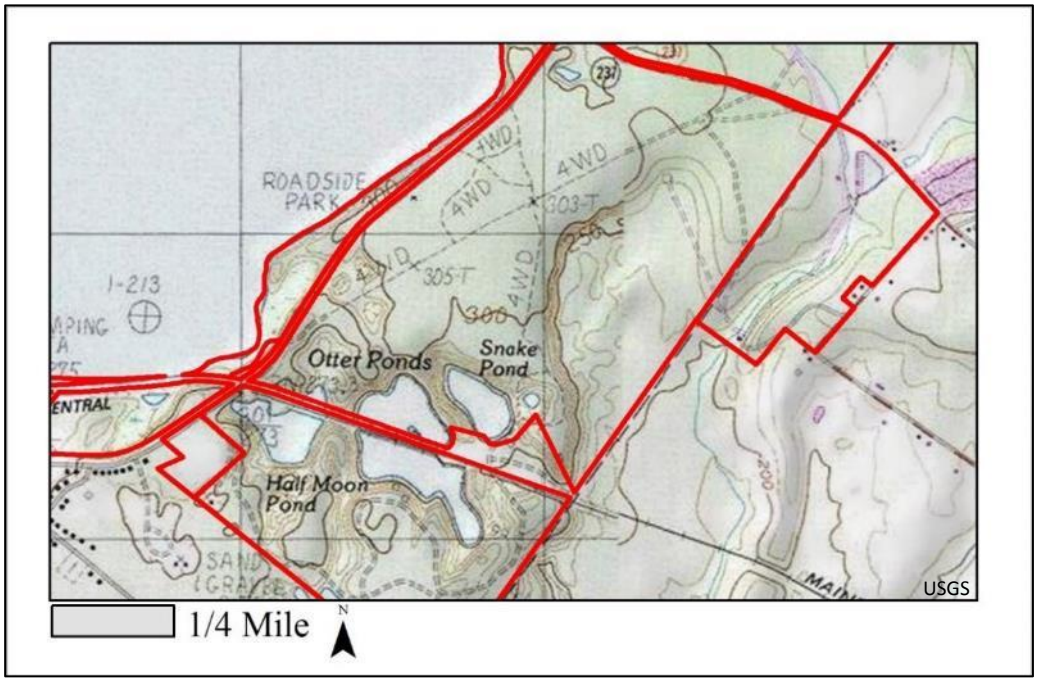


Figure 7. Topographic map showing the kettle ponds (Snake, Otter, and Half Moon) in the Sebago Lake Land Reserve (outlined in red).

Surficial Geology Overview: LiDAR

Since about 2006, the state has been collecting a new type of topographic data called LiDAR. LiDAR stands for Light Detection and Ranging, and it is collected by planes that scan the earth's surface with lasers. The laser beams bounce back to the plane and the signal that is received can be processed to remove trees and buildings, revealing the topography of the bare earth. (See Thompson (2011) for more information about geology and LiDAR.) LiDAR has revealed many interesting things about Maine's surficial geology, one of them being over 100 large landslides in southern Maine. A portion of one of these landslides is located in the Sebago Lake Land Reserve, and can be recognized by its "rumpled" topography (Figure 8).

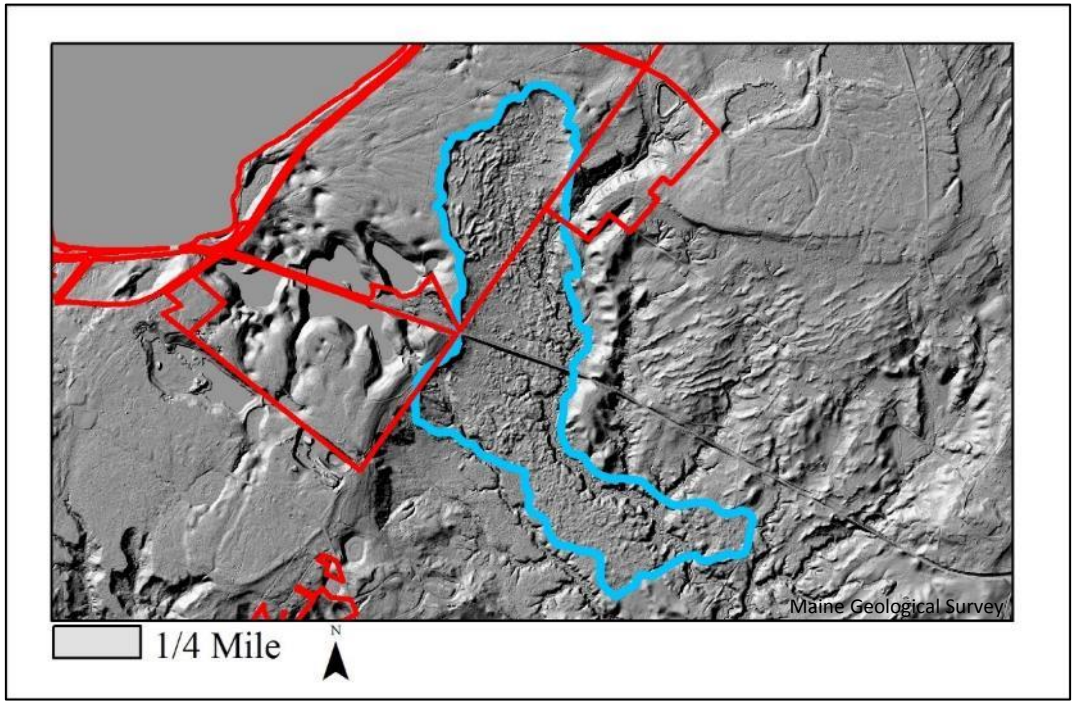


Figure 8. LiDAR imagery reveals a large landslide (approximately outlined in blue). The red lines indicate the Reserve boundaries.

Surficial Geology Overview: Landslides

The geologists that initially mapped the Reserve area (see Figure 2) did not show the landslide. This is very common. Many landslides have subtle, swampy topography that is covered with thick forests, making it easy for them to blend in with the rest of the irregular glaciated landscape. At the time of mapping in the late 1990's, the Reserve trail network did not exist, so it would have been much more difficult to observe the topography than it is now. So when and how did this landslide occur? Large modern landslides are not common in Maine, with the largest known historical occurrence in Westbrook, 1868. It is likely that the large landslides revealed by LiDAR occurred thousands of years ago, but so far, only one of these landslides (in Portland) has been dated to early post-glacial times, about 13,500 years ago (Thompson and others, 2011). Geologists can determine the age of a landslide through radiocarbon dating of vegetation that was buried and killed by the landslide (Figure 9). These landslides occurred prior to recorded historical time so geologists refer to them as "paleolandslides."

Figure 9. Tree that was buried by a paleolandslide in Portland.

Surficial Geology Overview: Landslides

Paleolandslides in southern Maine all have one thing in common: the Presumpscot Formation. The soft clay found at depth can deform and flow when disturbed by events such as: earthquakes; over steepening of a slope, such as a coastal bluff or river cut bank; added weight when soils are saturated by heavy rains or snowmelt. There are many types of landslides, but Maine's paleolandslides are commonly "spread" type landslides (Figure 10). When the soft clay fails and flows, blocks of the overlying materials (known as slide blocks) spread apart and ride along on top of the flowing clay, or sink/slump into the clay. The upslope boundary of the slide is the scarp, and this area is often very noticeable with a steep drop-off. The downslope boundary of the slide is the toe, and this area can be difficult to define as the slides tend to degrade into jumbled flows here.

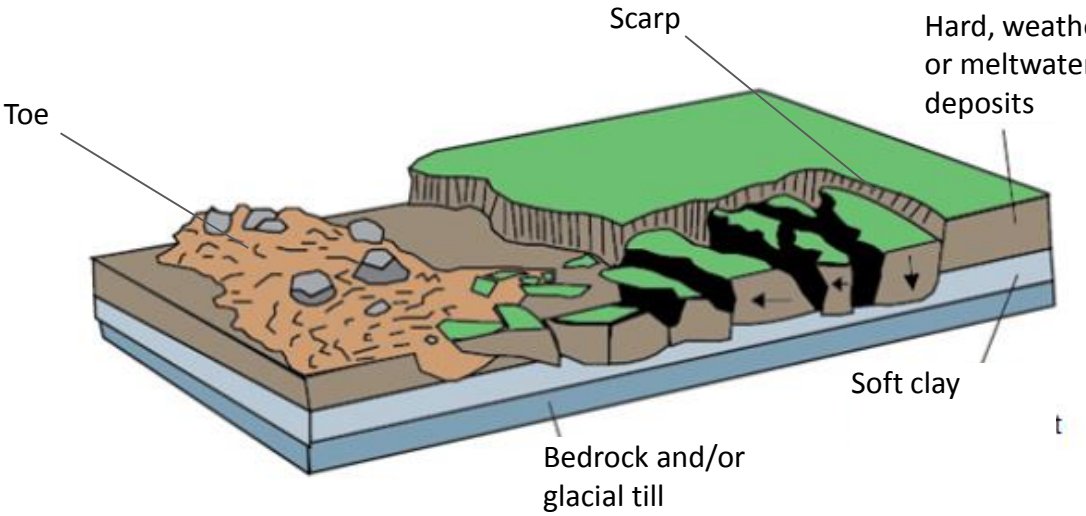


Figure 10. Diagram of a spread landslide.

Surficial Geology Overview: Landslides

What do these landslide features look like in the Sebago landslide? The scarp, slide blocks, and toe are indicated in the image below (Figure 11). The toe area of this landslide is difficult to define since it is long and ambiguous; some of it has been reworked by stream erosion. It is also possible that there was more than one landslide in the area, adding to the complexity.

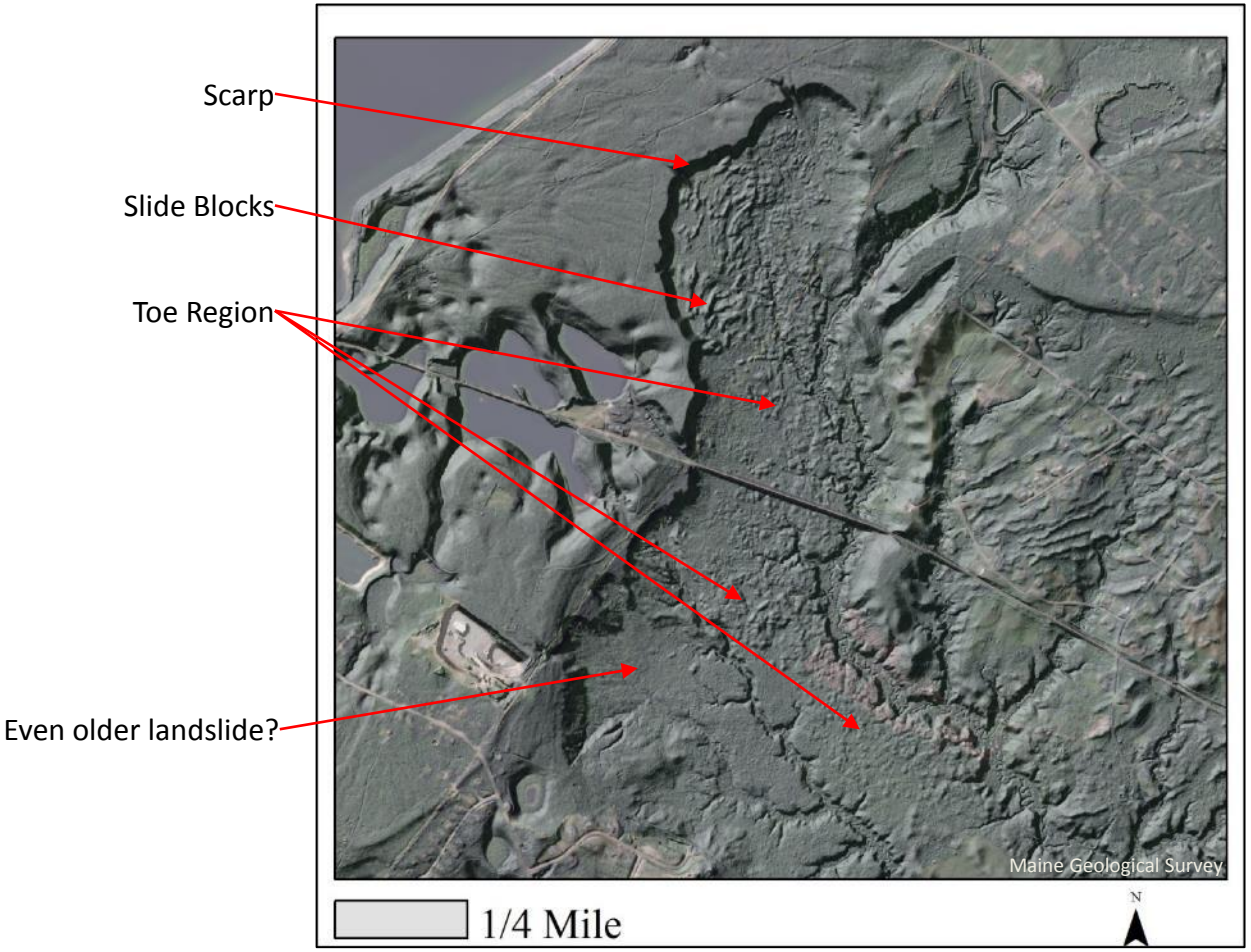


Figure 11. Sebago landslide features.

Directions

Now that we have an overview, let's take a tour of the Sebago Lake Land Reserve and see some of the surficial geologic features! From Maine Route 35, turn south on Maine Route 237. Park in the lot with the kiosk where the Sebago to Sea Trail crosses Route 237. The following suggested easy-moderate hike is about 3.3 miles roundtrip, with a variety of topography.

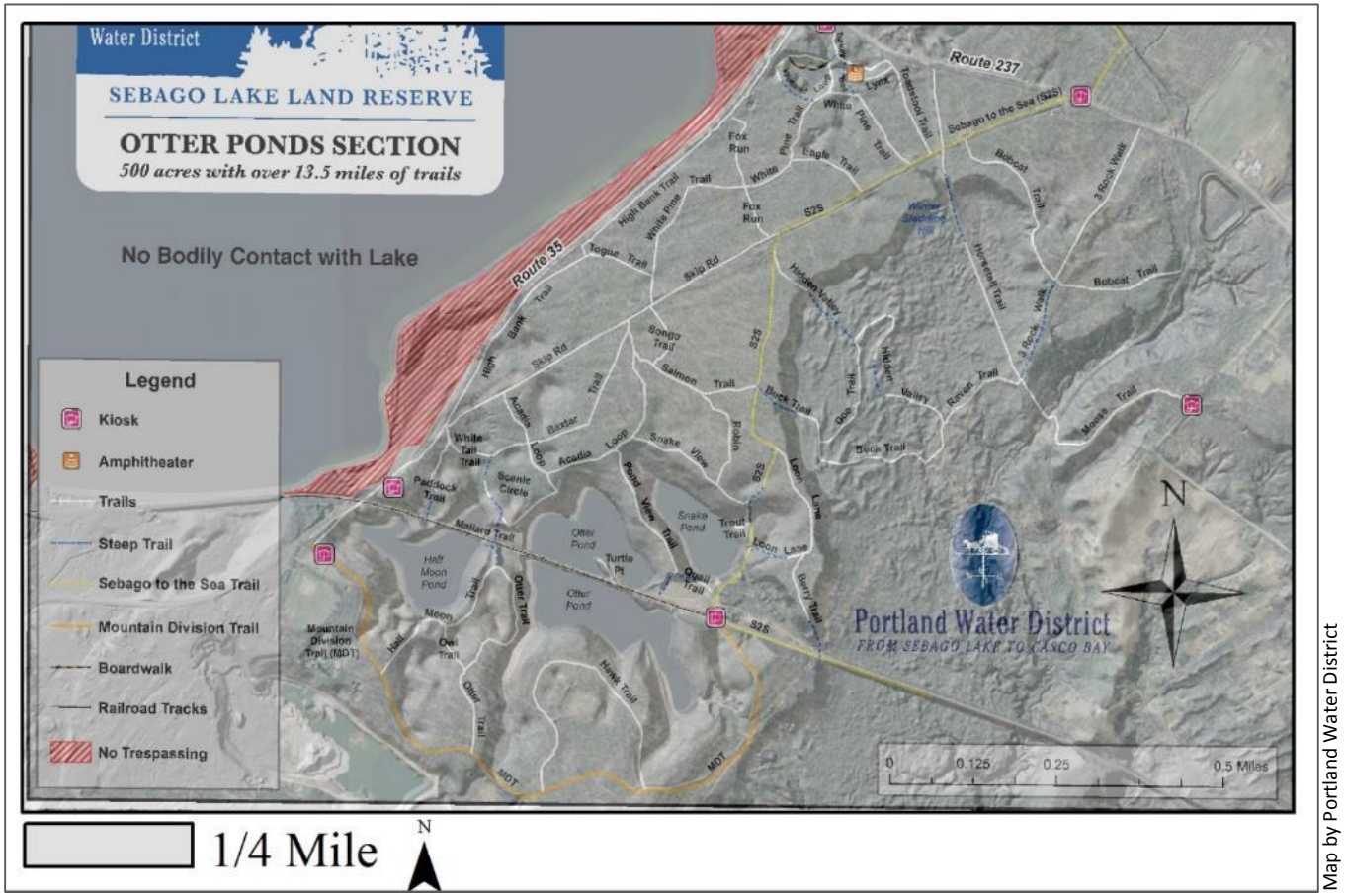


Figure 12. Trails map superimposed on LiDAR.

Sign In

Stop at the Kiosk (Figure 13). **YOU MUST FILL OUT A FREE PERMIT OR YOU WILL BE TICKETED**. Follow the directions on the permit form. There is no cost for the permit. Paper trail maps are available here.

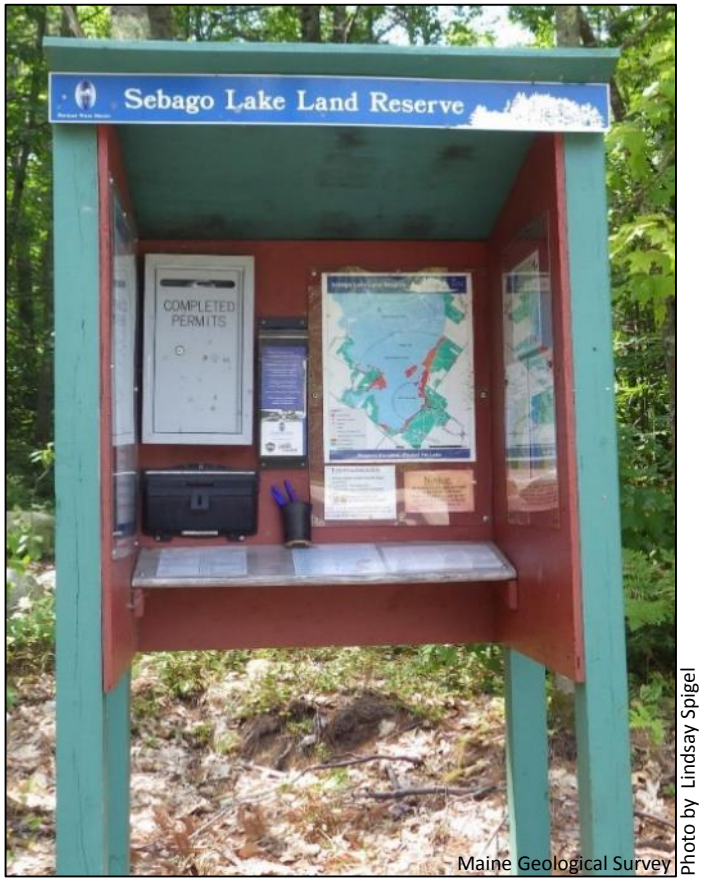


Figure 13. Trail Kiosk – fill out a permit and pick up a map.

Sandy Delta and Braidplain

Head west on the Sebago to Sea (S2S) Trail. Notice how flat and sandy it is – you are walking on the glaciomarine delta surface (Figure 14). In late glacial times, you would have been at the beach! The meltwater stream channel pattern is visible on the LiDAR, but very hard to detect on the ground (Figure 15).

Figure 14. Flat, sandy delta surface on the S2S Trail shown at point A in Figure 15.

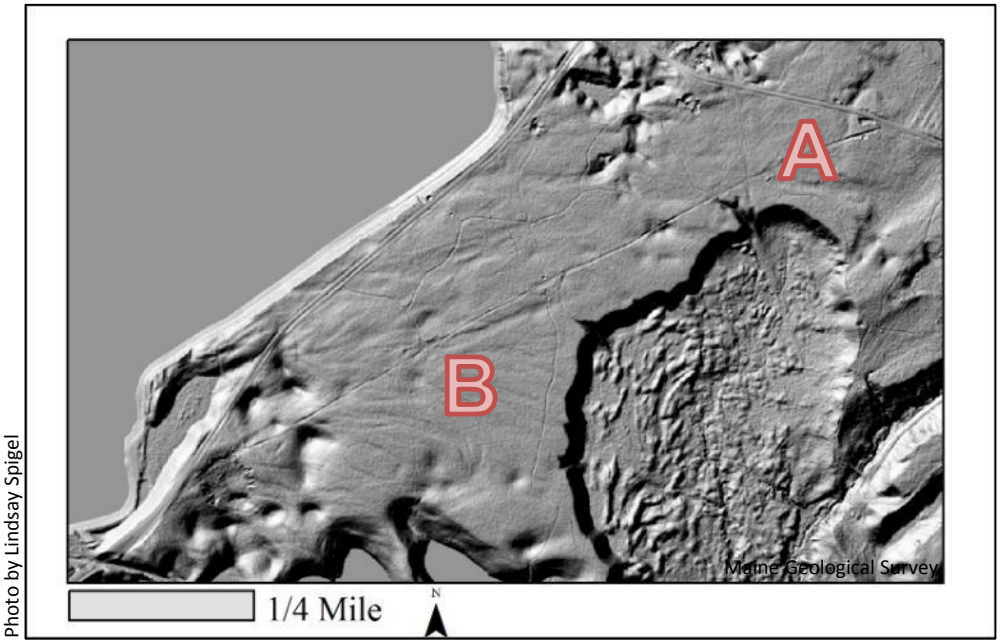


Figure 15. LiDAR image of meltwater stream channels, also known as a "braidplain", shown at point B.

Slide Blocks

Turn left onto the Horsetail Trail. Soon after, the path will drop down the landslide scarp and into the landslide deposit (Figure 16). The path has actually been built up here so that it is not as steep as the actual scarp. There will be a better view of the scarp later in the hike. Once you are in the landslide, look to your right. The irregular "hummocky" topography that resemble small hills are the slide blocks (Figure 17).

Figure 16. View down the Horsetail Trail, down the scarp and into the landslide deposit.

Figure 17. The small hill on the left side of the photo, in the red circle, is a slide block – these are much more noticeable in person!

Subtle Slide Blocks

Continue down the Horsetail Trail and cross the power lines. Look right down the power lines – here you can see all of the way across the landslide. The rolling topography is evidence of the subtle slide blocks in this part of the deposit (Figure 18).

Figure 18. View southeast across the landslide deposit, where the Horsetail Trail crosses the power lines.

More Slide Blocks

Turn right onto the Raven Trail and cross back under the power lines. More slide blocks are visible to the right along this section of the trail. Turn right onto the Hidden Valley Trail. This trail goes up and over many slide blocks (Figure 19). There are also exposures of the sandy and gravelly sediments that were part of the glaciomarine delta and comprise the slide blocks along this trail (Figure 20 on the next page).

Figure 19. The Hidden Valley Trail has rolling topography as it traverses many slide blocks.

Glaciomarine Delta Sediments

Photo: Lindsay Spigel.

Figure 20. Exposures of glaciomarine delta sediments along the Hidden Valley Trail. We can tell that the coarser sediments on the left were moved by water because they were abraded and rounded over time as they were transported – just like the rounded gravel and cobbles we tend to find in modern stream and beach environments. The finer sediments on the right may have been a beach deposit or sediments that were reworked by wind. There are not any exposures of the Presumpscot Formation along the trails, but it is likely not far below the surface in some areas. The geologists that mapped the area prior to LiDAR probably assumed that the slide deposit had Presumpscot Formation at the surface (Figure 2) due to its lower elevation.

Scarp View

Turn right to stay on the Hidden Valley Trail at the intersection with the Doe Trail. Ascend the steep scarp and look left and right for more views of the scarp (Figure 21). When you reach the top, you are back on the flat delta surface. What a difference in topography over such a short distance!

Figure 21. The Hidden Valley Trail ascends the landslide scarp with good views of the topography on either side of the trail.

Scarp View

Turn left onto the S2S Trail and then veer left onto Loon Lane. Shortly after the intersection, take a few steps off the trail to the left for a view of the scarp and down into the landslide (Figure 22). Use caution – it's a steep drop off!

Figure 22. View of the scarp and down into the landslide from the Loon Lane. What a steep drop!

Scarp View

Turn left onto the Berry Trail. This trail has a steep descent along the scarp and down to the railroad bed. When you reach the rail bed, turn around and look northeast up the power lines for another view across the landslide.

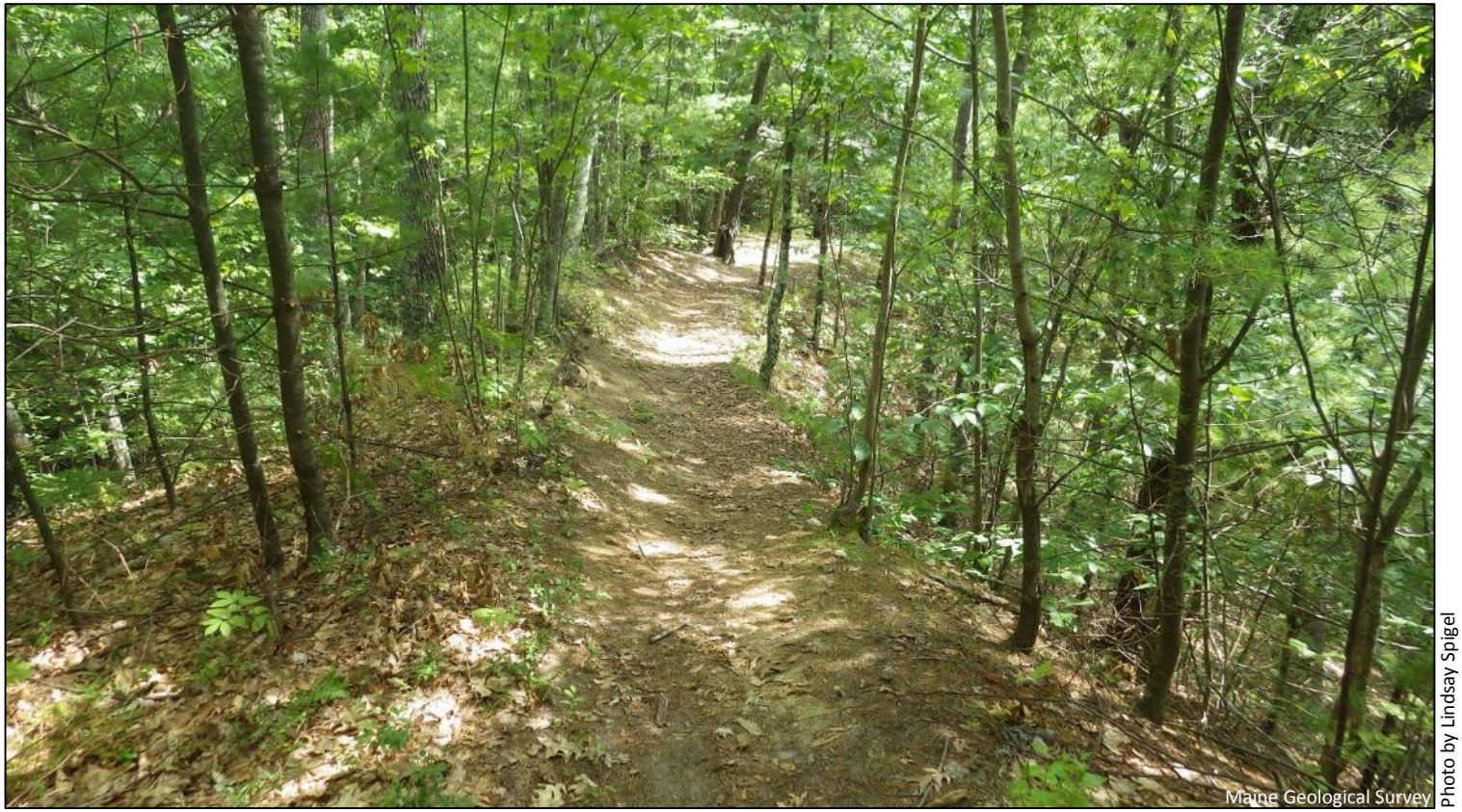


Photo by Lindsay Spigel

Figure 23. Descending on the Berry Trail. To the left is the landslide scarp; to the right is a drop into the Otter Ponds area. It is unclear if the drop on the right was accentuated by clearing for the railroad.

Kettle Pond

Turn right (northwest) and follow the S2S Trail along the rail bed. Turn right at the kiosk area to follow the S2S Trail across a clearing to get a view of Snake Pond (Figure 24). Think about how large the block of ice that formed this kettle must have been! Take the Quail Trail to the Pond View Trail for more views of Snake Pond and Otter Pond. At the junction with the Acadia Loop, you are now back on the flat glaciomarine delta surface. Follow this trail to Skip Road and the S2S Trail to head back to the parking area on Route 237, or keeping hiking and explore more of the Reserve!

Figure 24. View of Snake Pond.

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