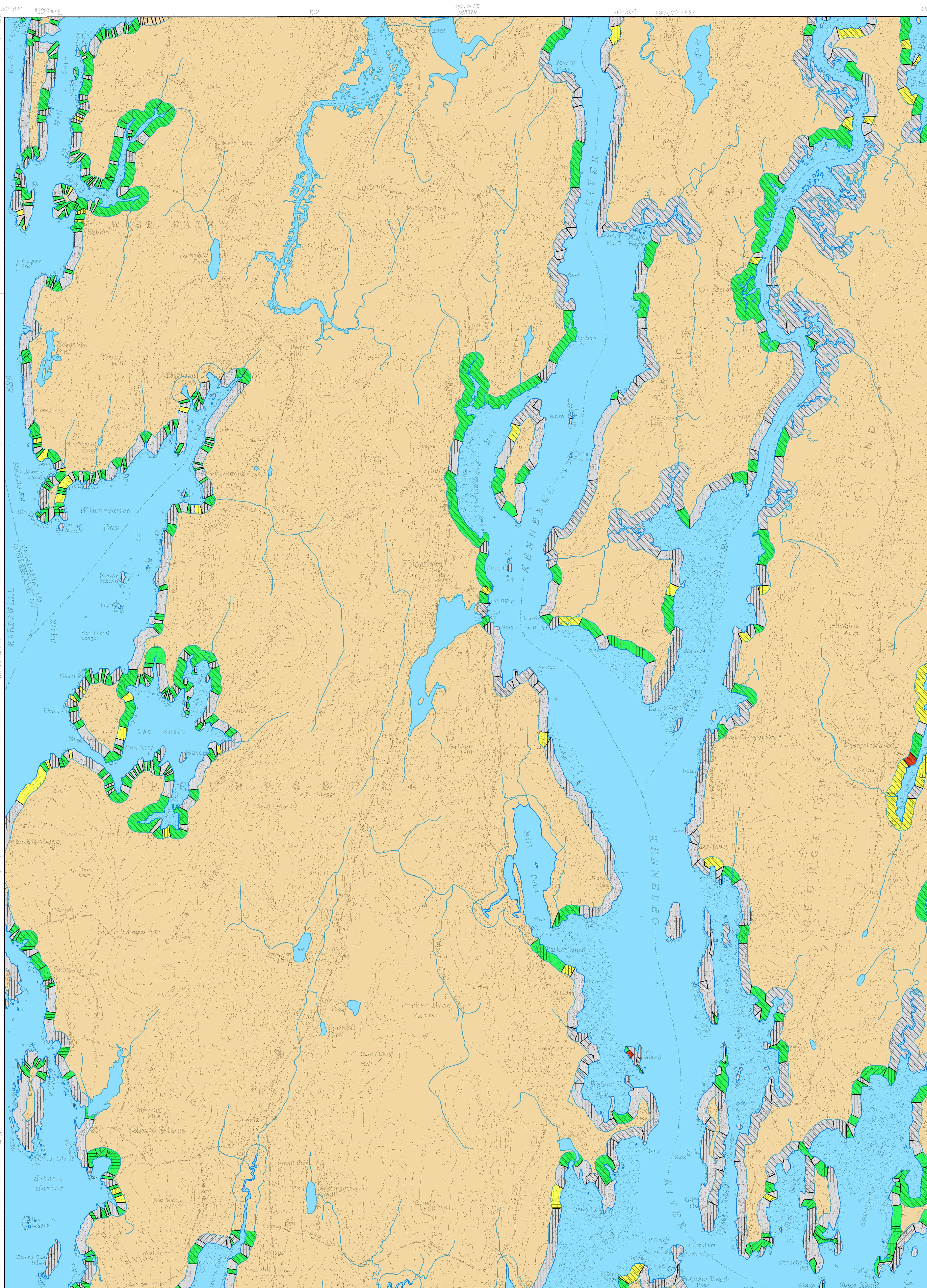
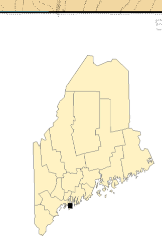
Coastal Bluffs



DATA COLLECTION AND COMPILATION

Field work for this map was done by Marita Bryant in 1991, and Allison L. Brandes, David A. Sinson, Rebecca A. Nestor, and Earle G. Hildreth III in 1999.



Quadrangle Location

SCALE 1 : 24,000

1 MILE · 1000 0 1000 2000 3000 4000 5000 6000 7000 FEET · 1 KILOMETER

CONTOUR INTERVAL 20 FEET

TRUE NORTH

Brunswick	Bath	Westport
Orrs Island	This Map	Boothbay Harbor
Bailey Island	Small Point	

Topographic base from U.S. Geological Survey Phippsburg quadrangle, scale 1:24,000 using standard U.S. Geological Survey topographic map symbols.

Index at left shows adjacent maps in this series.

Phippsburg Quadrangle, Maine

Coastal bluff mapping by

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This map supersedes Open-File Map 00-80.

Types of Bluffs Along Maine's Coast

This map shows the shoreline type and relative stability of bluffs along a section of the Maine coast. The slope, shape, and amount of vegetation covering a coastal bluff and the adjacent shoreline are directly related to the susceptibility of the bluff face to ongoing erosion. As might be expected, less vegetated bluffs are more likely to be eroding than completely vegetated bluffs. Another important factor related to bluff stability is the material which makes up the bluff. Materials such as clay, gravel, and sand react differently to erosion and, when combined with variations in vegetation and slope, affect the rate of erosion for an individual bluff. When planning to reduce the risks of coastal erosion, it is important to take vegetation, slope, erosion rate, and sediment types into consideration.

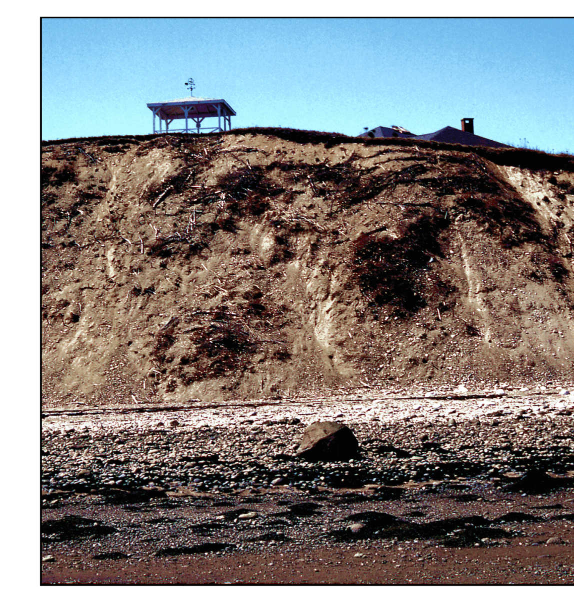
On this map, a bluff is defined as a steep shoreline slope formed in sediment (loose material such as clay, sand, and gravel) that has three feet or more of vertical elevation just above the high tide line. Cliffs or slopes in bedrock (ledge) surfaces are not bluffs and are not subject to significant erosion in a century or more. Beaches and dunes do not form bluffs, except along the seaward dune edge as a result of erosion. This map does NOT identify erosion trends on beaches or sand dunes.

Coastal environments are dynamic and subject to continuous change. Gravitational processes of creep, slumping, and occasional landsliding modify the shape of coastal bluffs. Rising sea level along Maine's coast (at a rate of about 2 mm/year, slightly less than a foot per century) allows storms and coastal flooding to reach further inland and erode sediments at the base of bluffs. Steepening of bluffs by erosion at their base may lead to increased slumping and deposition of clay, sand, or gravel in the intertidal zone which then acts to stabilize the bluff for a period of several years to decades as coastal processes rework and remove the slumped material. Once the material at the base of the bluff is removed entirely, the bluff may then be undercut again and the cycle of slumping followed by protection of the bluff base will be repeated. Most bluffs erode erratically, perhaps losing ground one year and not the next. Over a period of many years a bluff may permanently retreat landward. Historical analysis can help determine the average rate of bluff retreat.

Over time, the appearance of bluffs will change. Coastal flooding, erosion, slumping, creep, deposition in the intertidal zone, ice action, ground-water drainage, and human alteration will change bluff appearance. For example, unvegetated beaches are more easily eroded than salt marshes, armored shorelines, or ledges. Also, bluffs covered with vegetation and having a gentle slope have been more stable than those with steep slopes and little vegetation. Understanding the processes that erode bluffs can help determine what solutions are appropriate to reduce future rates of property loss.

This map can help identify shorelines with increased risk of coastal erosion. Review the legend below in order to understand what the map shows and does not show. The colored categories correspond to field conditions when the map was made. Conditions may have changed in the last few years. Comparison of the information on this map with current conditions may indicate that a stability category is different now. Since bluff erosion may be cyclical, the change may only be temporary. If coastal development is near any bluff we recommend a professional evaluation be made to determine the risk to structures.

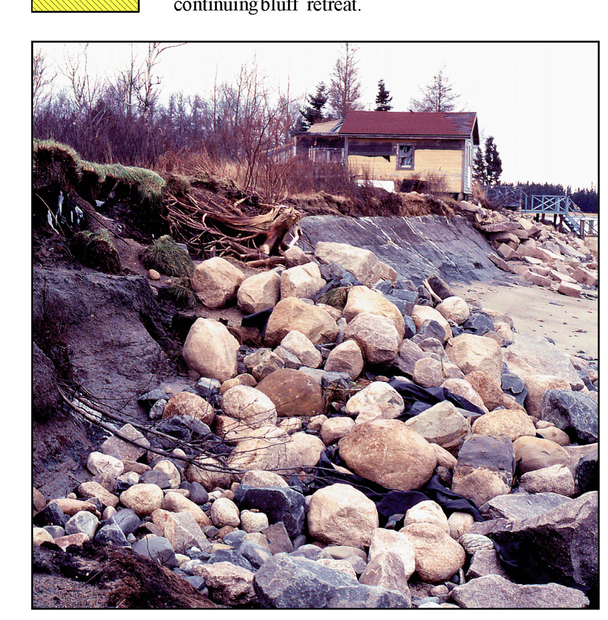
Highly unstable bluff with an unvegetated bluff face and a salt marsh shoreline. Sediments on the bluff face are exposed and fallen tree trunks lie at the base of the bluff. A salt marsh has recently formed on the tidal flat, partly on the top of an old landslide deposit.



Highly unstable bluff with an unvegetated bluff face and a beach/gravel flat shoreline. The bluff face is too unstable to support vegetation. This bluff, a glacial esker, is eroded by waves to create a mixed sand and gravel beach in front the bluff.

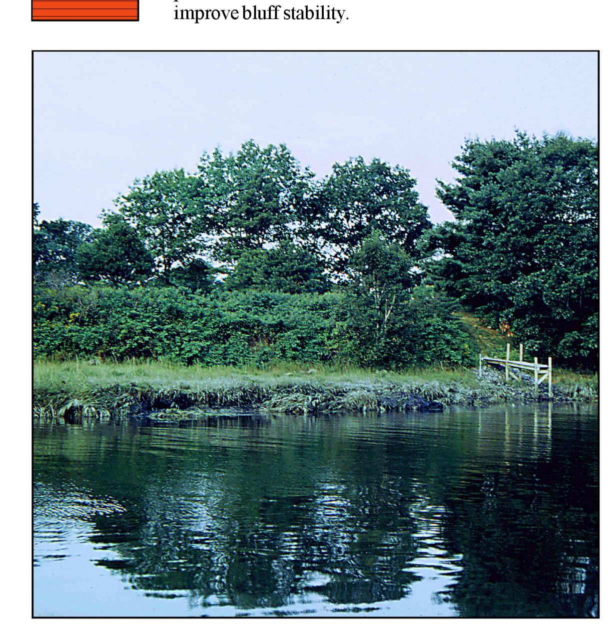
Unstable bluff with a partially vegetated bluff face and a salt marsh shoreline. This bluff, protected by a salt marsh, remains unstable. There are small bushes on the bluff as well as small non-vegetated areas that indicate continuing bluff retreat.

Unstable bluff with a partially vegetated bluff face and a beach/gravel flat shoreline. Slump scars on the bluff face expose sand, gravel, and roots. Fine sediments are removed by waves and currents, leaving gravel to form a beach at the base of the bluff.

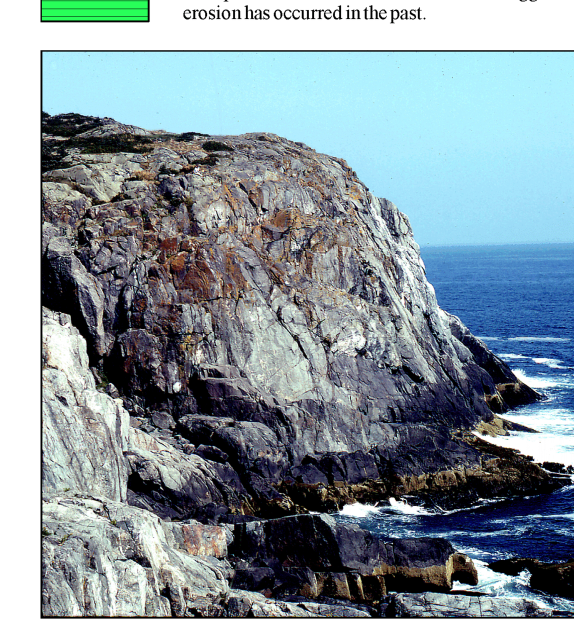


Highly unstable bluff with an unvegetated bluff face and an armored shoreline. This armored bluff is eroding despite an effort to shore it up with riprap, or loosely piled stone blocks. Maintenance at this site could improve bluff stability.

Stable bluff with a vegetated bluff face and an armored shoreline. The bluff face is fully vegetated and supports a mature stand of trees with vertical trunks. The presence of a wooden bulkhead suggests that erosion has occurred in the past.



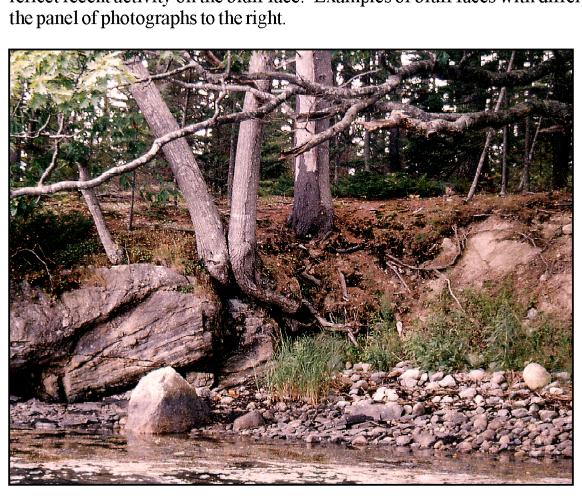
Stable bluff with a vegetated bluff face and a salt marsh shoreline. A low bluff face is covered by shrubs landward of a salt marsh terrace. In this location the mature marsh protects the base of the bluff from rapid erosion and slows bluff recession or retreat.



No bluff with a ledge shoreline. A steep slope on the bedrock surface is not a bluff. On this map, bluffs must be made of sedimentary material, generally with 3 feet or more relief. This shoreline type is very slow to change.

Classification and Mapping of Maine's Coastal Bluffs

Geologists classified the coastal bluffs on this quadrangle map by observing the shoreline from small boats. They assigned one of the following categories to the type of shoreline seen below the high tide line: (1) ledge (exposed bedrock outcrops); (2) armored (seawall, riprap, gabion, bulkhead, etc.); (3) salt marsh; or (4) beach, mud flat, or other loose sediment. Ruled patterns on the map indicate the shoreline type. Gray areas on the map indicate segments of the shoreline without significant coastal bluffs. Where significant bluffs were present, geologists noted various characteristics of the bluff face such as the slope of the bluff (steep to gentle), features on the bluff face indicating recent movement of material down the slope (slumped blocks of sediment, landslide scars, fallen trees), and the amount and type of vegetation (bare sediment, grass, shrubs, mature trees). From this information, geologists assessed the relative stability of each bluff face as being (1) stable (green), (2) unstable (yellow), or (3) highly unstable (red). This classification is based on observed features that reflect recent activity on the bluff face. Examples of bluff faces with different stabilities are shown in the panel of photographs to the right.



Map Resolution

Since these are regional maps, some shores mapped as stable may contain small areas that are unstable. A bluff, too small to appear on the map, is shown in the photo. This bluff exhibits the characteristics of an unstable bluff: curved tree trunks, exposed roots, and bare ground on a steep slope. It is an area to be concerned about on a local scale. However, this degree of detail is not shown on the map above.

Limitations of the Data

This map is intended to provide only general information on the overall stability of bluffs. It is not intended to be the sole basis upon which specific land-use decisions are made. The information portrayed on this map is based on visual inspection of the coast from offshore, and parts of the shoreline may have changed slightly since the field work was completed. Because of the map scale, shoreline characteristics are generalized into 150-foot segments. It is important to realize that the bluff classification only shows the average stability inferred for each section of the shoreline (see Map Resolution section above). For an evaluation of specific shoreline erosion risks, landslide potential, or historical trends, certified geologists or geotechnical engineers should conduct site-specific studies.

Classification of Coastal Bluffs

SHORELINE TYPE →	Ledge	Armored	Salt marsh	Beach / flat
BLUFF FACE				
Highly unstable				
Unstable				
Stable				
NO BLUFF				

Note: The classification of the bluff is indicated by a colored, patterned band extending landward from the shoreline (dark blue line). The width of the band is NOT related to the width of the bluff. Stability rank refers to RECENT bluff face activity.

Shoreline Type	Description of Shoreline at or Below the High-Tide Line
Ledge	Greater than 50% bedrock. May include minor accumulations of sediment that occur in small coves or other sheltered areas (see photo at left).
Armored	Consists of riprap, seawalls, groins, jetties, and other engineered structures. Condition of armor may indicate degree of stability of bluff face.
Salt marsh	Mostly to fully vegetated salt marsh with minor tidal flat environments. May include small rocky outcrops.
Beach / flat	Sediment, ranging in texture from mud (tidal flats) to cobbles (gravel beaches). May include small rocky outcrops or small patches of vegetation.

Bluff Face	Typical Characteristics of Bluff Face (above high-tide line)
Highly unstable	Near vertical or very steep bluff with little vegetation and common exposure of bare sediment. Fallen trees and displaced blocks of sediment common on bluff face and at base of bluff.
Unstable	Steep to gently sloping bluff mostly covered by shrubs with a few bare spots. Bent and tilting trees may be present.
Stable	Gently sloping bluff with continuous cover of grass, shrubs or mature trees. Relatively wide zone of ledge or sediment occurs at the base of the bluff.
No bluff	Broad, gently sloping vegetated land or bare ledge with less than three feet of sediment cover.
Not Mapped	Some portions of the shoreline have not been mapped for bluff type.

Shoreline Processes and Bluff Hazards

Bluffs are formed in a dynamic coastal environment by terrestrial and marine processes. Bluff erosion is part of a natural cycle with consequences for the land below and above the bluff. Fine-grained silt and clay eroded from bluffs may be deposited on mud flats or salt marshes which help reduce wave energy at the base of a bluff and slow the overall rate of bluff erosion. Coarse-grained sediments, such as sand and gravel, eroded from bluffs become part of a beach at the base of the bluff and help stabilize the shoreline position. Transfer of sediment from the land to the sea is natural and sometimes essential to sustain beaches, flats, or salt marshes.

Bluff erosion can result in a landward shift of the top edge of the bluff. This shoreline change is a natural process that, by itself, is not a coastal hazard. Only when erosion threatens something of value, such as a building near the bluff edge, does bluff retreat become a hazard. Understanding local erosion rates can help determine the severity, and perhaps longevity, of coastal development along a bluff edge.

Coastal bluffs erode episodically. Some bluffs may not change much over many years, even though there are steep banks along the shore. Bluffs may not lose much ground in any one year. Instead, the bluff may slump a large amount of sediment once every few years. The bluff erosion rate will vary from year to year, much like the weather. A long-term average erosion rate is the most meaningful measure of the bluff retreat rate. The hazard to development on or above the bluff can be better evaluated using long-term erosion rates. Once the risk is evaluated, then appropriate solutions to reduce the risk can be considered and balanced with cost and environmental consequences.

Landslide Risk

This map of Coastal Bluffs describes the processes and stability of the ***face*** of a bluff. A companion map, **Coastal Landslide Hazards**, describes the ***internal*** stability of sediment bluffs and their potential to rapidly move large amounts of land downslope under the influence of gravity. In general, landslide-prone bluffs have (a) high and steep faces, (b) clay sediment, (c) erosion near the high-tide line, and (d) a high ground water table. As with processes on the bluff face, landslide movement is episodic. To determine the risk of a landslide, a site-specific study of the geology and strength characteristics of the bluff should be made by certified geologists or geotechnical engineers.

A 1996 landslide in Rockland Harbor (photo below) occurred in an area where the bluff face is classified as unstable. In addition, the bluff had all the characteristics (a-d) listed above. This fact emphasizes that the map above does not indicate sites with a potential for catastrophic landslides. Additional factors need to be considered beyond the appearance of the bluff face and type of shoreline below the bluff. Maps of topography, surficial sediments, and Coastal Landslide Hazards are available from the Maine Geological Survey to help assess the landslide potential in an area.

Lengths of Bluff Types Shown on This Map

Town	Highly unstable bluff	Unstable bluff	Stable bluff	Non-bluff shoreline	Unmapped shoreline
Arrowsic	0	0.5	4.9	16.4	0
Georgetown	0	2.3	7.2	32.3	0
Phippsburg	0	1.5	12.1	29.5	8.4
West Bath	0	0.5	5.8	9.2	0.7
Total	0	4.8	30.0	87.4	9.1

Note: Length of bluff types in the table above are in miles. Distances are only for the town shoreline shown on this map, not for the entire town or unmapped locations.

Related Maps

Dickson, S. M., 2001, Coastal landslide hazards in the Phippsburg quadrangle, Maine: Maine Geological Survey, Open-File Map 01-533.

Smith, G. W., 1976, Surficial geology of the Phippsburg quadrangle, Maine: Maine Geological Survey, Open-File Map 76-37.

Locke, D. B., 1999, Surficial materials of the Phippsburg quadrangle, Maine: Maine Geological Survey, Open-File Map 99-58.

Other Sources of Information

Berry, H. N., IV, and others, 1996, The April 1996 Rockland landslide: Maine Geological Survey, Open-File Report 96-18, 55 p.

Kelley, J. T., Kelley, A. R., and Pilkey, O. H., 1989, Living with the coast of Maine: Duke University Press, 174 p.

Osberg, P. H., Hussey, A. M., II, and Boone, G. M., 1985, Bedrock geologic map of Maine: Maine Geological Survey, map, scale 1:500,000.

Thompson, W. B., and Borns, H. W., Jr., 1985, Surficial geologic map of Maine: Maine Geological Survey, map, scale 1:500,000.

Additional information and products are available through the Maine Geological Survey publications mail-order catalog or via the Survey's web site (address shown in title block). The web site includes fact sheets about coastal processes, hazards, sea-level rise, and geologic history.