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**Overview Report of Coastal Processes and Hazards in Northeast Coastal
National Parks and Recommendations for Addressing Coastal Hazard
Issues**

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Acadia National Park (ACAD)

Unlike other coastal national parks in the Northeast, Acadia, is a rocky coastline with very few sandy beaches. Granite underlies most of Acadia, and is highly resistant to erosion. The largest beaches in the park, such as the aptly named Sand Beach, have formed at or near the mouths streams, and are protected by rocky headlands at either end (Fig. 1). Analyses of shoreline erosion have been conducted for the sandy beaches in Acadia National Park and results suggest that there are no long-term chronic erosion issues. Bank erosion is occurring near the narrow opening of Somes Sound, where the banks are composed of soft glacial till as opposed to granite (Figure 2). The erosion is driven primarily by tidal currents in and out of the Sound. No critical park resources are threatened by the bank erosion and it is considered a low hazard. At this time, Acadia does not have a pressing need to address issues of coastal erosion hazards.



Figure 1. Sand Beach occurs at the mouth of a small river, which delivers enough sediment to keep this recreational beach in equilibrium.



Figure 2. Undercutting of a bank along Somes Sound at The Narrows is causing some localized erosion. No park resources or infrastructure are threatened at this time.

St. Croix Island International Historic Site (SACR)

St. Croix Island International Historic Site has several issues of potentially severe erosion hazards. There are cultural resources on St Croix Island, and interpretive facilities on the mainland across from the island. On St. Croix Island, high bluffs (~20m) composed of glacial till overlie a granite substrate. The granite protects the island on the north and west side where the glacial till occurs only as a thin veneer and is well above the water level of the river. The till layer thickens to the south and forms the high bluffs on the south and east sides of the island (Fig. 3). Here the soft till is directly exposed to high tide river currents. Over the past several decades, rapid erosion of the bluffs has led to natural exhumation of the remains of the island's first settlers. Although some erosion rate analyses have been conducted for the island bluffs, existing data and information is not readily available for application to management of the park resources relative to the erosion hazards.

On the mainland, an interpretive trail runs along a small promontory in the river bank (Fig. 4). The exposed 2-3 m high riverine bluffs are composed of soft alluvial deposits. According to anecdotal

evidence, erosion rates have increased in the last 5-10 years. Riprap placed at the apex of the promontory 6 years ago attests to the perceived need by the park to mitigate this increased hazard. Little or no information has been compiled regarding rates of erosion on the mainland portion of the park. Both the interpretive trail and some of the structures are severely threatened by continued bluff retreat.

It is recommended that a bluff retreat monitoring program be undertaken on the mainland portion of the park to evaluate threats from erosion to park infrastructure. A simple monitoring program that doesn't require specialized or high-tech equipment should be implemented to measure the distance from the bluff edge to permanent park structures. The monitoring can be carried out by local park personnel (with initial training by a field scientist). Since the interpretive trail area is quite small, a team of two should be able to conduct such surveys in a half-day or less. Initially the bluff edge position should be surveyed once per month, and after especially large rainstorms or tidal events.

Additionally, an aerial photographic analysis would be helpful to establish the historical bluff retreat rates and to identify areas that may threaten additional park infrastructure in the future. This is recommended for both the mainland interpretive area and St Croix Island. Existing bluff erosion data for the island does exist, but not in a digital format for use in a GIS environment. It is recommended that the existing bluff erosion data be obtained and incorporated into GIS for systematic analysis and so that additional data can be combined with it for monitoring.

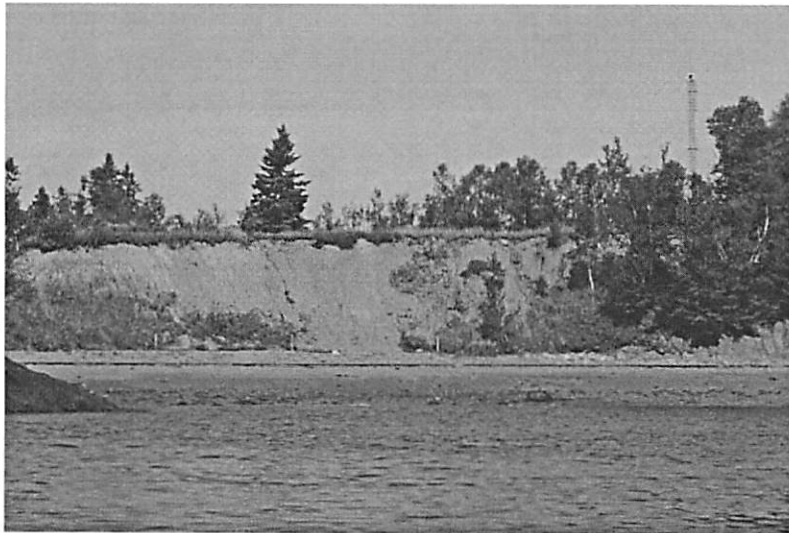


Figure 3. Actively eroding bluffs on southeast side of St. Croix Island.



Figure 4. Low bluffs surrounding promontory, on which the SACR interpretive trails is built, are actively eroding. The apex of the promontory is now protected by riprap (large boulders in left foreground) but north side of promontory is eroding (note leaning trees just below bluff edge). The pavilion (in trees), which is a part of the interpretive trail, is threatened by bluff erosion.

Assateague Island National Seashore (ASIS)

Assateague Island National Seashore is an undeveloped barrier island along the Atlantic coast of Maryland and Virginia. In 1933, an inlet formed during a hurricane, and was subsequently stabilized with jetties by the Army Corps of Engineers (USACE). The jetties effectively shut off the sand stream from the north, and as a result Assateague is sand-starved and has retreated landward nearly 1 km since the inlet opened (Fig. 5). USACE has recently begun a nourishment program that involves dredging sand from offshore bars north of the inlet jetty and depositing it on the edge of the ebb tidal delta where natural wave energy delivers it to the beach downcoast.

Within the Northeast National Park network, Assateague Island National Seashore has an excellent coastal monitoring program in which they produce GPS shorelines four times per year (since 1994), and cross-shore topography is now collected two times per year. In addition, bathymetric data exist for the area around the ebb-tidal delta at the northern end of the park near the Ocean City Inlet, and lidar data has been collected once per year since 1998. Assateague is also the only one of the Northeast parks with a coastal geologist on staff (Courtney Shupp). Mapping of Chincoteague Bay has

been done by the Maryland DNR (MD Coastal Bays Sediment Mapping Project, <http://www.mgs.md.gov/coastal/vmap/czmatlas/index.html>) and includes sediment distribution, sedimentation rates, and various chemical analyses for contaminant mapping. Additionally, researchers from NOAA and the University of Toledo are conducting offshore mapping and geophysical analyses. These data will provide valuable information on the evolution of Assateague Island, but will likely provide little useful information for better management of park resources due to both the resolution of survey (1 km spacing of seismic lines) and distance offshore (data begin at 200 m offshore).

Discussions with park geologists and resource managers indicated that ASIS data needs are nearshore bathymetry and bottom type (benthic habitat map). The existing geologic maps of the park, from an unpublished dissertation (UDeI) in 1960s, are not presently in a format whereby they can be incorporated into a GIS database.

Recommendations for addressing coastal hazards issues include regular monitoring (bi-annual) of the northern end of the island where USACE is placing material offshore to determine the success of the nourishment and assess impacts (negative and positive) on park resources. The current monitoring conducted by park personnel should be sufficient to provide data for this analysis. A consistent methodology should be developed for assessing change.

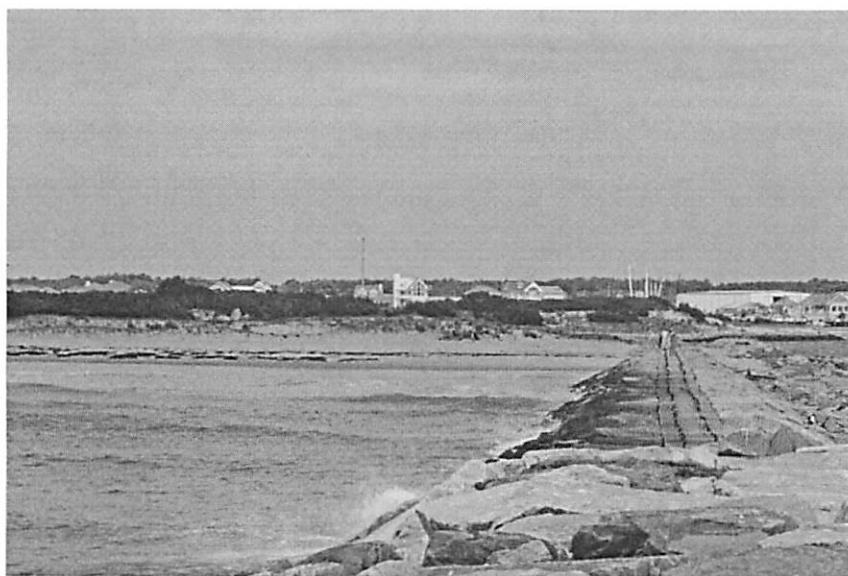


Figure 5. View from jetty at Ocean City Inlet looking west. Beach on left side of photograph is the northernmost beach in ASIS, and the inlet is to the right. The ebb tidal delta nourishment will impact the beach several kilometers south of the jetty.

The USACE built an artificial berm along the northern portion of the park in 1998, after a series of storms overwashed the beach and caused severe erosion. Overwash zones are now becoming vegetated, potentially impacting plover habitat. Additional impacts on the low-relief geomorphology of this portion of the island include another berm that was reconstructed in 2002 prior to onset of the inlet bypassing. The artificial fill material used in the 2002 berm construction contained a percentage of material that is coarser than the natural beach. Since construction, the fine sand has been removed from the berm via aeolian processes, and microdunes are forming in overwash area; a layer of coarse sediment lag remains where the berm was constructed (Fig. 6). This affects the geomorphology of the island, as it disrupts natural processes of sediment transport.

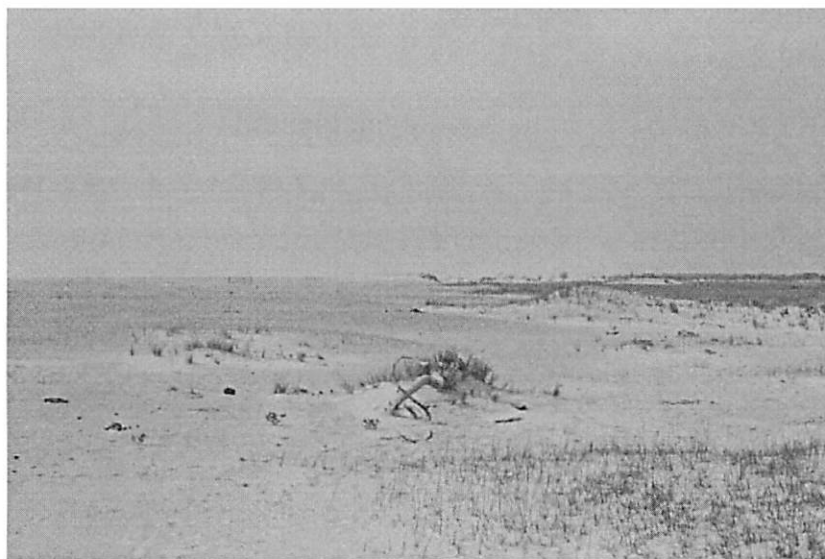


Figure 6. Looking south along the low-relief barrier island. The darker colored material is a coarse-grained veneer that is a remnant of an artificial berm built by the ACOE in 1998. Note the small, vegetated microdunes forming bayward (to the right in the photograph) of the veneer.

Finally, it is recommended that an analysis of the impacts of driving on the beach to the park resources be undertaken. At Assateague, seasonal driving is permitted in the central and southern portions of island (Fig. 7). The impacts of extensive beach driving, such as at Assateague and Fire Island, are unknown in terms of changes to the beach geomorphology and disruption to sediment transport processes.



Figure 7. There is extensive off-road vehicle traffic in the central and southern portions of ASIS. Little is known about the impacts (if any) of such activity on the morphologic evolution of the beach/dune system.

Boston Harbor Islands National Recreation Area (BOHA)

The Boston Harbor Islands are a field of partially submerged glacial drumlins, soft mounds of glacial till overlying bedrock. The coastal hazards of the islands include both beach erosion and bluff erosion. Coastal erosion processes are driven by northeast storms, tidal currents, and rising sea level. Additionally, some erosion may be driven by the wake of boats and ferries as they travel between the islands. Islands visited during the reconnaissance field trip include Thompson, Lovells, Peddocks and Spectacle.

On Thompson Island a coastal pond is being monitored to determine if restoring it to a saltwater pond is feasible. The pond, originally saltwater, was cut off from tidal processes by a artificial boulder barricade. The pond then flooded with fresh water, killing the seagrass which had been established there. Recent erosion has reduced the elevation of the barricade and the pond has been opened to periodic tidal flushing.

Tall bluffs flank much of the northern shoreline of Peddocks Island. The bluffs are composed of soft glacial till, and are eroding rapidly due to both marine (waves) and terrestrial (rain, overland flow) processes (Fig. 8). Recent analyses suggest that marine erosion may be accelerated by the wake generated by boats passing through the channels between islands. Currently a program is in place to conduct regular ground surveys of the eroding bluffs and study the impacts of boat wake on bluff

erosion processes and rates. Since the bluffs are heavily vegetated along the top edge, a topographic analysis using lidar data may be difficult but the feasibility of this should be explored.



Figure 8. Tall bluffs on the northern end of Peddocks Island are undergoing rapid erosion. The rills on the unvegetated portions of the cliff face are indicative of erosion by surficial overland wash processes.

Cape Cod National Seashore (CACO)

Cape Cod is essentially a large sedimentary deposit of glacial origin. Since the last deglaciation, the deposits have been reshaped by nearshore currents, waves and wind. The resulting geomorphology includes linear beach/dune systems, barrier islands, spits and tall coastal bluffs. Similar to Assateague, Sandy Hook, and Fire Island, the coastal geology and geologic framework of Cape Cod National Seashore has been widely studied and general coastal processes and coastal hazards are well understood. Needs of the park are more focused on monitoring, and developing a database to better manage park resources into the future.

A shoreline monitoring program is well established in the park and this should continue on a regular basis. In addition, analyses of coastal bluff retreat have been primarily conducted using widely spaced profiles. Bluff retreat is perhaps the greatest coastal hazard in Cape Cod, as very tall cliffs erode (Fig. 9) episodically during large storms, threatening park infrastructure. Useful data for understanding the dynamics of bluff retreat would be to develop a time series of topographic models from existing lidar data to assess short-term changes to the beach/bluff system. Areas of concern in terms of beach erosion hazards include rapid erosion at a popular beach near Provincetown (Herring Cove Beach, Fig. 10), where some existing shore protection structures are being undermined and could

make use of sections of the beach unsafe for park users. This site should be monitored and the park should consider the possibility of removing the asphalt bulkhead from the foreshore. Other areas of concern include issues related to management of the highly dynamic Monomoy Wildlife Refuge barrier island. Due to the dynamic nature of these islands, which are partly managed by the Fish and Wildlife Service and partly managed by the National Park Service, jurisdictional issues arise because boundaries (e.g. mean high water) are not stable.



Figure 9. Bluffs as high as 50 m are formed in soft glacial till along the Cape Cod coastline.



Figure 10. An asphalt bulkhead that lines a section of the foreshore at Herring Cove Beach is failing and may be unsafe.

Fire Island National Seashore (FIS)

Fire Island National Seashore is a barrier island flanking the southern coast of Long Island. Unlike most National Seashores, Fire Island contains numerous private developed communities. These communities are sandwiched between undeveloped parcels of park service lands. The park has an ongoing shoreline and dune position change monitoring program, in part to understand how the development on the island affects the natural resources and natural processes in the park. Comprehensive analyses have been completed on understanding many of the processes driving coastal change as well as the underlying (offshore) geologic framework. However, little is known about nearshore sediment transport processes and how the current management practices of the private communities (beach scraping and beach nourishment) are impacting both the natural resources of the park and long-term sediment transport.

Coastal issues of most concern to park management include the impacts of beach scraping (Fig. 11) and nourishment, lack of data or information on nearshore sediment transport processes, need for better understanding of inlet formation and overwash dynamics, and how to address issues of bayside erosion (Fig. 12). The beach on Fire Island is also used heavily by vehicles (Fig. 13) except in restricted areas. There are very few studies to date on the impacts that driving on the beach may have on the long-term evolution of the beach.

It is recommended that studies be undertaken to look at the long- and short-term impacts of beach scraping on the morphology of the barrier island system. Analyses should include assessments of storm, seasonal and historical changes in beach morphology in scraped versus unscraped areas. This

analysis should include an assessment of how well scraping and nourishment mitigate erosion on a variety of scales. Complementary to this analysis would be a side-scan sonar survey to map the nearshore environment. Sidescan sonar does exist for the entire length of the island but does not extend closer to shore than 10m water depth. Sidescan data will provide some insight into the processes of nearshore sediment transport.



Figure 11. Beach scraping to create artificial dunes for erosion mitigation is a common practice in the communities on Fire Island. Snow fencing is generally used in conjunction with scraping to help hold the sand in place.



Figure 12. The edge of the maritime forest is no longer protected from waves by marsh or sand due to increased erosion, and the result is the dying out of the trees along the bayside edge of the of the island.



Figure 13. Vehicular use is heavy on Fire Island in the off-season. School bus routes and stops are actually on the beach.

Gateway National Recreation Area (GATE)

Gateway National Recreation Area is a large, diverse and dominantly urban recreation area in the New York Bight. Jamaica Bay, Sandy Hook and Staten Island Units are all a part of the GATE system. The Sandy Hook Unit is a dynamic spit, portions of the Jamaica Bay unit (e.g. Breezy Point and Rockaway Beach) are barrier islands, and the majority of Jamaica Bay is a tidal estuary. Finally, Staten Island is an island formed as sea-level rose during the last deglaciation, and is composed of glacial outwash, moraine and till deposits. In addition large portions of the island are artificial fill.

Jamaica Bay:

During a reconnaissance field trip, several specific areas of Jamaica Bay were discussed by park staff as those of coastal hazard concern. These include erosion around sections of Floyd Bennett Field, artificial ponds in the wetland marshes, Riis Park and Breezy Point. Floyd Bennett Field has a highly engineered and modified coastline, as it was once part of a Naval facility. Chronic erosion is occurring where a dilapidated bulkhead no longer provides shore protection from waves and tidal currents (Fig. 14). Ideally, all the old, non-functional structures should be removed and the shoreline restored to a more natural state. Currently the structures may be dangerous to park users. However, restoration would likely be prohibitively expensive. In the interim, the area should be monitored, and possibly closed to public use.

Artificial ponds were dredged in the Jamaica Bay marshes in the 1930s to create habitat in Wildlife Refuge. In order to preserve the dredged ponds, artificial sand levees were built and these levees are now rapidly eroding (Fig. 15). A long-term shoreline change analysis has been completed and beach profiling is underway to monitor additional changes. It is recommended that the monitoring be continued, and because of the value of the ponds to the natural resources of the park, they should be repaired or renourished as necessary.

Breezy Point is a very young section of land that formed over the last 130 years due to the emplacement of shoreline stabilization structures, such as groins and jetties, along the Rockaway Shore. Breezy Point immediately north of the Breezy Point Jetty has not only increased in areal extent but has increased in elevation as well (Fig. 16). The elevation is presently too high to allow overwash to occur. Thus vegetation (primarily beach grass) is beginning to colonize the growing dunes, resulting in a loss of piping plover habitat. Pilot studies have been undertaken to determine if removal of the beach grass would allow sand to mobilize (through both aeolian and wave processes), and restore the plover habitat. If the grass removal does not help to restore overwash processes, it may be

necessary to manually lower the beach elevation, if the plover habitat is to be restored. Breezy Point will continue to increase volumetrically as long as sediment transport from the north continues to deliver sand to the jetty.



Figure 14. Erosion caused by scouring behind bulkhead at Floyd Bennett Field.



Figure 15. Erosion of artificial sand levees around West Pond in Jamaica Bay.

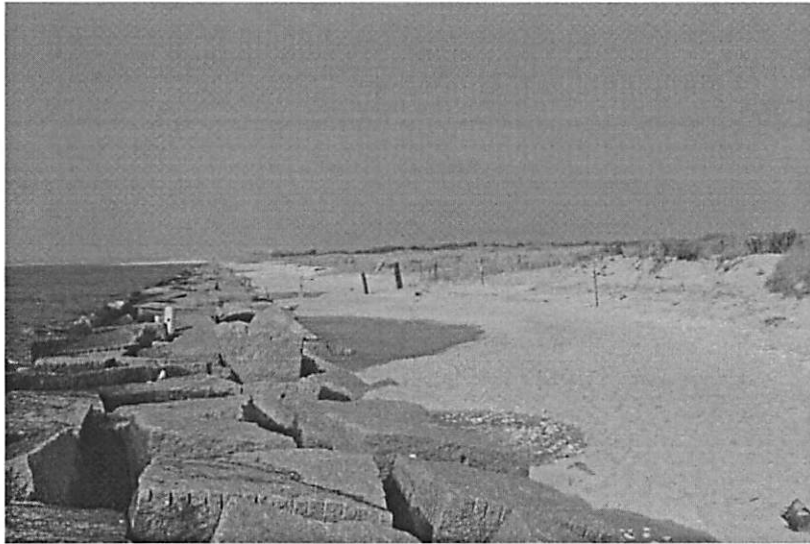


Figure 16. Beach and dune system at the southern end of Breezy Point is very wide, due to impoundment of sand against the Breezy Point jetty. Photo is looking west, Rockaway Inlet is to the left.

Sandy Hook:

The coastal geology of Sandy Hook is well documented, and a shoreline change monitoring program has been established in the park. Sediment transport along this coast are from south to north, and as such there are areas of high erosion in the south, while the shoreline is accreting in the north, mainly from disruption of sediment transport processes from groins and seawalls. There is currently a management plan in place to pipe-slurry sediment from accreting to eroding areas to maintain the beach. Coastal processes and hazards are well understood and no further recommendations are made here.

Staten Island Unit, Great Kills Park:

On the east side of Staten Island, coastal bluffs are formed in the soft glacial outwash deposits. Very rapid erosion of the moderate-relief (~5m) bluffs is currently threatening to destroy a bathhouse; continued erosion may lead to damage of other park infrastructure (Fig. 17). Additionally, rapid erosion of the marsh in front of the bluffs may be related to erosion hotspots in that the marsh may provide some bluff-toe protection from waves. The erosion of both the marsh and the bluffs may be exacerbated by a large groin at the northern end of the bluffed section of coast. It is recommended that a historical aerial photographic analysis of this area be conducted to quantify the erosion rates and investigate the reasons for the high erosion in this area. The groin to the north may be trapping sediment from upcoast, resulting in reduction of the marsh and erosion of the natural protective beach

at the base of the bluff. It would be useful to park management to have a spatial inventory of what infrastructure may be threatened in the future as a result of rapid bluff erosion.



Figure 17. Rapid erosion of bluffs composed of soft glacial outwash deposits is threatening a bathhouse in Great Kills Park.

George Washington Birthplace National Monument (GEWA)

This National Monument is situated adjacent to a dynamic river estuarine setting, Pope's Creek Estuary, which feeds into Potomac River (Fig. 18). The estuarine environment includes a migrating sand spit and tidal marsh developed on flood tide delta. Moderate-relief bluffs (5-15m) are formed in Miocene sediments just north of the estuary mouth (Fig. 19). The bluffs are actively eroding, and act as a continual source of sand for the barrier spit system. The rapid, episodic bluff erosion does present a threat to park resources (Fig. 20) but there is very little known about the rates of erosion, including the spatial and temporal variations. Some data on sandy shoreline change already exists, and there is active monitoring of coastal processes by USGS scientists from the Earth Surface Processes Program in Reston.



Figure 18. Looking south along barrier spit at mouth of Pope's Creek Estuary. Body of water on left side of photo is the Potomac River.



Figure 19. The coastline north of Pope's Creek Estuary is characterized by poorly lithified, moderate-relief bluffs. Photo is looking north.



Figure 20. Bluffs are actively eroding through processes of undercutting and subsequent slumping. This photo shows the undercut bluff as well as debris (boulders on beach) left from an earlier failure. The numerous tree roots exposed at the top edge of the bluff are evidence that the bluffs are actively eroding.

USGS scientist (Wayne Newell) has developed framework geology for the Monument and environs, including an analysis on coastal erosion. However, these are not readily available in digital or GIS format. It is recommended that the data be compiled into a GIS database for access by coastal managers and that a summary report be prepared to provide an overview of processes and research findings, especially of barrier spit and estuary mouth. The existing shoreline change data need to be evaluated for consistency and accuracy and change rates should be calculated in GIS using the Digital Shoreline Analysis Software (DSAS) for consistency. Additional investigation should be undertaken to compile other existing shoreline data (especially historical), and these data should be incorporated into the summary report.

It is also recommended that an analysis be undertaken to examine and understand the spatial and temporal distributions of bluff erosion. Some of the same data sources used for the shoreline change study can be used for the bluff erosion analysis. Existing lidar data could be used to quantify short-term bluff erosion rates and historical maps and/or aerial photography can be used to determine the long-term rates. In addition, it would be useful to develop a program to monitor shoreline change

and collect profiles of the bluff on a bi-annual basis, using GPS (preferably RTK). These data should be incorporated into the coastal change GIS database to monitor the change in relation to park resources.