Summary of Significant Features

A. Geological
1. Fringing pocket beach with two central beach stream outlets (non-tidal).
2. Low sand budget with dramatic summer buildup resulting in a wide berm.
3. Stable shoreline position.
4. The southwestern end is the long-term downdrift end. This is indicated by the width of the back dune, but the beach has finer sand toward the northeast, suggesting short-term downdrift toward the northeast.
5. Good illustration of seasonal accretionary profile.
6. Height of the frontal dune ridge is a function of width of the berm more than a function of the direction it faces.
7. There are no parabolic dunes, but there are good dry dune flats with associated dune plant species in the back dune.

B. Botanical
1. The northern coastal range limit of Wormwood (Artemisia caudata).
2. Good Beach Heather (Hudsonia tomentosa) patches and associated plants.
3. The presence of Freshwater Cord Grass (Spartina pectinata).
4. No pitch pines or semi-open community. (Not a positive feature.)
5. Good vegetation cover, no foot traffic damage, well managed.

C. Size
Crescent Beach State Park covers an area of 31 hectares and has a length of 1524 m.

Bailey Beach – Phippsburg, Sagadahoc County

Description of Geological Features

Bailey Beach (Figure 27) is a small fringing pocket beach (2.4 hectares) with a relatively wide back dune area for such a short beach. A large volume of sand has been blown onshore to cover low-lying bedrock upland. Exposure of a coarse cobble/boulder lag surface at the western end of the beach and the rapid grading to coarse sand beneath the lower beachface suggests that the shoreline has probably never been much further back than today. The sand appears to be locally derived and is not spillover from the Popham-Seawall system. This is indicated by the presence of a lag surface and the rapid grading, i.e. poor sorting, and high (feldspar + mica)/quartz ratio of the coarse grains. The source is probably:

1. Onshore transport from a small till or ice-contact stratified drift deposit, which was submerged by the Holocene rise of sea level.
2. Erosion of local bedrock headlands and their covering of glacial sand.
Figure 27  Seawall beach, Bailey Beach

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A marked variation in grain size is a significant feature of the beach. The following grain size gradations are recognizable:

1. Vertically, from an underlying lag unit to beachface surface.
2. Laterally, from west to east, a change from coarse to fine, suggesting some short-term drift of sand to the east.
3. Along the profile: coarse sand on lower beachface + less coarse sand on upper beachface + medium sand berm + medium and fine grain frontal dune ridge and seaward half of back dune + coarse grain wind-lag surface on landward half of back dune flat + medium and fine sand precipitation dunes at forest edge.

The most significant geological feature of Bailey Beach is the presence of large precipitation dunes at the forest edge. These are up to 4 m high and rim the shrub-tree line along the northern edge of the back dune area. Precipitation dunes are a rare geomorphic form in Maine and only this beach and Main Beach at Cape Elizabeth have precipitation dunes of any size. A lag surface has formed in the back dune area after many years of removal of finer sand to the precipitation dunes behind. The coarse grain wind-lag surface is unusual for a back dune area, especially on such a small beach well up in an embayment away from strong winds. The highest precipitation dunes are at the east end of the shrub-tree line where SW winds would deposit them after blowing across Casco Bay, north of Hermit Island and diagonally across the back dune.

The frontal dune ridge at Bailey Beach also has some unusual features which include relatively high relief (~2 m), a stable position, and a very long back slope. These features indicate both a current sand source and the importance of wind transport in supplying the frontal dune ridge and back dune area with sand. An healed winter scarp remained along the length of the frontal dune ridge at the time of field checking, though recent, active building of the frontal dune ridge is evident at one point where the aeolian ramp reaches the crest. The berm is narrow (~8 m) and the beachface is very steep. The reason for such a steep beachface is unknown and worthy of study.

Botanical Features

Seaward + Landward zonation is well illustrated at Bailey Beach. There is extremely good vegetational cover and a high number of species. The seaweed row is thick and abundant and is almost immediately followed by the beginning of the vegetational line. The berm and aeolian ramp are populated by Sea Rocket (Cakile edentula), Saltwort (Salsola kali), and Seabeach Orach (Chenopodium rubrum). On the frontal dune ridge are found Beach Pea (Lathyrus japonicus), American Beach Grass (Ammophila breviligulata), and Quack Grass (Agropyron repens). The succeeding area contains mainly Beach Grass (Ammophila breviligulata) and Meadowsweet (Spirea latifolia); however, Yarrow (Achillea millefolium), Blueberry (Vaccinium angustifolium), Goldenrod (Solidago spp.), Chickweed (Cerastium arvense), Strawberry (Fragaria sp.), Gooseberry (Ribes hirtellum), Beach Pea (Lathyrus japonicus), Raspberry (Rubus idaeus), Rush (Juncus Greenei), and several lichen species including British Soldiers (Cladonia cristatella) and a Birds Nest Fungus, grow there. In the depau-
perate former deflation zone is scattered sparse Beach Grass (Ammophila brevili-
gulata) interspersed with Sandy Sedge (Carex silacea) and Pinweed (Lechea maritima). The
ground there is well covered with small hummocks of folious lichens and Clad-
donia spp. including British Soldiers (Cladonia cristatella). There are also two
small circular patches of healthy Beach Heather (Hudsonia tomentosa). The last
zone is that of the forest fringe which is populated by the following: Meadow-
sweet (Spirea latifolia), Sweet Gale (Myrica Gale), Northern Wild Raisin (Viburnum
cassinoides), Prunus spp.), Staghorn Sumac (Rhus typhina), Wild Sarsaparilla (Aralia
nudicaulis), Bayberry (Myrica pensylvanica), Red Maple (Acer rubrum, Populus sp.,
Betula sp.), Fireweed (Epilobium angustifolium), Yarrow (Achilles millefolium,
Juncus sp.), and Raspberry (Rubus idaeus).

Summary of Significant Features

A. Geological

1. Presence of precipitation dunes – relationship with southwest winds and
fetch.
2. Coarse sand wind-lag surface.
3. Stable shoreline position with one frontal dune ridge, long frontal dune
ridge back slope, seasonal accretion and erosion, and steep beachface.
4. Clear example of aeolian dominated mechanism of sand supply to back dune (no
recent overwashes).

B. Botanical

1. High percentage of plant cover, even in fragile areas; little foot traffic
damage.
2. Good site for the study of dune plant survival on a deflating surface.
3. Undisturbed fragile association: depauperate American Beach Grass, Lichen
species, Mosses, Fungi, Pinweed, and Beach Heather.

C. Size

The total beach and back dune area is 2.4 hectares, which include 0.8 hectares
of intertidal area.

Seawall Beach – Phippsburg, Sagadahoc County

Description of Geological Features

Seawall Beach (Figure 27) assumes particular importance among Maine's sandy beach
systems since it is the largest undeveloped barrier spit in Maine. The other large
barrier spits (Ogunquit-Moody, Wells, Camp Ellis and Old Orchard) have been heavily
altered and developed. Characteristic of barrier spit systems, Seawall Beach is
connected to a rocky headland, in this case, at the northeast end. The beach and
back dune areas extend over 2200 m to the southwest and protect an extensive salt
marsh and tidal river complex behind. The beach, back dune, and marsh areas cover
158 hectares.
The interaction between strong northwest winds and a broad (up to 400 m) back dune area is very well illustrated at Seawall Beach, which has the largest acreage of stabilized parabolic dunes in Maine. The entire back dune area consists of northwest-oriented, stabilized, parabolic dunes with a few still active dunes toward the spit end at the Sprague River. One of these has the largest dimensions of any active parabolic dune in Maine and, on the basis of measurements of aerial photographs, has migrated 17 m between 1940 and 1972.

The frontal dune ridge at Seawall provides an excellent example of not only annual cycles of response processes but the interaction between longer term changes and active back dune processes as well. The single frontal dune ridge undergoes erosion during the winter and spring followed by a late spring through fall rebuilding through aeolian sand transport which fills in the frontal dune ridge erosional scarp by establishing an aeolian ramp. The aeolian ramp is then invaded and stabilized by successional vegetational colonization. Measurements from vertical aerial photographs indicate frontal dune ridge retreat rates of 33 to 44 cm/year, averaged over the period 1940 to 1972. During this same period, average sea level in Casco Bay, according to tide gauge data, rose a vertical distance of 15 cm. On an average beach slope of 1° this would correspond to an annual landward encroachment rate of approximately 27 cm/year. This correlation suggests that the gradual frontal dune ridge retreat, despite significant annual regrowth, may be the result of a response to the secular rise of sea level along the Maine coast. Along some sections of the beach, a consequence of this frontal dune ridge retreat through high relief parabolic dunes, formerly behind the ridge in the back dune area, is that the frontal dune ridge attains heights of 4 to 5 meters. Wherever parabolic dunes are not being transgressed by the retreating perennial winter scarp, the frontal dune ridge relief diminishes to an average of 1.5 meters. The lower sections are subjected, annually, to storm over washes and breaches.

The marsh-dune boundary follows broad curves which suggest the shaping of the present boundary by, and the former presence of, tidal river channel meanders. As these ancient meanders moved landward, sand on their seaward banks was colonized by dune vegetation. The rear edge of the barrier could thereby migrate landward in a manner similar to the growth of a point bar in a large meandering river. When stable, tidal river channels along the rear boundary of the barrier dune field provided a supply of sand for the formation of rear dune ridges by seaward transport by northwest winds. Such rear dune ridges are present today as relics. The relict ridges are now bounded by salt marsh rather than tidal river channels. Other geomorphic features, such as curvilinear sand ridges suggest substantial late Holocene modifications of Seawall Beach.

Coring transects (Trudeau, 1977) indicate that in some places the back dune sand has transgressed over the marsh at least 18 meters. In many places, however, the marsh appears to be transgressing seaward over the rear dunes in response to sea level rise. The failure of the dunes to retreat over the marsh appears to be due to: 1) the stability and inactivity of the dunes, and 2) washover fans fail to transgress the entire dune field. The result is that the barrier dune field is being narrowed by a marsh encroachment from the rear and slow frontal dune scarp recession in front, both due to rising sea level. This narrowing process is very slow.
The sand at Seawall is probably derived originally from the Kennebec River since, on a larger scale, Seawall is part of the Popham-Seawall strand plain and barrier system which covers a total of 408 hectares, including 158 hectares at Seawall and 250 hectares at Popham. The net long-term drift is from the northeast to the southwest, away from the Kennebec River, probably due to northeast storm waves and the counter-clockwise Gulf of Maine current gyre which is driven by the Kennebec and other coastal rivers. Finer-grained sand on Seawall than Popham supports the Kennebec River as a source.

The beachface has several interesting features, as follows:

1. A beachface which is always broad (~150 m), even in winter, and never steep. Summer profiles show a moderately constructional aspect with berms around 25 m wide.

2. In summer the lower beachface has a ridge and runnel system with a broad, convex upward, accretionary ridge.

3. The sand of both the beachface and the dune at Seawall is significantly finer than at Popham, but no significant difference in textural characteristics, including mean grain size, exists between dune sands and the beachface.

Description of Botanical Features

There are high, northwest-wind oriented, parabolic dunes with very interesting relationships between vegetation and the dune morphology and behavior. The depositing leeward slopes of the active parabolic dunes at Seawall Beach are good sites to study the response of American Beach Grass (Ammophila breviligulata) and Beach Heather (Hudsonia tomentosa) to sand deposition in the back dune area, away from salt spray and seaweed. Both plants show increased growth rates and more robust forms under these depositing conditions.

The vegetation pattern at Seawall is mosaic rather than zonal because of hummocky parabolic dunes which dominate the back dune field. This causes vegetation patterns which are related to the depth to the water table, and accretion and deflation rates, successional age, and sand stability rather than distance from the frontal dune ridge.

Most important is the area covered by Beach Heather (Hudsonia tomentosa) at Seawall. There is probably more acreage of Beach Heather at Seawall and Reid State Park than in all other stands in Maine combined.

Seawall appears to be the northernmost coastal dune habitat for the Earthstar Puffball (Geaster hygrometricus) in Maine.

There are a few relict overwash sites through the high frontal dune ridge which are indicated by the presence of patches of Dusty Miller (Artemisia Stelleriana) and flotsam debris.
There is a young pitch pine forest with many upland forest species in the back dune of Seawall. This forest is not as mature as the one at Popham. Its youth and the generally mosaic floristic patterns of the rest of the dune field suggest that fire or timber cutting may have taken place here in the last century.

A complete species list for Popham, Reid and Seawall beaches has been compiled by Trudeau (1977), thus only the dominant cover species of the back dune are noted here. The dominant vegetation species in their approximate order of importance are:

1. American Beach Grass — *Ammophila breviligulata*
2. Beach Heather — *Hudsonia tomentosa*
3. Bayberry — *Myrica pensylvanica*
4. Pitch Pine — *Pinus rigida*
5. Meadowsweet — *Spiraea latifolia*
6. Beach Pea — *Lathyrus japonicus*
7. Raspberry — *Rubus idaeus*

Summary of Significant Features

A. Geological Features

1. The only large, undeveloped or unaltered, barrier spit in Maine.
2. The largest parabolic dune field in Maine.
3. A few high relief, active, northwest-wind oriented, parabolic dunes.
4. A measured shoreline retreat of 11 to 14 m during the period 1940 to 1972.
5. Because of its unaltered state, a good laboratory for the study of natural barrier maintenance, sedimentary events of the Kennebec River, and sea level rise effects.
6. Relict dune ridges exist because of northwest wind transport of sand from ancient channel banks of the Sprague River during neap tide periods.

B. Botanical

1. The highest percentage of cover of non-forest dune vegetation in Maine's large back dune areas.
2. Extremely high diversity and large numbers of dune species.
3. Full range of successional stages.
4. The most mosaic floristic patterns in Maine's back dune areas, due to sand accretion and deflation processes, depth to water table, and successional age of sites, i.e. controlled by the preponderance of parabolic dunes rather than back dune aeolian flats.
5. Most important, a large share of Maine's Beach Heather (*Hudsonia tomentosa*) is located here.
6. Northernmost stand of Earthstar Puffball (*Geaster hygrometricus*) on coastal sand dunes within the state.
7. Immature or near edaphic climax pitch pine forest in the center of the back dune area.

C. Peripheral Significant Features
1. Habitat for specially adapted spiders, insects and small mammals.
2. Least tern and piping plover nesting site at spit end.
3. Feeding habitat for other shore birds.
4. Solitude/Isolation. Seawall is cut off from shoreline access by two tidal rivers. This improves management and preservation potential.
5. Surfboard riding is a popular summer recreation because of broad beachface and isolation.

Popham Beach Areas — Phippsburg, Sagadahoc County

Popham Beach (Figure 28) is one of the largest (250 hectares of supratidal sand) and most complex systems in Maine. Because of the complexity, Popham Beach has been divided into seven separate areas. However, it is instructive to list all the significant features of Popham in one list. Some of the features listed below are general or more important to the Holocene history of Maine than to sandy beach and dune processes.

Significant Geological Features of Popham Beach System (Morse River to Fort Popham)

1. Complex spit in mouth of Morse River.
2. Two large cuspatte forelands.
3. The only two large, sandy tombolos in Maine — the only large tombolos which connect a public beach to an island.
4. Presence of accretionary ridge and swale topography from a past accretionary period. Another area of accretionary ridge and swale topography may form in the next few years at the eastern end of Popham Beach State Park.
5. Relict erosional scarps — especially at the seaward edge of the pitch pine forest west of the State Park parking lot.
6. Relict shorelines, possibly 2900 years old, behind Popham village in a small salt marsh.
7. Possible former marine lagoon which is now a freshwater lake — Silver Lake.
8. Configuration and bathymetry illustrating river-derived sand and influence of Coriolis force, one of the few beaches in Maine with predominantly river derived sand.
9. Evidence that overwash is important in supplying sand to some of the back dune areas.
10. Large stabilized parabolic dunes, created by northwest winds, in Popham Beach State Park pitch pine forest and some on Hunnewell Beach.
11. Presence of a dated relict intertidal sand flat beneath Atkins Bay salt marsh may indicate catastrophic barrier formation about 6,800 years ago.
12. Potential key to catastrophic Holocene sedimentary events in the Kennebec and Androscoggin Rivers.
13. Best illustration of very unstable natural geological processes; major shoreline changes have occurred which are due to: Kennebec River tidal current effects on sand bodies, Kennebec River tidal current effects on wave refraction, and migration of Morse River tidal channel.
14. Relict garnet layer (former erosional shoreline) preserved beneath dunes near Rockledge, active garnet fractionation occurring where beach is being eroded during storms.
15. Extremely variable beach profile types, both spatially and temporally.
16. Accreting berm at Popham Beach State Park (on both sides of Fox Island cuspate foreland) which has value for recreation, as least term nesting sites, and as an illustration of a short-term accretionary process in a time of rising sea level.
17. Extensive variety of sandy bedforms, especially ripple mark patterns of many types.
18. Eroding profiles — until recently Hunnewell Beach was eroding at the fastest rate in Maine.
19. Obvious examples of wave refraction/wave energy/erosion-accrretion relationships (especially obvious when selecting a spot from which to launch a boat at Hunnewell Beach).
20. Natural laboratory for the study of the relative magnitude of man-induced versus natural changes in beach profiles and sand supply.
21. A good example of the influence of southwest wind on the height of the frontal dune ridge (large southwest facing frontal dune ridge south of State Park parking lot).
22. Two very large nearshore sand bars, persistent and migrating onshore, the only ones of this size in Maine.
23. Large sandy ebb-tidal delta features up to two miles offshore formed by the Kennebec River, includes Pond Island Shoal with its surficial bars. Largest ebb-tidal delta in Maine.
24. Example of poor relationship between grain size, distance from sand source, and beachface slope (unless Seawall Beach is included in system).
25. High relief parabolic dunes behind Hunnewell Point formed by onshore southwest winds.
26. High rear dune ridge (along access road to Morse River from Route 209).
Significant Botanical Features of Popham Beach System (Morse River to Kennebec River to Fort Popham)

Trudeau (1977) has mapped the complex floristic patterns of this beach and dune area and has compiled an extensive species list for Popham as well as Seawall and Reid beaches. Consequently extensive species lists have not been compiled for the Popham areas in this report.

General dune plant habitat types which are of statewide significance are listed below:

1. Parabolic dunes of various ages since last activity have many successional stages from Beach Heather (Hudsonia tomentosa) association through edaphic climax Pitch Pine (Pinus rigida) forest.
2. Relict berm-and-ridge dune areas, as in the complex spit at the mouth of the Morse River.
3. Sandy marsh flats, newly formed.
4. Overwash deposits in back dune and on perennially accreting berms.
5. Perennially accreting berms.

Specific botanical features which are of statewide significance are listed below:

1. Absence of Wormwood (Artemisia caudata), which is present on all major beaches south of Casco Bay, but none north of the bay.
2. Presence of: Poverty Grass (Corema Conradii), Bearberry (Arctostaphylos uva-ursi), Golden Heather (Hudsonia ericoides).
3. Associations of Beach Heather (Hudsonia tomentosa), Sandy Sedge (Carex silicica), Pinweed Aster (Aster linarifolius), Pinweed (Lechea maritima), Jointweed (Polygonella articulata), Greene's Rush (Juncus Greenei), and Lichens (Cladonia spp.) in stabilized parabolic dunes of the State Park and behind portions of Hunnewell Beach.
4. The northernmost coastal dune stands in Maine of Earthstar Puffball (Geaster hygrometricus) are located either here at Popham or at Seawall (never observed personally at Popham, but have been seen at Seawall).

The seven divisions of the Popham Beach System are arranged in geographic order from Fort Popham to the Morse River and are as follows:

1. Village Marsh Ancient Shoreline at Popham Village
2. West Bank of the Kennebec River, from Coast Guard Station to Hunnewell Point
3. Wood Island Tombolo and Intertidal Cupate Foreland at Hunnewell Point
4. Pond Island Shoal's Offshore Bars
5. Hunnewell Point Back Dune Area
6. Hunnewell Beach Back Dune Area
7. Popham Beach State Park
Village Marsh Ancient Shoreline – Popham Village

Description of Geological Features

A single type of geological feature makes this a critical area of statewide significance, i.e. the presence of two probable former shorelines far back from the present shoreline in an historically stable area. The shorelines occur as two curved sandy ridges in the Village Marsh and are wind deposited features which outline underlying wave shaped sandy shorelines. The wave deposited sand is now buried by the encroaching salt marsh peat – a result of sea level rise since the shorelines formed.

These former shorelines may be either a complex spit or accretionary ridges of a swash aligned beach section. If they are part of a complex spit, the waves which formed them approached from the north and the relict shorelines have been followed by only 100 to 200 m of beach accretion. If they are swash aligned ridges, the waves which formed them approached from the east and 450 m of accretion has since taken place.

The Village Salt Marsh north of the ancient shorelines is underlain by a coarse-sand flat at 1.5 m below the present marsh surface. This is strong evidence for ancient wave approach from the north. Deposition of salt marsh peat first occurred when the sand flat was sealed off either by the ancient ridges or by the present harbor shoreline to the north or by both. C\textsuperscript{14} dating of the first marsh peat over the coarse sand flat puts this event at about 2900 years ago. The ancient shorelines are part of the longest lasting accretionary regime known for any Maine beach in the late Holocene. They may represent a catastrophic accretionary event at the mouth of the Kennebec River; otherwise, normal beach processes in a regime of rising sea level would have long since obliterated them as geomorphic features.

Description of Botanical Features

The two sandy ridges are vegetated by Bayberry (Myrica pensylvanica), Gooseberry (Ribes sp.), Raspberry (Rubus idaeus), Great Angelica (Angelica atropurpurea), Pasture Grasses, Seaside Rose (Rosa rugosa) and a few isolated trees. Proximity of the salt water table beneath these low ridges prevents later succession despite the age of the ridges. Wind whipped salt spray from the flooded salt marsh during spring high tides probably has the same inhibiting effect on succession.

Summary of Significant Features

A. Geological

1. Two relict shorelines – oldest late Holocene sandy beach shorelines with surficial expression known in Maine – potential key to catastrophic sedimentary events at Popham and in the Kennebec River.

2. Coarse grain wave deposited sand flat and basal salt marsh peat contact – further key to sedimentary events of the area and source of C\textsuperscript{14} date of
shor lines. This is also a regressive sedimentary sequence (peat over sand) in a rising sea level regime where transgressive sequences (sand over peat) are expected.

B. Botanical

Illustrates stagnated plant community succession on a relict frontal dune ridge of great age — due to effects of salt spray and proximity of salt water table.

C. Size

The size of the area is 2.4 hectares.

West Bank of the Kennebec River at Popham

Description of Geological Features

This area is significant because it has a perennially accreting berm of at least five years age. The age is based on the presence near the southern end of a relict erosional scarp, formed in 1972, behind the vegetated overwash berm. The berm continues to accumulate sand by wave overwash despite the fairly abundant vegetational cover.

The Kennebec River shore is one of the few beach areas in Maine where wave overwash is the dominant means of sand transport into the vegetated dunes normally above high water. Overwash is significant here largely because the beach faces east, a direction from which wind seldom blows. Thus, onshore aeolian transport is minimal and there is no frontal dune ridge to block the flow of overwash sand. There is no aeolian ramp. The dominance of overwash deposition has favored Dusty Miller (Artemisia Stelleriana) and berm colonizers over American Beach Grass. It has also left abundant flotsam exposed, especially large logs and driftwood.

The perennially accreting overwash berm is about 50 m wide. It might be a good piping plover and/or least tern nesting site if the area were not so heavily used by beach strollers and sunbathers.

The overwash sands of the river shore are rich in garnet. This is an important key to the mechanism of sand transport at Hunnewell Beach. Only the extensive wave erosion of eastern Hunnewell (over the last few years) could fractionate out the large volumes of garnet seen today on the river shore. The garnet has acted as a tracer which indicates that the initial path of sand eroded from eastern Hunnewell is eastward and northward upriver around Hunnewell Point.

The beachface of the river shore area is fairly steep due to the velocity of the longshore river tidal current. A swale of variable dimension is located on the beachface today and can be seen in most old photos of the area. Study of this swale and its history may indicate the rates and directions of sand movement on the Kennebec and Hunnewell Beach shores of Popham.
Description of Botanical Features

The species composition of an overwash-dominated, vegetated, relict berm is of interest because of the rarity of overwash dominated areas in Maine. The most striking feature of the flora here is the abundance of Dusty Miller (*Artemisia Stelleriana*). Berm colonizers extend well into the relict berm because of overwash transport of their seeds and the presence of a suitable nutrient-rich substrate such as seaweed. American Beach Grass (*Ammophila breviligulata*) is fairly healthy in this environment, though it grows in isolated clumps rather than a thick carpet.

The common species are:

- **American Beach Grass** — *Ammophila breviligulata*
- **Dusty Miller** — *Artemisia Stelleriana*
- **Saltwort** — *Salsola kali*
- **Sea Rocket** — *Cakile edentula*
- **Beach Pea** — *Lathyrus japonicus*

Summary of Significant Features

A. Geological

1. An accretionary area, accreting while Hunnewell's south shore was eroding.
2. Extensive garnet in overwash indicates path of sand eroded from Hunnewell.
3. Illustrates importance of overwash in supplying sand to vegetated area. Relative importance of overwash at this site may be greater than almost any other sand beach in Maine (cf. Pemaquid Beach).
4. Presence of relict erosional scarp — educational warning of instability of shoreline position.
5. Examples of beachface features related to Kennebec River — steep beachface slope (caused by river's tidal current); persistent swale, perhaps related to the path and rate of longshore sediment movement.

B. Botanical

Illustrates floral composition of an overwash site, characterized by dominance of Dusty Miller.

C. Size

The size of the area is 5 hectares.
Wood Island Tombolo and Hunnewell Point Intertidal Cuspate Foreland – Popham Beach

Description of Geological Features

All significant features of the tombolo and cuspate foreland area between Wood Island and Hunnewell Point are geological since the area is entirely intertidal with no vascular plants.

Wood Island Tombolo is one of only two large, sandy tombolos in Maine and provides public access to a wooded island of significant geological, botanical, and wildlife value. The tombolo demonstrates extreme seasonal and longer term variability in size and shape. The variability is attributed to a response to changing wave refraction patterns, changes in channel characteristics of the Kennebec River, and man-induced removal of sand from the adjacent Kennebec River channel. Because of the strong tidal potential across the tombolo created by the Kennebec River flow, a transverse channel is cut across the tombolo occasionally. Such breaching of the tombolo and subsequent current velocity increases may trigger major changes in the erosional-accretionary status of Hunnewell Beach and Hunnewell Point by increasing current scour along Hunnewell Beach and altering current influence on wave refraction patterns. The effects of Kennebec River ebb-current and onshore wave transport of sand can be seen in the occasional formation of oppositely oriented spits on opposite ends of the tombolo breach channel. Where transverse tidal currents are strongest in the low portion of the Wood Island Tombolo, excellent examples of small and large ripple bed forms are found.

The Hunnewell Point portion of the area is an excellent example of a cuspate foreland formed by two processes: confluence of currents and wave refraction in the lee of an island. Hunnewell Point cuspate foreland is significant for its history of extremely rapid perennial accretion with an associated formation of a band of ridge and swale dune topography between 1910 and 1930. The accretionary phase was eventually followed by a period of equally rapid erosion beginning in 1965. Some features observed during 1977-78 may presage a new perennial accretion of Hunnewell Point. The features which suggest this are the present filling of the breach channel of the Wood Island Tombolo, the higher and broader relief of the tombolo throughout its length, the accretionary summer berm on the south shore of the Hunnewell Point cuspate foreland, and the confluence of wave sets from the east and the west just to the west of Hunnewell Point.

Hunnewell Point and the Pond Island Shoal may be the nearest approximation to a river delta in Maine. The sands comprising these features are almost certainly derived from the Kennebec River. On a larger scale, the entire Popham-Seawall-Pond Island Shoal system is an example of river-derived beach and nearshore sand. The influence on river-derived sand distribution by the counterclockwise Gulf of Maine current gyre and the Coriolis force is well illustrated in the large-scale features of this system.

Size

The size of the area is 20 hectares.
Pond Island Shoal's Offshore Bars

Description of Geological Features

These two offshore bars are surficial features of the large cusp shaped Pond Island Shoal. Pond Island Shoal is a subtidal extension of the Hunnewell Point cuspatte foreland. The Shoal is a constructional, delta-like feature formed at the equilibrium trap point of net onshore and net downstream sediment movement. The surficial bars are variable features which can be likened to the ebb-tidal delta bars of a barrier beach inlet. They are significant as features of the largest sandy ebb-tidal delta in Maine. They may, in fact, be features of a true river delta. Their significance to the beach proper lies in their influence on: 1) wave refraction patterns and wave energy striking the beach, 2) sand supply to the beach from the bars. Changes in these bars may be the key to explaining drastic erosion and accretion at Hunnewell Beach.

Hunnewell Point Back Dune Area — Popham Beach

Description of Geological Features

The most significant geological features of this area are its stabilized high relief parabolic dunes formed by winds blowing out of the south or southwest. These are the only high relief parabolic dunes with this orientation yet encountered in Maine. Most of Maine's parabolic dunes are formed by strong northwest winds. Here the orientation is different because of: 1) fetch restriction — Rockledge Ridge blocks northwest winds, 2) wind direction changed by local topography — west and southwest winds take on a southerly wind direction as they blow around the tip of Rockledge Ridge.

Description of Botanical Features

The stabilized parabolic dunes here are notable for their thick healthy cover of Beach Heather *(Hudsonia tomentosa)*. There are probably less than 40 hectares of Beach Heather in the State of Maine. This is a fragile sand dune cover, more susceptible to foot and vehicle traffic than American Beach Grass because it is slow growing, takes decades to colonize new areas and grows in historically stable dunes where development pressure is highest.

Summary of Significant Features

A. Geological
   1. South wind oriented, stabilized, high relief parabolic dunes — a rare or unique orientation in Maine.
   2. Part of a cuspatte foreland — one of the largest in Maine.

B. Botanical
   Good Beach Heather *(Hudsonia tomentosa)* cover.
C. Size

The size of the Hunnewell Point Back dune area is restricted to 1.2 hectares.

Hunnewell Beach Back Dune Area – Popham Beach

Description of Geological Features

This area has well vegetated, stabilized parabolic dunes with both semi-open dry dune slacks and thick Pitch Pine (Pinus rigida) cover. The orientation of these parabolic dunes is no longer obvious but they probably formed under the influence of south and southwest winds, thus making them unusual in Maine. The wind fetch is restricted on the northwest side by Sabino Hill.

Just south of this area a boundary exists between an edaphic climax community of Pitch Pines and a younger successional stage relict frontal dune ridge. This boundary represents the approximate historical limit of former beach erosion at Hunnewell Beach. The age of this erosion limit is 1900 or earlier.

Description of Botanical Features

The area has a variety of cover types and species mixes. The floristic pattern is mosaic due to the presence of parabolic dunes. Cover type ranges from open Lichen carpets through thick Pitch Pine cover. Species present include:

1. Pitch Pine – Pinus rigida
2. Beach Heather – Hudsonia tomentosa
3. Lichens – Cladonia spp.
4. Jointweed – Polygonaella articulata
5. Early Sedge – Carex pensylvanica

The area includes part of a Cranberry-Sweet Gale bog which is seasonally flooded. In the bog area are Cranberry (Vaccinium macrocarpon), Sweet Gale (Myrica gale), Swamp Winterberry (Ilex verticillata) and numerous Rush, Sedge and Grass species.

Summary of Significant Features

A. Geological

Examples of parabolic dunes created by south to southwest winds, now stabilized by various mixtures of Pitch Pines (Pinus rigida) and dry dune slack vegetation.

B. Botanical

1. Good example of vegetational variety of open dry dune slack plants mixed with Pitch Pines.

2. Example of a seasonally flooded temporary bog dominated by Cranberry and Sweet Gale.
C. Size
The Hunnewell Beach back dune area is 1.9 hectares.

Popham Beach State Park — Phippsburg

Description of Geological Features

The dune vegetation and oceanic processes of Popham Beach State Park have been described in detail by Trudeau (1977). The emphasis of his work has been on vegetation. He has compiled floristic maps and a species list for the park. Because of his work a species list and detailed floral description were not attempted during field checking of the Popham Beach System.

A detailed shoreline change map of Popham Beach has been compiled by Nelson, 1977. It includes information from cores, old ground level photos, a vertical air photo collection and three years of sequential oblique and near vertical air photos. Trudeau's report and Nelson's shoreline change map are available for reference from the Bureau of Geology, Dept. of Conservation, Augusta, Maine.

The Popham Beach State Park area includes a barrier dune field, associated salt marsh, and a complex spit and tidal inlet. The shoreline and intertidal features throughout the area are among the most unstable in Maine. Drastic accretion and erosion have characterized this area historically. This instability is the single most significant geological feature of the area. The degree of instability is responsible for the formation of a variety of geological and botanical features.

For ease of discussion, these various features are categorized into thirteen sub-units.

1. Fox Island Tombolo

This is one of only two large sandy tombolos in Maine, the other being the Wood Island Tombolo. It is a complex feature, flanked by two large nearshore sand bars when field checked and sometimes traversed by a distributary channel of the Morse River. Migration of these bars and sealing of the distributary has sometimes left relict longitudinal and transverse swales on the tombolo. Fox Island Tombolo (including the proximal ends of the associated nearshore bars) is larger than Wood Island Tombolo. Since the tombolo is uncovered throughout most of the tidal cycle, it provides public access to Fox Island from Popham Beach State Park. The Tombolo area is about 14 hectares (excluding the nearshore bars or flanks).

2. Western Hunnewell Beach Large Nearshore Sand Bar

This feature has grown in size and moved shoreward over the last three years. Before reaching the beachface it had a hook-shaped downdrift on spit end in front of the seawalls of central Hunnewell Beach. The bar has grown in a northeast direction toward the eroding section of Hunnewell. It protects and supplies sand
to all the beachface behind it – causing appreciable perennial accretion. Remnants of a beachface runnel were visible on the landward edge of the large nearshore bar in August of 1977. The bar and runnel once formed a ridge and runnel beachface profile type of exaggerated proportions. The size of the nearshore bar in December 1976 was about 16 hectares.

Though the direction of transport of sand in this bar is onshore and toward the Kennebec River, the bar's formation and growth have been contemporaneous with sand loss from central and eastern Hunnewell, suggesting a paradox, i.e. the beach at the downdrift end of the bar was the source area for the bar. What is even more confusing is that in the late 1940's a similar nearshore bar formed off western Hunnewell when no portion of Hunnewell was eroding.

This nearshore bar may be one reservoir in a cyclical path of sand which includes the Wood Island Tombolo, the Kennebec channel and Pond Island Shoal. Rates of sediment flow from one reservoir to another may be triggered by breaching of the Wood Island Tombolo, changing Kennebec sand supply, dredging, spring runoff rates, evolution of the Kennebec ebb-tidal delta bar configurations and other factors. The cycle itself may exist since there are natural and artificial tracers to document the cycle path. Behavior of the cycle may be the major cause of drastic erosion and accretion at Hunnewell Beach.

An alternative explanation for the development of the nearshore bar would not require major and large-scale transfers of sand but only a short-term reversal, during a northeast storm, of the usual alongshore current direction toward the Kennebec River. Such a reversal is possible because of the properly oriented wind stresses during the passage of a northeast storm, which also produces the sand volume which can be rapidly transported to an equilibrium trap position where the nearshore bar then forms.

3. Large Perennially Accreting Berm of Western Hunnewell.

The berm here is 90 to 120 m wide, the widest berm in Maine. There is a broad aeolian ramp being invaded by American Beach Grass. The berm itself is being invaded by American Beach Grass and Dusty Miller. This is a good area for viewing frontal dune ridge formation; however, the mature ridge will not be very high since the beach faces southeast. The perennial accretion of this area is noteworthy because only three years ago it was eroding perennially. The accretion is also noteworthy because it is contemporary with drastic erosion of eastern Hunnewell. Thus, general statements about the erosional status of Popham Beach, the effect of Kennebec dredging on Popham Beach or the effect of sea level rise on Popham Beach can not safely be made. The area of the berm is 4 hectares.

4. Relict Ridge and Berm Province of Western Hunnewell (Accretionary Ridge and Swale Topography).

Prior to 1940 all of Hunnewell Beach was accreting. Some of the relict frontal dune ridges and berms left by this accretion are still visible at the western end of

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Popham Beach State Park between utility poles #825-164S and #169-87. The area is dominated by American Beach Grass which is now depauperate because of the age of these dunes and lack of sand burial. The landward-most ridge may be more than 100 years old. Formerly disturbed areas have been invaded by Beach Heather (Hudsonia tomentosa), Lichens (Cladonia spp.), Pinweed (Lechea maritima) and Early Sedge (Carex pensylvanica). There are no parabolic dunes in the area, which covers 2.8 hectares.

5. Morse River Ebb-Tidal Delta.

The complex bars, channels, and small bedforms of the Morse River ebb-tidal delta are valuable features for the study of the formation and preservation of barrier inlet sedimentary structures. The characters of these features are very variable. The meanders of the intertidal Morse River ebb channel are significant for their effect on erosional/accretional status of the dunes between Morse Mountain Headland and Fox Island Tombolo. The area of the ebb-tidal delta is about 32 hectares (including the large nearshore bar west of Fox Island Tombolo).

6. Large Nearshore Sand Bar West of Fox Island Tombolo.

This bar is similar to the one off western Hunnewell in that it formed in the last three years and is migrating onshore, protecting and supplying sand to the berm and dunes landward of it. It does not have an apparent downdrift or spit end, but this may be because the western end is truncated by a distributary of the Morse River ebb channel. The runnel landward of this nearshore bar is also a former ebb channel distributary which once traversed Fox Island Tombolo, but now is sealed off. The large nearshore bar may, therefore, be part of the Morse River ebb-tidal delta. Its eastern end is welded to, and part of, the Fox Island Tombolo. A bar similar to this one existed in the same area in 1964. Onshore migration of such large bars leads to shoreline accretion. Subsequent meandering of Morse River ebb channel distributaries removes sand seaward and leads to shoreline erosion. This cycle does not have a regular periodicity. Boundaries are indistinct, but the area of this bar is approximately 15 hectares.

7. Incipient, Perennially Accreting Berm Landward of Western Large Nearshore Sand Bar.

This is an indistinct area of accretion which has formed only since the channel, or runnel, landward of the western large nearshore bar became sealed and began filling. Prior to sealing of the channel, which used to breach the Fox Island Tombolo and connected with the runnel landward of Hunnewell's large nearshore bar, tidal currents maintained a steep upper beachface below the berm edge.
8. Overwashed, Perennially Accreting Berm West of Fox Island Cuspate Foreland

This large area accreted subsequent to a channel shift in the early 1970's. Frequent winter washover and ice damage inhibited vegetation in most of the area until 1975. In the last 2½ years washover accretion has replaced washover damage. The area is now sparsely vegetated by American Beach Grass and Dusty Miller as well as berm colonizers. There is a very broad, actively growing, incipient frontal dune ridge on the seaward edge of the area and another actively growing frontal dune ridge near the rear of the area (just seaward of the 1972 river channel bank position). The second frontal dune ridge derives its sand from a deflation zone seaward of it, but landward of the first frontal dune ridge.

The area is unique in Maine in that it has two actively growing frontal dune ridges, one behind the other. Overwash accretion has played an important role in the supply of sand to this area, but the role of aeolian transport should become greater as the seaward frontal dune ridge builds vertically.

The area is a significant nesting habitat for least terns and piping plovers.

The western margin of the area is being eroded by a cut bank of one of the Morse River ebb-tidal channels. The area size is 5.3 hectares.

9. Thick Healthy Beach Grass Zone

This zone has the shape of an acute triangle, bounded on the north by the approximate 1953 scarp line (caused by meander of the Morse River at that time), on the southwest by the 1972 scarp line, and on the south by the 1976 scarp line (from a now sealed off minor distributary of the Morse River). The area has been vegetated for about twenty years and now has some of the healthiest American Beach Grass in Maine, certainly one of the largest stands of healthy beach grass on young dunes in the State. Sand is supplied to the back dune here by wind transport more than by overwash. Not much vertical sand accretion (sand burial) is taking place, however. Dead culms and blades of Beach Grass form a dry straw carpet over the sand. This is a good site for studying natural senescence rates of Beach Grass on young dune flats without sand burial. This area also has the highest frontal dune ridge at Popham - 3 m. This is because the ridge faces the prevailing, onshore-directed southwest wind and because there has been an abundant sand supply from the overwashed perennially accreting berm described above. The area is 2.8 hectares.

10. Semi-open Parabolic Dunes and Old Overwash Area

This small dune area surrounds the north, east, and south sides of the state park parking lot. The parabolic dunes are of high relief and were formed by winter northwest winds. The dunes were active in the 1930's and 1940's. These are the highest relief parabolic dunes at Popham. They are also significant for providing most of the habitat for Beach Heather (Hudsonia tomentosa) within the park boundaries (recall that there are less than 40 hectares of Hudsonia tomentosa in Maine and that this plant is highly susceptible to foot traffic damage).
About thirty per cent of these high relief parabolic dunes with semi-open Pitch Pine (Pinus rigida) cover and Beach Heather (Hudsonia tomentosa) were leveled when the parking lot was constructed at Popham Beach State Park. Further construction of parking lots or large user facilities should be discouraged in this area.

The area also includes what appear to be old overwashes with thick beach grass cover just south of the parking lot. These overwashes would be about twenty-five years old, having formed subsequent to an erosional event around 1953. Construction of a parking lot or large user facilities in this area would be unwise since its proximity to an historical erosional shoreline indicates a potential for repeated erosion here. The area is 3.6 hectares.

11. Stabilized Parabolic Dunes with Climax Pitch Pine Forest.

This is the largest mature pitch pine forest on sandy dunes in the state. It forms the bulk of the Popham Beach barrier. The area is highly valuable for studying the edaphic climax of Maine's coastal dunes. For this purpose it is more valuable than the immature pitch pine forest of Seawall Beach (Phippsburg). There are many upland forest species in the ground cover and understory. Species diversity is higher than that for most dune communities.

The area is the least fragile of any of Popham's dune communities, especially since a soil layer has developed. It is, therefore, the best choice within the dune system for placement of picnic tables, parking lot expansion or large user facilities. Nonetheless, encroachment of such facilities should be discouraged because of the area's unique scientific value, particularly when there is the option of placing such facilities on upland bedrock.

There is a rear dune ridge to the northwest of the forested area at the marsh/sand border. The size of the area is 20 hectares.


This is the best example of a complex spit in Maine. Its orientation is a key to the net westward drift of sand at Popham (away from the Kennebec River). The spit formed as a result of a major channel shift in the Morse River in the 1940's. An unusual bar island, originally formed by waves and currents, remains preserved in the complex spit with a vegetated wind-deposited veneer. The spit reached an accretionary maximum in 1972 and has since eroded dramatically as a result of the meanders of a distributary channel of the Morse River. The eroding scarp has left behind heavy garnet sand as a result of density fractionation. The eroding shoreline is also notable for its considerable overwash deposits which take place because there is no berm or frontal dune ridge to stop them.

During the storms of January 9 and February 7, 1978, almost all the grassy dune surface of the complex spit was overwashed. Observations after the January 9 storm do not indicate any significant vertical accretion or landward migration of the dunes via overwash sand deposition. The impact of the overwash on the vigor of the next season's Beach Grass remains to be seen.
Because the dunes here are less than thirty years old they still have a thick, healthy American Beach Grass cover. In the southeast corner are some parabolic dunes formed prior to 1940. They are stabilized with Early Sedge (Carex pensylvanica), Sandy Sedge (Carex silicea), and Pasture Grasses. The eastern margin is of greater age and provides an example of late succession on moist back dune. Raspberry (Rubus idaeus) and Fireweed (Epilobium angustifolium) are common here.

The complex spit is also significant in that it provides protection for a newly formed salt marsh on a former sand flat behind the spit. A geological cross section through the new marsh and spit would indicate a regressive (lowering sea level) or accretionary regime. This is unusual since sea level is rising in Maine. The anomaly can be explained as the result of a locally abundant sand supply caused by a shift in the Morse River channel. The area is 7.7 hectares.

13. Former Sand Flat with New Salt Marsh Behind Complex Spit, Old Shoreline Behind

This area is significant primarily for its geological indications of a regressive regime as explained above. It is interesting to note that more than a meter of pure salt marsh peat has accumulated vertically over portions of the sand flat in just a few decades. This verifies the need for using basal salt marsh peat for C14 dating of sea level rise or sedimentary events. The area is thus very instructive in a geological sense.

The area is of statewide significance because it is a large, newly created salt marsh of great ecological value.

There is an old shoreline and sand dune at the rear edge of the marsh. There has been no sand activity here since the salt marsh formed, yet the vegetational composition (American Beach Grass, Dusty Miller and Beach Pea) resembles that of a young frontal dune ridge or aeolian ramp. The vegetational assemblage is due to salt spray and the proximity of the water table. The influence of either salt spray or sand blasting damage to back dune trees on the Maine coast is dramatically illustrated on the utility poles of this rear sand dune. Pitting of the poles is greatest on the southwest side. The metallic letters on the poles are raised in relief on wooden pedestals as all the wood around them has been removed by windborne abrasive agents (sand or salt).

The rear dune and shoreline are valuable as: 1) indicator of extreme variability of shoreline position, 2) example of stagnant succession due to salt spray and salt water table.

The area of the former sand flat with new salt marsh, including the narrow dune at the rear, is 12.1 hectares.

Reid Beach – Sagadahoc County

Description of the Geological Features

There are two significant areas at Reid State Park (Figure 29). They are 1040 m long Mile Beach and adjacent 420 m long Half Mile Beach. Mile beach connects Todd's
Figure 29 Reid State Park Beaches: Mile and Half Mile Beaches
and Griffith's Heads and is a long, straight closed barrier. It protects a salt marsh which drains to the sea north of Griffith's Head. The straightness is due to the position of the beach at the mouth of the underlying bedrock embayment and at the mouth of Sheepscot Bay. Incoming waves are not refracted into a curve before striking the beach. (Recall that baymouth beaches are straight whereas bayhead beaches are curved).

Half Mile Beach is an open barrier spit with a tidal reentrant (Little River) draining out of the southwestern end. Half Mile Beach also protects a substantial salt marsh. The diversity of habitats and thus the diversity of species in the back dune is lower at Reid than in the Popham-Seawall system, but Reid is the northernmost, large, back dune habitat in Maine and thus may be the northern range limit in the state for several species. It has the northernmost stands of Beach Heather (Hudsonia tomentosa) in Maine.

Mile and Half Mile beaches have interesting features relevant to the study of barrier formation, barrier maintenance, sea level rise, drift versus swash alignments, sand source, and inlet migration.

The salt marsh behind Mile Beach is connected via a sill to the ocean. This sill is about 1 m below present mean high water. Thus when sea level was about 1 m lower than today (about 2000 years ago) the present inlet was too high to permit passage of salt water into the marsh behind the barrier. Perhaps an inlet once existed through the closed barrier of Mile Beach. Sealing of this former inlet may have taken place when sea level became high enough to open the existing inlet over the rocky sill north of Griffith's Head. Sealing of such an inlet may be responsible for: 1) the historical shoreline stability of Reid due to both an increased sand supply when sand was no longer lost upstream into the tidal reentrant and the removal of the complicated effect of an ebb-tidal delta on wave refraction, sand supply and drift direction, 2) an end to breaching caused by cut banks of the meandering tidal river channel, 3) an end to sand supply from the rear for barrier maintenance and parabolic dune field broadening. (The shore of the tidal Little River provides abundant sand to the backside of Half Mile Beach's dune field. The same process is active at Ogunquit, where parabolic dunes are supplied by sand brought in by the Ogunquit River.)

It is also possible that the marsh behind Mile Beach is only as old as the present inlet over the sill north of Griffith's Head. Coring of the marsh to determine thickness of marsh peats would indicate the age of Reid as a barrier.

Because of contrasting characteristics, the two sections of beach at Reid are discussed separately.

Mile Beach — Geological Features

The sand is coarse or medium in the entire beachface and berm. It is young (i.e. not far from its source of eroded rock or glacial sand deposit). Youth is indicated by the high percentage of feldspar and schist fragments. Because of the relative
The coarseness of grain size there is a steep upper beachface (coarse sand has higher permeability to water and thus can be accumulated into a steeper slope by waves). The sand of Half Mile Beach is finer in comparison, but also young. The beachface slopes are moderate there.

In recent years, all of Mile Beach has experienced erosion. When field checked, this trend had reversed along the northeast half of the beach, where the relict frontal dune scarp was healed by a perennally accreting talus slope and aeolian ramp. This sand wedge was vegetated predominantly by American Beach Grass (Ammophila breviligulata) and Beach Pea (Lathyrus japonicus).

The southwest half of Mile Beach has an unhealed frontal dune scarp caused by winter erosion into the frontal dune ridge. The frontal dune ridge of all of Mile Beach is, historically, fairly stable. There is no accretionary ridge and swale topography and the single frontal dune ridge is straight and uniformly high (3 to 5 m). This suggests that the dune ridge is stable or retreating very slowly in response to sea level rise. The ridge has a long back slope extending through half or more of the back dune. The height and extensive back slope are due to: 1) shoreline stability, and 2) exposure near the tip of a peninsula where south and southeast winds are stronger than might be otherwise. South to southwest winds (the predominant onshore winds in Maine) have a net onshore component, thus making them important in frontal dune ridge accretion at Reid despite the southeast exposure of the beach.

There is a rocky lag surface on the beachface at the southwest end of Mile Beach indicating that the beachface is eroded to its past limit at this point. In 1976, metal from Navy World War II landing operations was exposed at this same spot indicating a precedent for beachface erosion to the depth of 1976 within the last thirty-five years.

The contrasting erosional versus accretionary status of the southwest half versus the northeast half of Mile Beach has a parallel contrast of beachface features. From southwest to northeast the seasonal berm broadens and the low-tide terrace narrows. The southwest end of Mile Beach has only a moderately constructional profile in summer with a narrow berm and wide low-tide terrace.

There was a double berm at the northeast end when field checked in 1977. Both berm crests had high relief sandy cusps with approximately 20 m wavelengths. High relief is due to the high permeability of coarse sand. The coarsest sand is usually concentrated at the limit of the last swash, that is, at the berm crest.

There is a large, high relief, parabolic dune on the back slope of the frontal dune ridge about one-third of the way up from the southwest end of Mile Beach. This dune, formed by northwest winds, is stabilized by Bayberry (Myrica pensylvanica) and other shrubs. The flank and leeward slopes of the high parabolic dune are now truncated by the frontal dune ridge, making the ridge appear higher at this point.

The dune field at Reid is narrow since transport of sand into the back dune and onto the marsh has not kept pace, apparently, with gradual recession of the frontal dune ridge and migration of salt marsh peat onto the back dune field in response to sea
level rise. The back slope of the high frontal dune ridge extends halfway across the barrier. The rear half of the back dune field is dominated by moderate relief parabolic dunes, formed by northwest winds and stabilized with Beach Heather (Hudsonia tomentosa), sparse American Beach Grass (Ammophila breviligulata) and xerophytic back dune plants.

A significant feature at Reid is the marked difference in grain size of the aeolian ramp versus berm and beachface sand. At finer grained beaches this difference would not be noticeable, but here the medium and fine grained ramp sand is obviously different in grain size from the predominantly medium and coarse sand of the berm and beachface from which it was blown. The frontal dune ridge and back dune sands are not markedly finer than beachface and berm sands, however. Perhaps strong northwest winds remove finer sizes from the dune field, leaving a coarse grained lag deposit.

Half Mile Beach — Geological Features

The most striking difference between this and Mile Beach is the medium to fine grain size of the sand. This may be partially due to lower wave energy, but is also due, probably, to this being the downdrift end for the entire system in the longer term. Finer sand is carried further from the source than coarse sand, since storm waves from the northeast are probably responsible for the net long-term drift direction alongshore at the Reid Beach system.

The beachface slope is moderate at Half Mile Beach due to the fine grain size and lower wave energy. When field checked in 1977 there was a double berm, a moderately steep, short, upper beachface and a broad, fine grained low-tide terrace. There were no sharp slope breaks. The berm and low-tide terrace actually dipped seaward forming a smoother profile without particularly steep sections.

There was a relict, erosional scarp along the entire length of Half Mile Beach, which was being healed by perennial accretion. The perennial accretion took the form of an aeolian ramp or wedge, which was vegetated with American Beach Grass and Beach Pea.

There are a few stabilized, moderate relief, parabolic dunes in the back dune area of Half Mile Beach. The frontal dune ridge is lower here than at Mile Beach, because of the recent erosion through the highest part of the ridge. In 1977 it was about 2.5 to 3 meters high, but still had a broad back slope like the frontal dune ridge at Mile Beach. The sand is also minerallogically young with high concentrations of feldspar and schist fragments.

An important barrier dune field maintenance mechanism is well illustrated at Half Mile Beach. The rear edge of the back dune field has shifted landward as the Little River channel has shifted landward. Sand blown from the south bank of the Little River by northwest winds formed two relict rear dune ridges (former shorelines) now in the interior of the dune field. This is an important mechanism for barrier maintenance and retreat in a regime of rising sea level and frontal dune erosion. The
mechanism is active here, possibly at Ogunquit, and on the spit ends of many barriers. The mechanism may have been active several thousand years ago at Seawall Beach and at Reid's Mile Beach.

Description of Botanical Features

The flora of Reid State Park have been studied by Trudeau (1977). He has compiled a fairly complete species list for this dune area as well as Popham and Seawall. A partial species list of the two areas was made during field checking in August 1977:

A. Berm and Aeolian Ramp

1. Sea Rocket — Cakile edentula
2. American Beach Grass — Ammophila breviligulata
3. Beach Pea — Lathyrus japonicus
4. Saltwort — Salsola kali
5. Sea Blite — Suaeda maritima

B. Broad Frontal Dune Ridge

1. American Beach Grass — Ammophila breviligulata
2. Beach Pea — Lathyrus japonicus
3. Poison Ivy — Rhus toxicodendron
4. Bayberry — Myrica pensylvanica (where the frontal dune ridge is receding into the high stabilized parabolic dunes)
5. Numerous composites (no identification)
6. Chickweed — Cerastium arvense
7. Gooseberry — Ribes sp.
8. Raspberry — Rubus idaeus
9. Seaside Goldenrod — Solidago sempervirens

C. Stabilized Parabolic Dunes and Open, Dry Parabolic Dune Slacks

1. Beach Heather — Hudsonia tomentosa
2. Bayberry — Myrica pensylvanica
3. Large Composite (no identification)
4. Jointweed — Polygonella articulata
5. Yarrow — Achilles millefolium
6. Sandy Sedge — Carex silicica
7. British Soldiers Lichen — Cladonia cristatella
8. Other Cladonia species including C. Rangifera
9. Virginian Rose — Rosa virginiana
10. Purple Stemmed Angelica — Angelica atropurpurea
12. Raspberry — Rubus idaeus
13. Poison Ivy — Rhus toxicodendron
14. Two Cherries — Prunus or Amelanchier sp.
15. Low Sweet Blueberry — Vaccinium angustifolium
16. Goldenrod — Solidago rugosa
17. Dodder — Cuscuta sp.
Notable general characteristics of the flora area:

1. Three general zones with increasing diversity:
   a. Berm and aeolian ramp with lowest diversity – only annual and perennial colonizers occur.
   b. Back slope of the frontal dune ridge where diversity is low – dominated by American Beach Grass, Raspberry, Gooseberry, and Beach Pea.
   c. Stabilized, moderate-relief, parabolic dunes with good stands of Beach Heather (Hudsonia tomentosa) and associated plants. The dominance of parabolic dunes in this area causes a mosaic floristic pattern and higher diversity than on the broad frontal dune ridge. This is due to variable depth to the water table, variable accretion and deflation rates, and variable successional age since the last aeolian activity. Such variable habitat parameters are always associated with parabolic dunes.

2. No Pitch Pine forest, only one large stand of Bayberry and Cherries in a large, stabilized, parabolic dune. Salt spray and narrowness of the dune field are the probable reasons. Reid is a high energy beach so salt spray is probably greater here than at Seawall Beach where Pitch Pines grow close to the frontal dune ridge.

3. Northernmost, large dune field in Maine – thus, the potential for being the northern range limit within the state of several of Maine's dune plant species exists. The northernmost Jointweed (Polygonella articulata) stands on coastal dunes within the state probably occur here. Non-dune stands do occur further north. Canadian distribution was not researched. The northernmost stands of Beach Heather (Hudsonia tomentosa) and the complete Hudsonia association occur at Reid's Mile Beach, though Beach Heather reappears on Canadian dunes. Hudsonia association includes Jointweed (Polygonella articulata), Sandy Sedge (Carex silicea), Pinweed (Lechea maritima), Pinweed Aster (Aster linariifolius), Greene's Rush (Juncus Greenei), British Soldiers Lichen (Cladonia cristatella), Alpine Reindeer Lichen (Cladonia alpestris) and Haircap Moss (Polytrichum sp.).

Summary of Significant Features

A. Geological

1. Strong contrast between aeolian ramp sand grain size and beach sand grain size, but the coarsest of back dune sand in Maine, suggesting very strong northwest winds.

2. Coarseness, poor sorting, and mineralogical youth of Mile Beach's sand indicate source of sand is nearby and is not the Kennebec River.

3. High, broad frontal dune ridge, historically stable, at Mile Beach. It may transgress the entire dune field in some places.

4. Numerous, moderate relief, stabilized parabolic dunes.
5. Narrow back dune field at Mile Beach - due to absence of an important barrier maintenance mechanism. This maintenance mechanism is active at Half Mile Beach.

6. Northernmost large dune area in Maine.

7. Both erosion and accretion taking place simultaneously at Mile Beach. The northeast end is accreting and the southwest end is eroding.

8. Perennial accretion along the entire length of Half Mile Beach after several years of dramatic perennial erosion.

9. Good site for study of barrier beach maintenance in response to sea level rise.

10. A very large beach considering that the sand is all locally derived. There is very little sand offshore. The bottom becomes rocky very quickly.

11. Unique among Maine’s large, barrier-marsh systems in that there is no tidal exit through the strandline. The baymouth shoreline is straight and continuous from one rocky headland to another rocky headland.

B. Botanical

1. There are three basic vegetational-geomorphological zones:
   a. Berm and aeolian ramp
   b. High, broad frontal dune ridge
   c. Stabilized parabolic dunes

2. Illustration of importance of salt spray effects on vegetation, in this case it maintains succession at the pre-pitch pine stage.

3. Northernmost parabolic dune field in Maine. May be the northern limit for several species. Northernmost stand of Beach Heather (Hudsonia tomentosa) within Maine. Northernmost dune stands of Jointweed (Polygonella articulata) in Maine.

C. Miscellaneous

1. The unstable spit end of Half Mile Beach is probably the northernmost potential nesting habitat for least terns and piping plovers on Maine beaches. There are none there now because of the non-accretive state and heavy visitation.

2. Large, burrowing spiders with web-lined burrows and burrow mouths were noted in the open dry dune slacks of the back dune among sparse Beach Heather, Beach Grass, and Jointweed.

D. Size

1. Reid One Mile Beach has a length of 1040 m, a dune area of 7.7 hectares and a beach area of 7 hectares.

2. Half Mile Beach has a length of 640 m, a dune area of 3.1 hectares, and a beach area of 7.2 hectares.