H2.1 ROCKY SHORE

Rocky shores are areas of bedrock exposed between the extreme high and extreme low tide levels on the seashore.

Plate H2.1.1: Exposed rocky shore seen near low water, with a tidal pool in the foreground. In the background is a cobble shore, mouth of St. Marys River, Guysborough County (Unit 842). Photo: D.S. Davis

FORMATION

Rocky shores form as a result of marine erosion of the overburden and the bedrock, due to a combination of rising sea level and wave action, in areas where there is low sediment supply.

PHYSICAL ASPECTS

1. *Bedrock:* resistant bedrock, such as granite, slate and quartzite, erodes slowly and produces steep gradients. Less-resistant sedimentary bedrock is commonly eroded into a wave-cut platform with gentle slopes.
2. *Wave action:* exposure to wave action, related to dominant wind direction, storms and ocean-swell conditions, controls plant and animal attachment.
3. *Tidal regime:* tide range determines the area of shore exposed to the air. There is considerable regional variation.
4. *Climatic conditions:* weather conditions include summer and winter temperature extremes, humidity, precipitation and wind exposure.

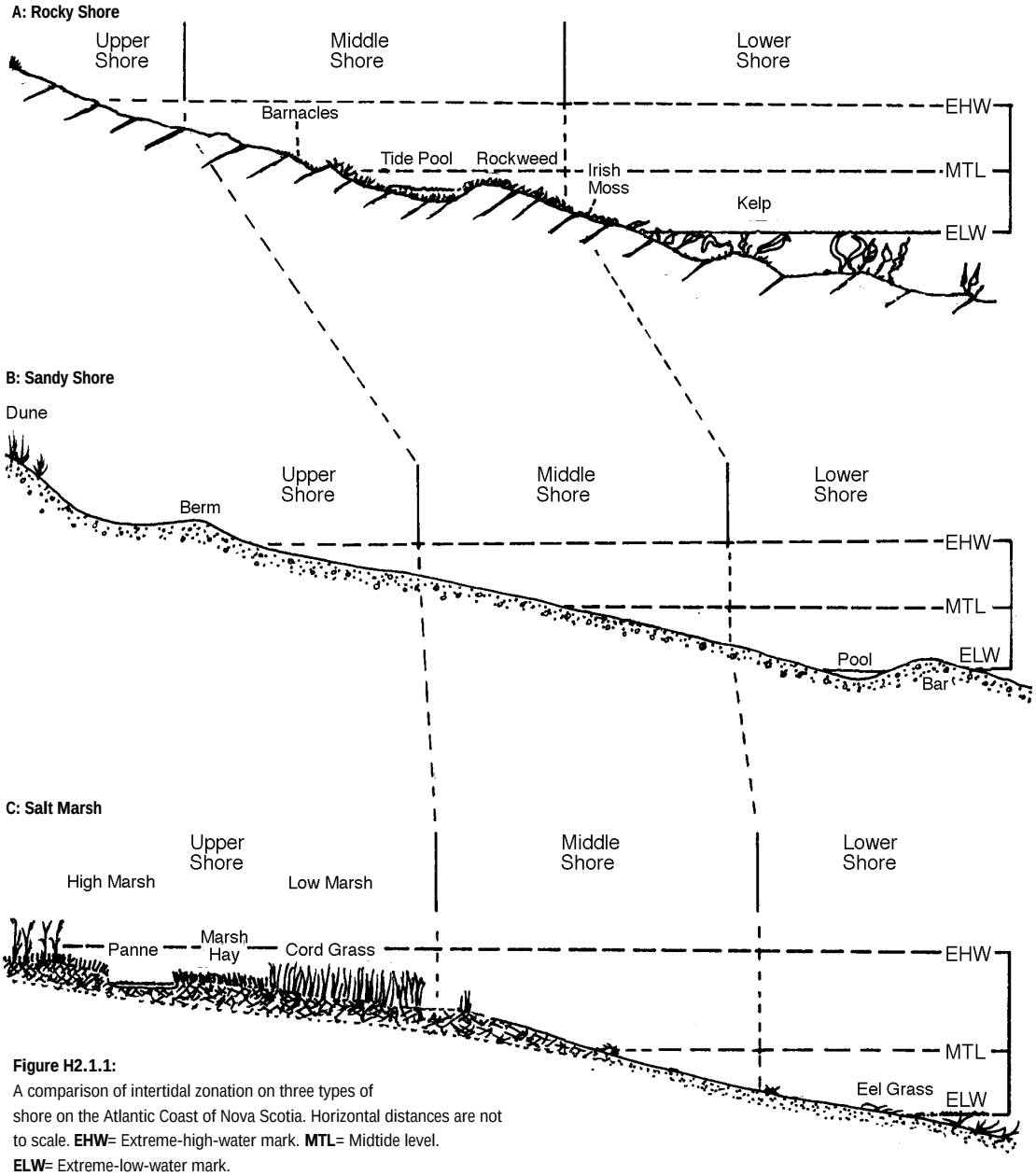

Figure H2.1.1:
A comparison of intertidal zonation on three types of shore on the Atlantic Coast of Nova Scotia. Horizontal distances are not to scale. **EHW**= Extreme-high-water mark. **MTL**= Midtide level. **ELW**= Extreme-low-water mark.

ECOSYSTEM

The ecosystem is complex, as it is an interaction between terrestrial and aquatic systems. Energy supply is obtained through primary production by seaweeds and phytoplankton and through organic detritus derived from adjacent land and other intertidal habitats (e.g., tidal marshes). This energy is directly utilized by a variety of herbivorous and detritus-feeding animals on the shore, which are, in their turn, preyed upon by several levels of carnivore on the shore, by fish entering the habitat at high tide and by terrestrial animals, particularly birds, entering at low tide.

PLANTS

The plants are typically algae and lichens. In sheltered or muddy locations where there is some sediment accumulation amongst the rocks and in tide pools, Cord Grass and Eelgrass may also be found. The seaweeds and lichens are distributed on the shore in horizontal zones that relate to tolerance of the species to either exposure to air (seaweeds) or submergence in water (lichens) during the tidal cycle.[1] Conspicuous plants inhabit different zones:

Splash Zone
Above the extreme-high-water mark but reached by storm waves, the splash zone is generally bare of vegetation. There may be grasses growing in cracks of rocks and some patches of lichens (e.g., *Xanthoria parietina*).

Upper Shore
Rocks bare at the top but, below the level of high water of spring tides, the upper shore supports algae (e.g., *Codiolum* spp., *Calothrix crustacea*) and lichens (*Verrucaria* spp.)

Middle Shore
The middle shore supports dense growth of brown rockweeds *Ascophyllum nodosum* and *Fucus* spp. The red seaweed *Porphyra* and *Fucus serratus* and green seaweeds, such as *Cladophora* spp., are common in some places. The epiphytic *Polysiphonia lanosa* can be found growing on the *Ascophyllum*.

Lower Shore
Below the dense rockweeds on the lower shore, there is a conspicuous zone of Irish Moss and calcareous algae (*Lithothamnium* spp. and *Corallina officinalis*). Below this, kelps (*Laminaria* spp.) are present but only visible at low water of spring tides. This zone continues into the sub-littoral benthic habitat (H1.1).

The seaweed growth is usually well developed on all rocky shores but is best in exposed, clear-water conditions, such as on the Atlantic Coast (Region 800 and Unit 911) and lower reaches of the Bay of Fundy (Unit 912). On the Northumberland Strait (Unit 914) and Inner Bay of Fundy (Unit 913), ice action and turbidity limit seaweed growth.

ANIMALS

The animals include marine benthic epifauna tolerant to various periods of exposure to the air at low tide, and vagrant terrestrial species. A system of horizontal zonation of the aquatic fauna is apparent.

Upper Shore
On the bare rock surfaces, there are very few animals present, except the Rough Periwinkle.

Middle Shore
At the top, there is a conspicuous zone of barnacles, which is limited at its lowest extent by the growth of rockweed. There is a variety of herbivorous animals, including Rough Periwinkles, Smooth Periwinkles, Common Periwinkles and amphipod crustaceans. Sessile species include Hydroids (*Sertularia* spp.) and Blue Mussels. The Green Sea Urchin is found at lower levels. Carnivores which feed mainly on the molluscs include Dog Whelks and Purple Starfish.

Lower Shore
Lower down the shore, the diversity of animals increases as more species are tolerant to the shorter period of exposure at low tide. This is particularly true where animals can find shelter under rocks or seaweeds. Herbivores include Common Periwinkles, Limpets, Green Sea Urchins, isopods and amphipods. The sessile particulate feeders include sponges, hydroids, tube worms (*Spirorbis* spp. on seaweeds), Horse Mussels, brittle starfish and tunicates. The carnivores include Sea Anemones, Scale Worms, Purple Starfish, Rock Crabs and Sea Slugs. On sedimentary rocks of the Minas Basin and Northumberland Strait, rock-boring bivalves *Petricola pholadiformis, Zirphaea crispata* and *Barnea truncata* are locally important. Vagrant terrestrial species, insects, birds and mammals enter the rocky-shore habitat at low tide to feed. Several shore-bird species feeding on rocky shores include Ruddy Turnstones; Herring Gulls are also typical.

(Sea urchins found the above high-water mark provide evidence of gull feeding.)

Rocky-shore habitats are important feeding grounds for White-tailed Deer in winter. There is a regular occurrence of deer eating kelp along the Atlantic coast east of Halifax, through to Louisbourg.

SPECIAL FEATURES

- The local modification of plant and animal zonation relates to the tide range, exposure, ice action and other environmental factors. Considerable regional variation is seen. Figure H2.1.1 shows some examples of zonation.

- **Tide Pools**: Where water is retained in depressions or cracks in the bedrock during the low-tide period, the plants and animals are not subjected to dessication. As a result, these pools often exhibit rich growths of organisms normally associated with the lower shore and subtidal habitats. Large pools are not strongly influenced by air temperatures, but smaller pools, particularly if located at high levels on the shore where they may not be flushed out by neap tides, experience wide ranges of temperature and salinity. In these conditions, only hardy algal species, such as *Enteromorpha intestinalis*, can occur.

DISTRIBUTION IN NOVA SCOTIA

Rocky shores occur all around the coast of Nova Scotia but vary in their character according to the physical aspects that prevail. Rocky shores in the Inner Bay of Fundy (Unit 913) are strongly influenced by mud and ice action and have poor seaweed growth. Different examples of rocky shores can be seen in the wave-cut platform in the basalt bedrock in the Outer Bay of Fundy (Unit 912). The granite and quartzite headlands of the Atlantic Coast (Region 800) form another type of rocky-shore habitat. In Cape Breton and the Northumberland Strait (Unit 914), soft sedimentary rocks, small tide range and winter ice action result in relatively poor rocky-shore development. There is no intertidal zone in the Bras d'Or Lake (District 560 and Unit 916).

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Associated Topics

T4 Colonization, T6.1 Ocean Currents, T6.2 Oceanic Environments, T7.1 Modifying Forces, T7.2 Coastal Environments, T7.3 Coastal Landforms, T10.9 Algae, T10.11 Lichens, T11.6 Shorebirds and other Birds of Coastal Wetlands, T11.10 Ungulates, T11.12 Marine Mammals, T11.14 Marine Fishes, T11.17 Marine Invertebrates

Associated Habitats

H1.1 Open Water, H1.2 Benthic, H2.2 Boulder/Cobble Shore, H2.3 Sandy Shore, H2.4 Mud Flat, H2.5 Tidal Marsh, H5.3 Cliff and Bank

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H2.2 BOULDER/COBBLE SHORE

Boulder/cobble-shore habitats are exposed between the extreme-high-tide and extreme-low-tide marks.

Plate H2.2.1: An example of a cobble-shore habitat at Cape Sable Island (Unit 841), Shelburne County Photo: A. Wilson

FORMATION

Boulder/cobble shores form where there is erosion of glacial till on headlands and islands. In high-energy situations, the cobbles may form a storm beach at and above the high-tide mark. In intermediate- and low-energy situations, the boulders rest on a wave-cut platform.

PHYSICAL ASPECTS

1. *Substrate:* boulders provide a relatively stable hard substrate. Cobbles and pebbles are usually mobile.
2. *Wave action:* in high-energy situations, exposure to wave action, related to dominant wind direction, storms and ocean-swell conditions, the boulders and cobbles are mobile, limiting colonization by intertidal organisms.
3. *Tidal regime:* tide range determines the area of shore that is exposed to the air.
4. *Water–land interaction:* water conditions include summer and winter temperature extremes, formation and movement of ice, and variations in turbidity and salinity.
5. *Climatic conditions:* air conditions include summer and winter temperature extremes, humidity, precipitation and wind exposure.

ECOSYSTEM

Primary production within the habitat is limited to the seaweed growth, which is very limited or absent in exposed situations. Energy also enters the system through primary production in the plankton, and through suspended organic detritus derived from the land and adjacent intertidal habitats. There are herbivores and detritus-feeders in the epifauna, but populations are often small. These animals are preyed upon by carnivores, including birds.

PLANTS

Mainly algae (seaweeds) colonize the surfaces of boulders. In intermediate- and low-energy situations, there is horizontal zonation related to the period of exposure at low tide.

Upper Shore
On the upper shore, where the cobbles are easily moved by wave action, there is no seaweed growth, but some lichens and flowering plants occur above the high-tide mark.

Middle Shore
On the middle shore, in sheltered conditions, there is a narrow black band of algae and lichens below which brown seaweeds, *Fucus* spp. and *Ascophyllum nodosum*, are conspicuous. Various filamentous algae are present in the spring. Cord Grass may be found growing in mud and gravel between the boulders at lower levels. In more exposed situations, the seaweed growth is limited by the movement of the boulders and cobbles. Where seaweeds do occur, there is usually a sparse growth of the brown seaweeds, with Irish Moss and the calcareous species *Corallina officinalis* and *Lithothamnium* spp. growing in the lower zone.

ANIMALS

The movement of boulders and cobbles in high-energy situations severely limits colonization by animals. In low and intermediate energy situations, barnacles, isopods, amphipods, periwinkles, Green Crabs, Dog Whelks, Blue Mussels and Purple Starfish are often present.

SPECIAL FEATURES

- On exposed, high-energy shores, the cobbles are often washed up to form a storm beach or berm. As they are largely beyond the reach of wave action, the cobbles are more stable and become colonized by encrusting lichens and flowering plants, such as Sea-lungwort and Beach Pea. Animal life is limited to various species of amphipods and fly larvae, which feed on decaying seaweed cast up by storms. Spiders and birds prey upon these animals.

DISTRIBUTION IN NOVA SCOTIA

Boulder/cobble-shores are found along the whole Nova Scotia coastline but are best developed along the Atlantic coast where there is sufficient glacial till source material. In St. Margarets Bay and Mahone Bay (District 460), for example, eroding drumlins have boulder and cobble beaches with varying degrees of exposure. The islands eventually erode away to leave boulder reefs visible only at low tide. Sheltered boulder beaches occur at the head of inlets, such as in Head Harbour (sub-District 460b).

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Associated Topics
T6.1 Ocean Currents, T6.2 Oceanic Environments, T7.1 Modifying Forces, T7.2 Coastal Environments, T7.3 Coastal Landforms, T10.9 Algae, T10.11 Lichens, T11.6 Shorebirds and other Birds of Coastal Wetlands, T12.7 The Coast and Resources

Associated Habitats
H1.1 Open Water, H1.2 Benthic, H2.1 Rocky Shore, H2.3 Sandy Shore, H2.4 Mud Flat, H2.5 Tidal Marsh, H2.6 Dune System, H5.1 Barren, H5.3 Cliff and Bank

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H2.3 SANDY SHORE

Sandy-shore habitats are areas of sand exposed between the extreme-high-tide and extreme-low-tide marks.

Plate H2.3.1: A sandy shore at Caribou Island, Pictou County (sub-Unit 521a). In the background is a sea cliff (H5.3) and rocky shore (H2.1).
Photo: R. Merrick

FORMATION

Sandy shores form through the deposition of sand resulting from the erosion of glacial till and bedrock in the area of occurrence.

PHYSICAL ASPECTS

1. *Substrate:* the substrate includes particle sizes ranging from fine gravel to sandy mud. In sheltered conditions the mud content increases and reduced drainage results in anaerobic conditions just below the surface. In exposed conditions the sand is often mobile, well-drained and well-aerated.
2. *Wave action:* exposure to wave action, related to dominant wind direction, storm and ocean-swell conditions, and influence of tidal and alongshore currents affects the mobility of the sand.
3. *Tidal regime:* tidal range determines the area of shore that is exposed to the air.
4. *Water–land interaction:* water conditions include summer and winter temperature extremes, formation and movement of ice, turbidity and salinity.
5. *Climatic conditions:* air conditions include summer and winter temperature extremes, humidity, precipitation and wind.

Figure H2.1.1 compares intertidal zonation of a sandy shore with a rocky shore and a salt marsh.

ECOSYSTEM

There is no significant primary production, except by blue-green algae and diatoms that occur on the surface of sandy mud in sheltered conditions. Energy input into the system is from the phytoplankton in the water and from particulate organic matter (detritus) derived from the land and adjacent intertidal habitats. Herbivorous and detritus-feeding and carnivorous animals are included in the sand infauna. Carnivores include vagrant fish and birds.

PLANTS

Due to the mobility of the substrate, plant life is very limited in both diversity and abundance. Seaweeds are mostly absent, but diatoms and blue-green algae may be common in sheltered, sandy-mud conditions. *Ulva* and *Enteromorpha* develop in summer on many sandy-mud flats. Also, in these conditions, some Cord Grass and Glasswort may occur as a first stage in tidal-marsh succession. On exposed shores, wind-blown sand accumulates above the high-water mark as dunes, and pioneer beach plants, such as American Beach Grass and Sea-rocket, may occasionally be subjected to waves or spray.

ANIMALS

The absence of hard substrate results in the predominance of infaunal species. Distribution and abundance are controlled largely by the tide level and mobility of the sand. At low-tide levels, the sand seldom dries out, but is mobile due to currents and wave action. Animals have to burrow to maintain their position on the beach. On exposed beaches, polychaete worms (*Dispio uncinata, Nephtys bucera*) and molluscs (*Tellina agilis, Spisula solidissima, Ensis directus* and *Lunatia heros*) occur at low-tide level. Isopod and amphipod crustaceans (*Chiridotea caeca, Haustorius canadensis*) also occur at the mid- and low-tide levels. At the high-tide mark, amphipods (*Talorchestia* spp.) are common, feeding on organic matter in the drift line, and overlap in their occurrence with insects, including the larvae of flies and beetles. Where the sand grades into sandy mud in sheltered conditions, the fauna increases in both diversity and abundance. Ribbon worms (*Cerebratulus* spp.), polychaetes (*Nereis* spp. and *Nephtys* spp.), bivalves (*Mya arenaria, Macoma balthica)* and mud snails (*Nassarius, Ilyanassa*) are typical. Where patches of gravel occur on the lower shore, clumps of Blue Mussels are found with associated barnacles and other epifauna. Sandy shores provide important feeding grounds for a variety of shore birds, including sandpipers and plovers. Flounders and other fish come in to feed at high tide.

SPECIAL FEATURES

- There is usually seasonal variation in the distribution of sand on the shore, due to wind and wave action. Sand is transferred from the beach to shallow water in the winter and is returned in the summer. This mobile sand can build up as well-drained bars that dry out at low tide and which support few animals.
- Sand shores are the best localities for beachcombing and shell collecting during the summer. Because of the on-shore movement of sand, it is possible to find shells of species that live offshore.

DISTRIBUTION IN NOVA SCOTIA

Distribution of sandy shores follows the whole coastline of Nova Scotia, with best development along the Atlantic and Northumberland Strait coasts and the Minas Basin.

Associated Topics
T6.1 Ocean Currents, T6.2 Oceanic Environments, T7.1 Modifying Forces, T7.2 Coastal Environments, T7.3 Coastal Landforms, T10.5 Seed-bearing Plants, T10.9 Algae, T11.6 Shorebirds and Other Birds of Coastal Wetlands, T11.17 Marine Invertebrates

Associated Habitats
H1.1 Open Water, H1.2 Benthic, H2.1 Rocky Shore, H2.2 Boulder/Cobble Shore, H2.4 Mud Flat, H2.5 Tidal Marsh, H2.6 Dune System

Additional Reading

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H2.4 MUD FLAT

Mud-flat habitats are areas of mud and sandy mud exposed between the extreme-high-tide and extreme low-tide marks.

Plate H2.4.1: Mud flat, with mussel shells and stones colonized by *Fucus* in the foreground. The forest is coastal spruce, fir–maple, birch association (H6.3). Sandy Cove, (St. Marys Bay), Digby County (District 810). Photo: R. Merrick.

FORMATION

Mud flats form from the deposition of mud in sheltered tidal water, particularly in estuaries where there is a large sediment supply.

PHYSICAL ASPECTS

1. *Substrate*: particles range from fine sand to silt, and are often compacted into clay. Drainage is poor, and anaerobic conditions exist just below the sediment surface.
2. *Wave action:* the surface sediment is mobile in moderate waves, due to exposure to wave action, related to wind and to a tidal and longshore currents.
3. *Tidal regime:* tidal range determines the area of shore that is exposed to the air.
4. *Water–land interaction:* water conditions include summer and winter temperature extremes, formation and movement of ice, turbidity and salinity.
5. *Climatic conditions:* air conditions include summer and winter temperature extremes, humidity, precipitation and wind.

ECOSYSTEM

Primary production is limited to diatoms and other microscopic and filamentous algae and to Cord Grass. Most energy enters the system from the plankton, or as organic detritus derived from the land or adjacent tidal marshes. The detritus and associated bacteria are consumed by large populations of bivalve molluscs, amphipods and polychaetes. These are, in turn, eaten by carnivores, and particularly by migratory shore birds. The crustacean *Corophium volutator* occurs in the Bay of Fundy intertidal mud flats (Units 912, 913) and is an important food source for the migratory Semipalmated Sandpiper (see T11.6).

PLANTS

Plants are limited to microscopic algae (diatoms) and filamentous algae on the sediment surface, and occasionally seaweeds, such as *Fucus* spp., attached to stones. Some Cord Grass is found at the first stage of tidal-marsh succession, and Eel Grass occurs on the lower shore.

SUCCESSIONAL SEQUENCE

1. In sheltered areas, the deposition of sediment on the shore will eventually raise the level so that seeded or ice-transported Cord Grass may become established.
2. The Cord Grass expands from the point of colonization by vegetative means and accelerates the rate of sediment deposition, developing into the low marsh (see H2.5).
3. When the substrate of the marsh rises to the mean-high-water mark through the accumulation of sediment, the Cord Grass gives way to Marsh Hay and associated plants, and the high marsh develops (see H2.5).
4. With further sediment deposition, the vegetation becomes mainly freshwater: cattail, rushes and reeds, possibly in association with spruce (swamp).

ANIMALS

Animals are predominantly detritus-feeding infauna that can tolerate exposure at low tide and the mechanical difficulties of living in mud. Polychaete worms (*Spiophanes wigleyi, Clymenella torquata)*, amphipods (*Corophium volutator*) and bivalves (*Mya arenaria, Macoma balthica*) are particularly common. Scavengers and carnivores present are polychaetes *(Neanthes virens*), crustaceans (*Chiridotea caeca, Crangon septemspinosus*) and molluscs (*Ilyanassa obsoletus, Lunatia heros*).

Sessile epifauna species, such as barnacles and Slipper Limpets, occur attached to small stones lying on the mud surface. Flounders and other fish species come on to the mud flats to feed at high tide. Mud flats are also important feeding areas for migratory shore birds, such as the Semipalmated Sandpiper, and land mammals (particularly Raccoons).

SPECIAL FEATURES

- Vast numbers of a few species of infauna depend on a diet of organic detritus. Examples of population densities are 15 000/m^2 for *Corophium volutator* and 3500/m^2 for *Macoma balthica*. These animal populations support large flocks of migrating shore birds during the late summer. This habitat is critical to the survival of the Semipalmated Sandpiper. Flocks totalling over 280,000 gather at the Head of the Bay of Fundy to feed before continuing their migration south. This is an important ecological

feature of Nova Scotia. Migratory fish also visit to feed on the benthic (e.g., *Corophium*) and epibenthic species (e.g., *Neomysis, Mysis, Crangon*).

DISTRIBUTION IN NOVA SCOTIA

Mud flats occur in all inlets and estuaries around the coast of Nova Scotia, but the best examples are in Minas Basin, Cobequid Bay (sub-Unit 913a) and Cumberland Basin (sub-Unit 913b).

Associated Topics

T6.1 Ocean Currents, T6.2 Oceanic Environments, T6.3 Coastal Aquatic Environments, T6.4 Estuaries, T7.2 Coastal Environments, T7.3 Coastal Landforms, T10.5 Seed-bearing Plants, T10.9 Algae, T11.6 Shorebirds and other Birds of Coastal Wetlands, T11.12 Marine Mammals, T11.14 Marine Fishes, T11.17 Marine Invertebrates, T12.7 The Coast and Resources

Associated Habitats

H1.1 Open Water, H1.2 Benthic, H2.1 Rocky Shore, H2.2 Boulder/Cobble Shore, H2.3 Sandy Shore, H2.5 Tidal Marsh

Additional Reading

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H2.5 TIDAL MARSH

Two types of tidal marsh occur in Nova Scotia: salt marshes and coastal fresh marshes. Both are marine intertidal areas with soft substrate, colonized predominantly by grasses. They occur only where there is regular flooding and nearby sources of fine sediment.

Plate H2.5.1: Salt marsh showing Cord Grass *(Spartina alterniflora)*, St. Marys River, Guysborough County (Unit 842). The surface water of the tidal estuary is almost always fresh. Photo: D.S. Davis

FORMATION

Salt marshes form on stable or emerging coastlines when sediment accumulates in sheltered intertidal areas in estuaries, behind spits, bars or islands, and in protected bays. Cord Grass colonization accelerates the accumulation of sediment and helps to develop conditions suitable to further marsh development. In Nova Scotia, where coastlines are submerging at a slow rate, marshes form when the rate of sedimentation exceeds the rate of submergence.

Coastal fresh marshes form when the effect of salt water on the low-lying coast is moderated by freshwater runoff. Where this occurs, the salt-tolerant plants of the intertidal zone give way to non-tolerant species, even though there may be a semidiurnal tide (upper reaches of estuaries) or occasional tidal flooding (low-lying areas behind salt marshes).

The upper limit of the tidal marsh is the highest high water, and the lower limit is mean sea level. In the Bay of Fundy (Units 912, 913), where the tidal range is most extreme (about 15 m), the marsh vegetation extends only to an elevation of about 4 m below high water.[1]

PHYSICAL ASPECTS

1. *Bedrock:* bedrock is not significant, as it is usually deeply buried beneath the marsh soil; however, soft bedrock in the general area (e.g., sandstones in Bay of Fundy [District 620 and Unit 913] and Northumberland Strait [District 530 and Unit 914]) may contribute to the sediment supply necessary for marsh construction. On the Atlantic coast, most sediment is derived from eroding till deposits (District 830). In coastal fresh marshes, mineral outcropping and soft sedimentary rocks in the watershed contribute to soil development.
2. *Soils:* salt marsh develops its own soil of accumulated mud, roots and organic material from the decay and breakup of salt-marsh plants. The high amount of organic debris in "salt marsh peat" leads to anaerobic, or oxygen-free, conditions around the roots. *Spartina alterniflora*, the principal low-marsh species, has air spaces in the stem, which allow oxygen to reach down into the sediment to supply the roots of the plant.[2] Soils in coastal fresh marshes are generally alluvial—fine material rich in organic materials and nutrients.
3. *Relief:* tidal marshes have low relief and are generally flat with a gradual slope deeply cut by drainage channels. In some areas, deep, straight-sided and permanent ponds, or pannes, are a common feature.
4. *Drainage:* drainage in tidal marshes is generally poor, due to the nature of the soil, which is at least partly covered by each flood tide and by surface runoff. There is often standing water in depressions. Salt marshes typically have networks of channels that drain tidal water.
5. *Physical regime:* although they get their name from the twice-daily inundation of seawater, tidal marshes are typically exposed to varying degrees of salinity. The higher parts of the marsh form the most landward extreme of the marine environment, reached only by very high tides or storm surges. Here, plants are exposed to groundwater and freshwater runoff and, typically, to low salinities. Seaward, the salinities of water covering the marsh rarely reach full strength, but on an exposed marsh, the sediments' salinity can reach ten times the salinity of the ocean as a result of evaporation. Figure H2.1.1 compares intertidal zonation of a salt marsh to a rocky and a sandy shore.

ECOSYSTEM

Salt marshes are among the most productive ecosystems in the world; however, Nova Scotia marshes are less productive than some of the extensive salt marshes found along the Atlantic coast of the United States and into the Gulf of Mexico.[3] Much of the productivity of the Nova Scotia salt marshes leaves the marsh as detritus from Cord Grasses (*Spartina* spp.) and becomes a food source for marine food chains. At the head of the Bay of Fundy (Unit 913), the marshes provide the principal food source for marine organisms, which support vertebrates, such as fish and shorebirds.

Soils and seawater inundation provide limited nutrients for growth of salt-marsh plants. Nitrogen comes from nitrogen-fixing bacteria found in the soils and from the films of blue-green algae growing on the surface of salt-marsh muds.

Small fish, birds (which includes the Great Blue Heron, various waterfowl, shorebirds and songbirds), and a variety of small mammals, insects and marine invertebrates are found in salt marshes.

Coastal fresh marshes are also highly productive systems with abundant nutrients. The primary production is largely carried out by grasses, sedges and rushes, and is either consumed or accumulates on

site, adding organic material to the soil. In estuaries, some of the production will be exported to lower reaches or to the sea. Consumers on site include insects, waterfowl and small mammals.

SUCCESSIONAL SEQUENCE

The salt marsh is characteristically divided into high marsh and low marsh, each with a distinct plant community.

As a result of submergence, profiles of sediments in a salt marsh usually show layers corresponding to successive stages in marsh development. The lowest levels are freshwater peat, corresponding to the period when the area was above sea level, and successive levels follow the change to mud flat, low marsh and eventually high marsh (see Figure H2.5.1[4]).

Low Marsh

Cord Grass is the dominant plant, but occasionally atypical algae, such as rockweed, can occur. On drier, bare patches, Glasswort, Sea-blite, Seaside Sand Spurrey and Orach may be found.

Middle and High Marsh

Marsh Hay is the dominant plant; however, other halophytes, such as Sea-lavender, Arrow Grass, Seaside Plantain, Milkwort, as well as various grasses, sedges and rushes, can also occur. The zone of Marsh Hay is sometimes classed as "middle marsh".[4] In Atlantic Coastal marshes, the sedge *Carex paleacea* is commonly the dominant high-marsh species. In the Bay of Fundy, the high marsh is inundated as frequently as once a month, in response to tidal cycles and surges as the result of storms.

The coastal fresh marsh is between salt marsh and freshwater fen. With rising sea level, freshwater marshes will become more saline and eventually be colonized by halophytes. Along riverbanks, the marginal estuarine species will give way to freshwater species upstream. The drier edges will be colonized by alder or willow.

SEASONAL CYCLE

In most of Nova Scotia, tidal marshes undergo a distinct seasonal cycle. Winter ice and wave action denude the lower exposed portions of the marsh, leaving a stubble field. The growth in spring forms a bright-green lawn, which grows luxuriantly through the summer, but a second crop develops in summer in some areas. No new leaves are produced

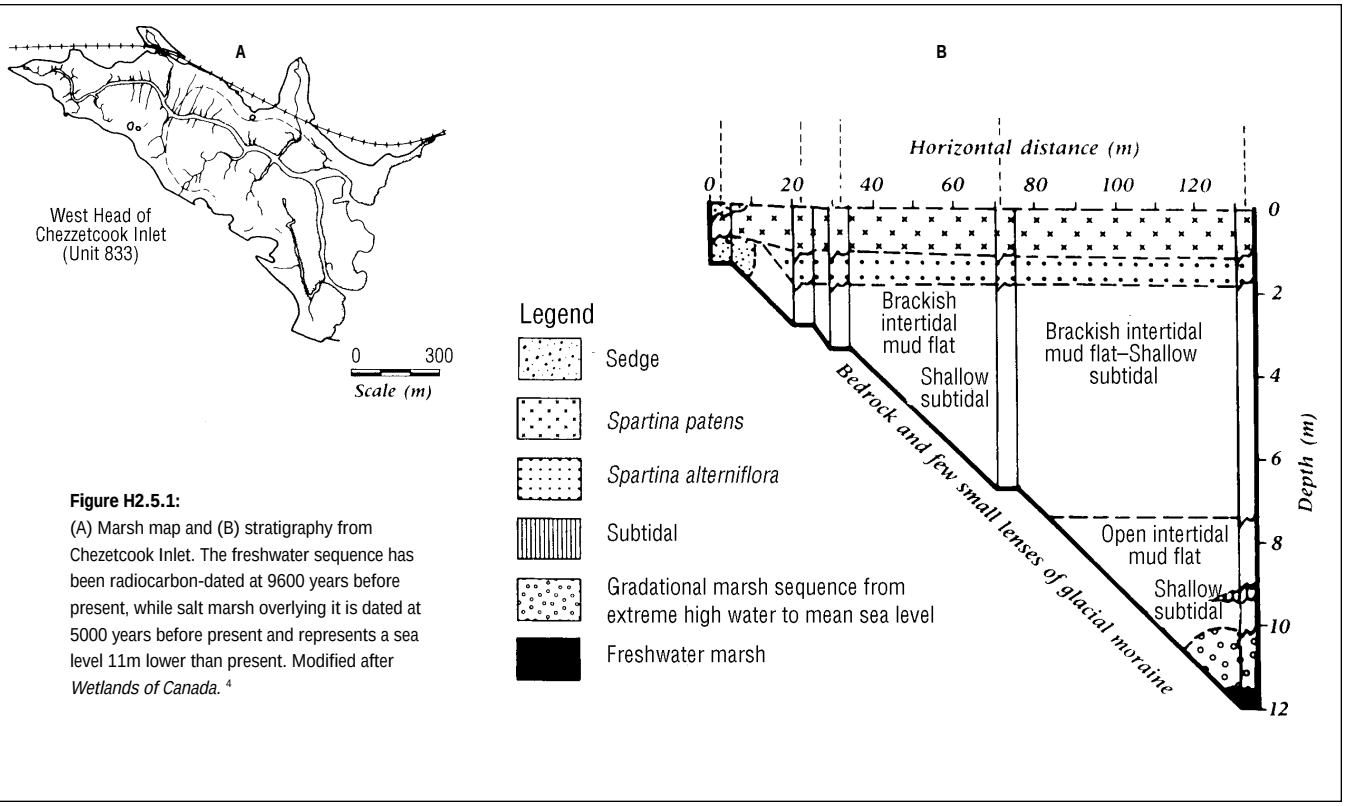

Figure H2.5.1:
(A) Marsh map and (B) stratigraphy from Chezetcook Inlet. The freshwater sequence has been radiocarbon-dated at 9600 years before present, while salt marsh overlying it is dated at 5000 years before present and represents a sea level 11m lower than present. Modified after *Wetlands of Canada.* [4]

after early August.[5] Fall frosts turn the marshes a rusty brown. The scraping in winter and sloughing off of leaves during the summer is key to the role of tidal marshes in marine communities, because the material becomes food for marine organisms.

Bay of Fundy low marshes have a limited growing season—from May to October—and all vegetation dies in the fall. Frequent and energetic tidal flooding, coupled with the low marshes' relatively exposed position, results in a substantial removal of vegetation through the year. Low marshes are also subject to destructive action of sea ice every winter.[6]

PLANTS

Salt marsh Plants

Plant life in the salt marsh is salt-tolerant and includes flowering plants (angiosperms), algae and microscopic fungi. Adaptations include salt excretion (e.g., Cord Grass) and succulent structures for water retention (e.g., Glasswort).

Nova Scotia salt marshes are dominated by the Cord Grass *Spartina alterniflora* in the low marsh and *Spartina patens* at higher levels, but marshes in the Bay of Fundy also include Seashore Salt-grass *Distichlis spicata* at higher levels. (Figure H2.5.2 shows the distribution of *Spartina* spp. at different locations in the province.)

Eel Grass frequently occurs in the lower intertidal and subtidal zones adjacent to Nova Scotia salt marshes, but is found infrequently in the Bay of Fundy (e.g., Five Islands Provincial Park [Unit 710]). In contrast to the salt-marsh vegetation, Eel Grass is found only below low-tide level.

Various marine fungi may be associated with and result in the decomposition of *Spartina*.[7]

Pannes frequently contain Sea Lettuce, filamentous algae and aquatic angiosperms

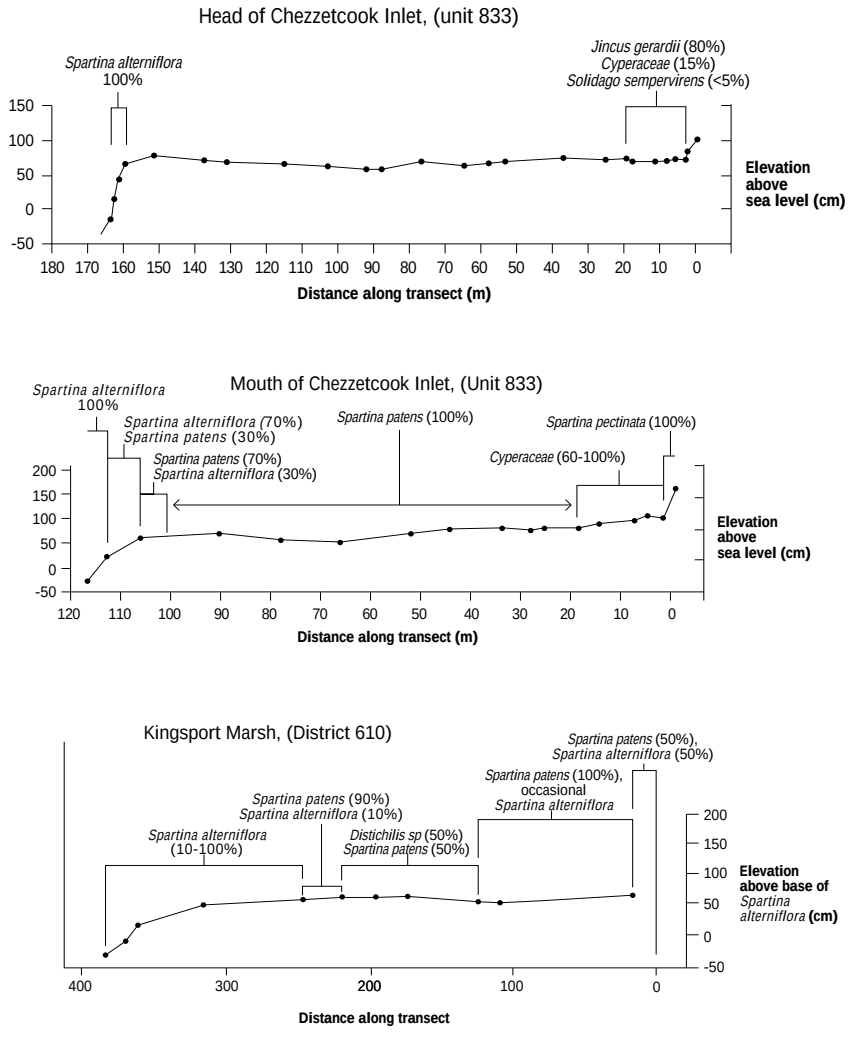

Figure H2.5.2: Distribution of *Spartina* spp. and other salt-tolerant species at different locations in the province. Percentages refer to surface area covered by each species. Modified after *Wetlands of Canada*.[4]
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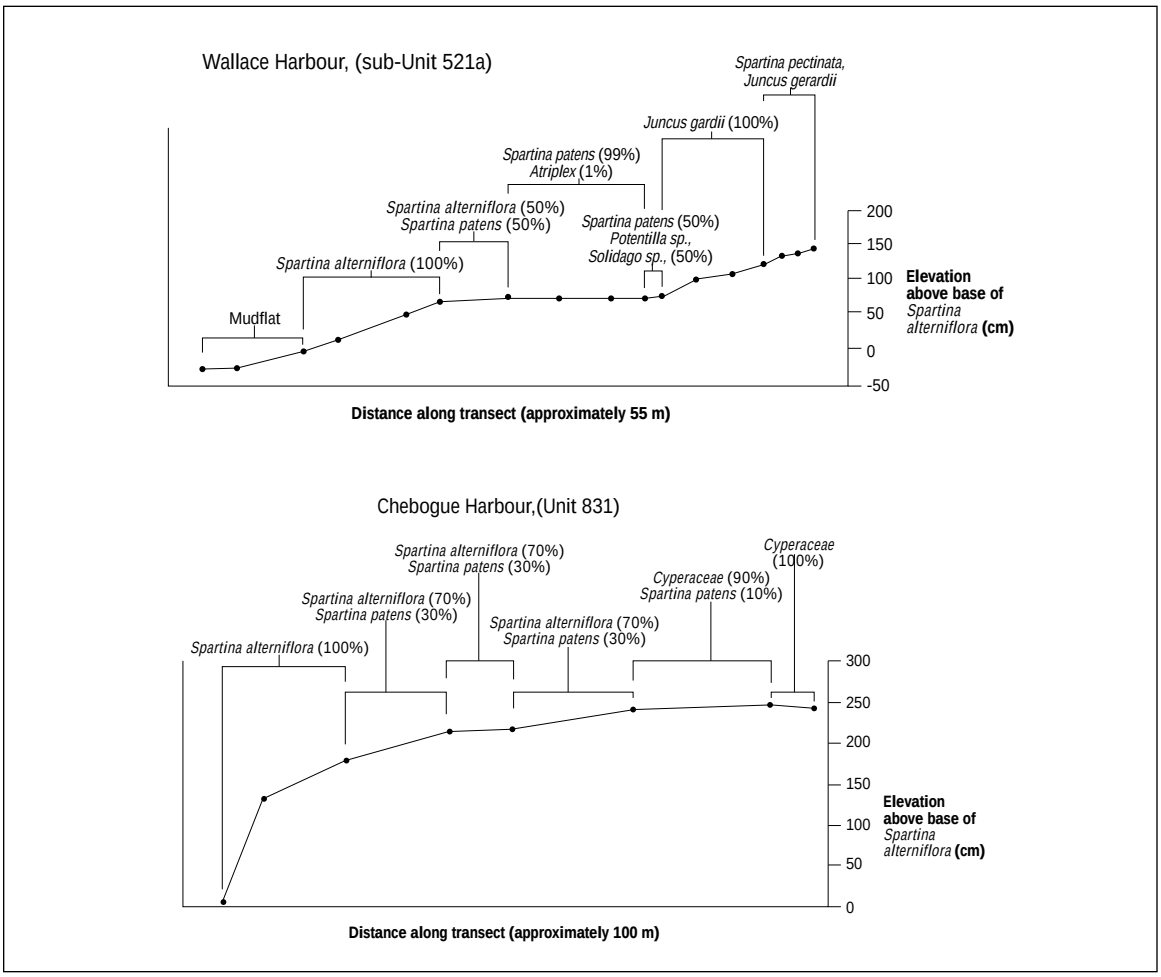

Figure H2.5.2 (Continued) : Distribution of *Spartina* spp. at different locations in the province. Modified after *Wetlands of Canada.* [4]

(particularly Widgeon Grass). Pannes in low marshes may contain Eel Grass; in high-marsh areas, they contain Ditch-grass and Horned Pondweed.

Coastal Fresh-marsh Plants

The plant life present in coastal fresh marshes will vary according to local conditions, but is dominated by conspicuous grasses, rushes and sedges.

At the upper edges of the marsh, where the fresh water from the water table is near the surface, bulrushes, cattails and sedges occur. *Spartina pectinata* is a common species. Reed Grass is common in some places in the Annapolis Basin, Minas Basin (District 610) and Chignecto Bay (Unit 533).

In sandy soil, the nutrient condition may be relatively poor, resulting in patches of vegetation similar to that of bogs. *Sphagnum* spp., rushes and cranberry, together with Sundew, Pitcher Plant, Seaside Buttercup, Marsh Cinquefoil and Silverweed commonly occur. This community is mainly found where sand dunes intergrade with tidal marshes.

Bulrush marsh may be extensively developed around shallow lakes, which also have abundant growths of pondweed (*Potamogeton*) and Ditch-grass, depending upon the salinity.

ANIMALS

Salt marshes are inhabited by a range of lower and higher animals. Invertebrates include both marine forms living on the sediments and terrestrial arthropods, such as insects and spiders, that invade the stands of *Spartina* during the growing season. The marine species are tolerant of a wide range of salinity and temperature, and of the high levels of suspended sediment which are characteristic of the marsh. Species may include amphipods (*Gammarus* spp.) and isopods (*Idotea* spp.); various bivalve molluscs (the Soft-shell Clam, Fingernail Clam, the Blue Mussel and Ribbed Mussel); and several gastropod species, including periwinkles, Spire Snail, and the Eastern Mud Snail.

In pannes, common species include the Spire

COUNTY	HIGH SALTMARSH	LOW SALTMARSH
Annapolis	122	103
Antigonish	61	228
Cape Breton	96	198
Colchester	723	463
Cumberland	1387	1098
Digby	268	380
Guysborough	77	78
Halifax	173	704
Hants	892	692
Inverness	118	248
Kings	617	832
Lunenburg	111	148
Pictou	41	275
Queens	144	118
Richmond	85	176
Shelburne	487	713
Victoria	91	168
Yarmouth	1650	1508

Table H2.5.1: Distribution of salt marshes in Nova Scotia, by county (areas in hectares). From the Nova Scotia Department of Development, 1984.

Snail and periwinkles. Bay of Fundy marshes and parts of the Atlantic coast have large populations of the anemone *Nematostella;* the sea slug *Elysia chlorotica*, which has photosynthetic algae embedded in its skin, occurs occasionally.

Killifish, sticklebacks, silversides and eels are often common in pannes, and many of these species, as well as juveniles of local fish species, including flounder, can be found in waters of the salt marsh.

Salt marshes are important feeding, overwintering and breeding habitats for waterfowl. Various species of ducks, herons, and shorebirds use the marshes or rely indirectly on food organisms nourished by salt-marsh production. The Sharp-tailed Sparrow uses the salt marshes for breeding.

Coastal Fresh-marsh Animals

The aquatic fauna in coastal fresh marshes is generally poor, being restricted to insects and their larvae—water boatmen (Corixidae), flies and mosquitos and succineid snails. Freshwater molluscs and other invertebrates may be introduced by migratory ducks and geese to more stable bodies of water. The bird and mammal life is important, particularly waterfowl, Muskrat, raccoon, mink and small mammals. The Northern Harrier nests on the ground in this habitat.

SPECIAL FEATURES

- Pannes are shallow ponds which develop initially in poorly drained low-marsh areas, but which may persist for long periods of time. Old pannes may be found in high-marsh areas. Pannes may also form in the high-marsh areas by destruction of marsh sod by ice action. The extreme salinities and temperatures of pannes prevent colonization by surrounding grasses.
- Rising sea level: The character of salt marshes in Nova Scotia is linked to rising sea level. Around the edges of marshes, dead spruce trees demonstrate the slow marine transgression of the land (0.3 m per 100 years).
- Halophytic (salt-tolerant) plants: Angiosperms capable of excreting salt and storing water are the characteristic plants of the tidal marshes.
- Elephant Grass (Common Reed): The small beds of *Phragmites australis* that occur in coastal fresh marshes around the Annapolis area (District 610), Minas Basin (District 620 and sub-Unit 913a) and Tantramar Marshes (Units 523, 913b) are notable because of the 2- to 3-m height of the full-grown plant. The species occurs in many old dyked areas and may have been introduced by the Acadians as a thatching material.
- Ecological significance: Salt marshes are probably the major source of food material for the marine ecosystem in the Bay of Fundy and make an important contribution to marine systems in other areas.
- Migratory waterfowl: Tidal marshes, particularly coastal fresh marshes, are important migratory-waterfowl feeding areas in fall and early winter. They are also important breeding areas for some species of ducks.
- Cultural associations: Traditional Mi'kmaq custom and decorative work uses Sweet-grass, which occurs at the upper edge of many salt marshes. Some of the salt-marsh plants are edible (Glasswort, Orach).

Salt marshes were used by early settlers, and are used to this day, as a rich source of hay. An early practice involved storing hay in stacks on platforms (staddles) in the marsh. The promise of the rich lands led early Acadian colonists to the area to construct dyke systems for reclaiming the land. As a result, much of the original Bay of Fundy salt marsh has been converted to permanent cropland (see T12.7).

DISTRIBUTION IN NOVA SCOTIA

Nova Scotia tidal marshes are part of a band of salt marshes which extends from southern Labrador to the Gulf of Mexico. Tidal marshes are found in sheltered locations all around the coast of Nova Scotia (their distribution is shown in Table H2.5.1 and Figure H2.5.3).[8]

The most extensive tidal marshes are the high and low marshes of the Inner Bay of Fundy, Minas Basin (District 610 and Unit 913) and Chignecto Bay (Units 533, 913). Large areas of these marshes, however, have been converted to dykeland. In the Amherst area at the head of Cumberland Basin, the Tantramar Marshes dominate the landscape (Unit 523). Marshes along the Northumberland Strait and Atlantic Coast are often well developed (e.g., Chezzetcook Inlet, Halifax County; and Chebogue, Yarmouth County [District 830]), but many small areas in bays and estuaries are also found here. These marshes are more productive than those of the Bay of Fundy. Marginal salt marsh vegetation occurs in the Bras d'Or lakes (Unit 916) due to the negligible tidal range in the area.

Coastal fresh marshes are widely distributed in small areas all around the province, especially in association with salt marshes. The best development occurs in the upper reaches of the Bay of Fundy, in Cobequid Bay (District 620 and sub-Unit 913b) and Chignecto Bay (Unit 523).

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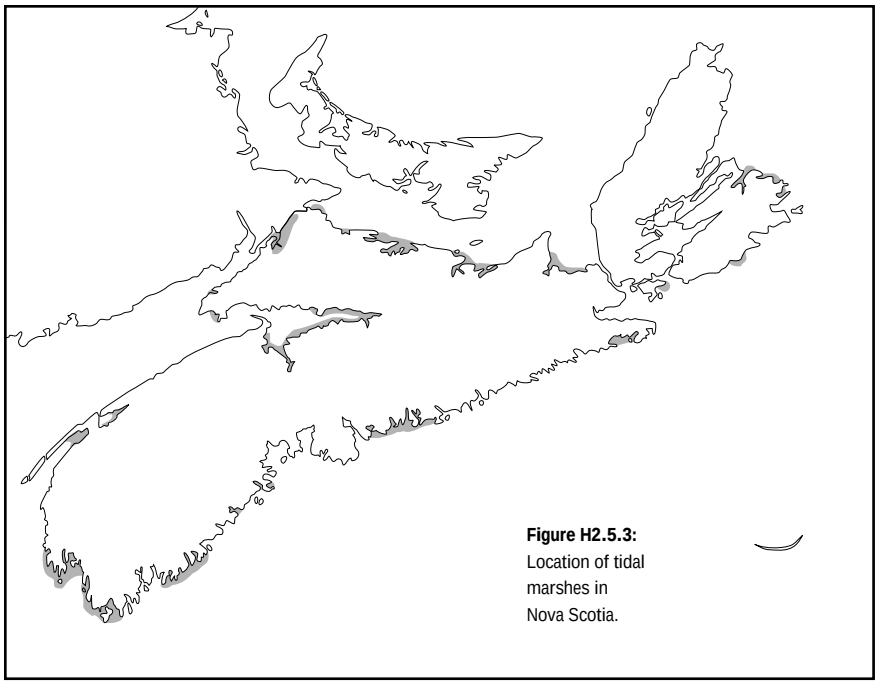

Figure H2.5.3: Location of tidal marshes in Nova Scotia.

Associated Topics

T4 Colonization, T7 The Coast, T10 Plants, T11.5 Freshwater Wetland Birds and Waterfowl, T11.6 Shorebirds and other Birds of Coastal Wetlands, T11.17 Marine Invertebrates, T12.7 The Coast and Resources

Associated Habitats

H1 Offshore, H2 Coastal, H2.6 Dune System, H6.3 Mixedwood Forest

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6 Gordon, D.C., Jr., and C. Desplanque (1983) "Dynamics and environmental effects of ice in the Cumberland Basin of the Bay of Fundy." *Can. J. Fish. Aquat. Sci.* 40.

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H2.6 DUNE SYSTEM

Dune habitats are exposed shoreline systems of one or more sand ridges derived from wind- and wave-transported material.

Plate H2.6.1: Dune system at Dominion Beach, Cape Breton County (Unit 531). Photo: R. Merrick

FORMATION

In Nova Scotia, this is a coastal habitat resulting from the deposition of sand on beaches in areas with sufficient sediment supply. Sand is deposited on the upper levels of the beach by both wave and wind action and becomes stablized by the growth of American Beach Grass (Marram Grass). New dune ridges are developed successively on the seaward side. The extent to which a coastal dune system will develop in Nova Scotia depends upon the sediment supply and the erosional/depositional environment, particularly the rate of sea-level rise.

PHYSICAL ASPECTS

1. *Soil:* wave- and wind-deposited sand is constantly shifting and has low nutrient levels.
2. *Relief:* topographically, the dunes are a succession of parallel ridges (dunes) and depressions (slacks). Ridges become lower and wider with age, due to compaction and spreading.
3. *Drainage:* ridges are well drained, but the leaching of material from the sand results in the eventual formation of hard pans and interrupted drainage in the slacks.
4. *Exposure:* dunes are subject to a high degree of exposure resulting from wind, blowing sand and salt spray

ECOSYSTEM

This is a natural ecosystem with low species diversity in the early stages of succession. Primary production is low, due to low nutrient levels and exposure. Diversity of consumers increases during the course of succession. The initial grassland system changes to a forest system over time.

SUCCESSIONAL SEQUENCE

On a prograding dune system, bare, loose sand of the beach is colonized and stabilized by American Beach Grass. As the stable soil increases organic (humus) content and water-retaining capability, the Beach Grass community is replaced by an increasing variety of plant species, including heath plants, before giving way to coastal spruce, fir forest. The seral stages are usually represented by dune ridges of different ages, with distinct plant communities. The details and extent of the successional sequence will depend upon local conditions. The destruction of the vegetation cover in the dune system can cause damage to the system by wind erosion (blowouts). Sand dunes often provide the shelter required for salt-marsh development.

PLANTS

There are distinct plant communities associated with the seral stages of dune succession. These are summarized on the diagram of the Pomquet dune system shown in Figure H2.6.1.

The most important species that dominates the pioneer-plant association is American Beach Grass. Colonization of new sand may be by seed or runners from the established plants on the primary ("Yellow") dune ridge. The pioneer-plant association includes typical beach plants: Sea-rocket, Sandwort and Orach.

The "Yellow dune" is also dominated by American Beach Grass but the diversity of plant species is increased to include Poison Ivy and the sedge *Carex silicea*. Beach Pea is another species of this community.

The "Grey dune" community, in which active deposition of sand has ceased, continues the basic association of "Yellow dune", but the Beach Grass

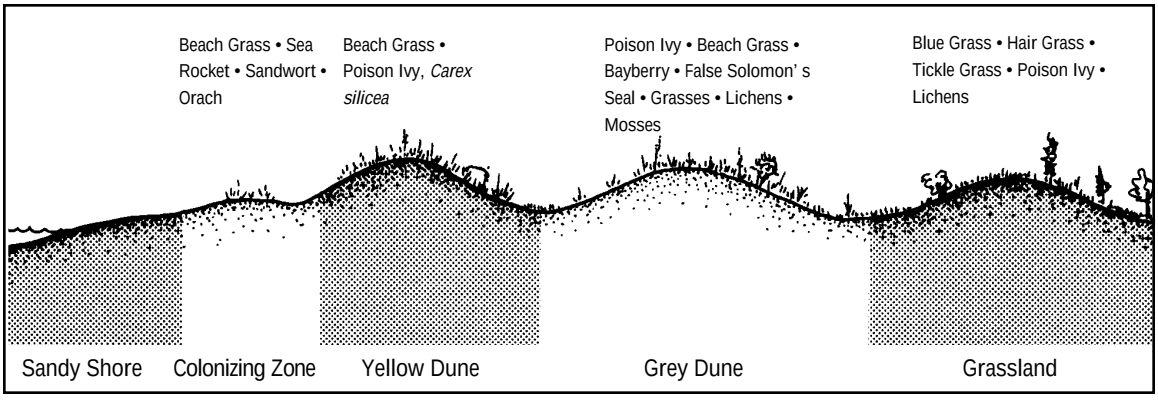

Figure H2.6.1: A diagrammatic cross section of a prograding dune sytstem, showing the main features of succession. Based upon information from Pomquet Beach (sub-Unit 521b). Not drawn to scale. (Continued on next page).

is beginning to give way to a variety of other plants, including grasses, Scouring Rush, Bayberry and lichens. Lichens, particularly species of *Cladonia*, may be the dominant vegetation in fairly extensive patches.

The "Grassland" community shows the final replacement of the Beach Grass by other grass species and the last stage before the "Heath and Scrub" ecotone that borders the White Spruce/fir, maple, birch forest association (H6.3). This community commonly includes Wild Rose and various heath plants, as well as individuals of the pioneer conifers.

In the depressions between beach ridges, known as "slacks", poor drainage and low nutrients support a plant association of a "bog" character, with *Myrica gale* and Cranberry. In later stages of succession, these may become alder swamp or pond habitat.

ANIMALS

The development of fauna relates to the stage of succession. Improved, stable soil and plant-species diversity support more diversified fauna. The upper sand, beach community of amphipods (*Talorchestia*), tiger beetles, flies and spiders (see H2.3) extends into the colonizing zone of the Beach Grass. At later seral stages, the diversity of insects increases and other groups of soil organisms, such as snails and slugs, become established. Vertebrates include snakes, small mammals and birds (Savannah Sparrow [Ipswich Sparrow on Sable Island] and Snow-buntings in winter).

SPECIAL FEATURES

- Pioneering role and adaptation of American Beach Grass
- Classic features of sand-dune succession
- Fragility of the system
- Special case of Sable Island–Ipswich Sparrow
- Dune-restoration programs in Nova Scotia include using discarded Christmas trees to stabilize the mobile sand prior to the Beach Grass establishment.

DISTRIBUTION IN NOVA SCOTIA

Sand-dune systems occur in exposed coastal areas where there is adequate sediment supply. The Northumberland Strait (District 520), Cape Breton (Districts 530 and 550), and the Atlantic Coast (Districts 830, 840 and 890) have the best examples. Pomquet Beach, Antigonish County, is the best provincial example of a prograding dune system. Management of sand dunes is an essential part of recreation-beach development. There are only a few sand dunes in the Bay of Fundy (for example, Apple River [Unit 532]).

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Associated Topics
T7.1 Modifying Forces, T7.3 Coastal Landforms, T10.2 Successional Trends in Vegetation, T10.5 Seed-bearing Plants, T10.11 Lichens, T12.7 The Coast and Resources

Associated Habitats
H2.3 Sandy Shore, H2.5 Tidal Marsh, H6.3 Mixedwood Forest

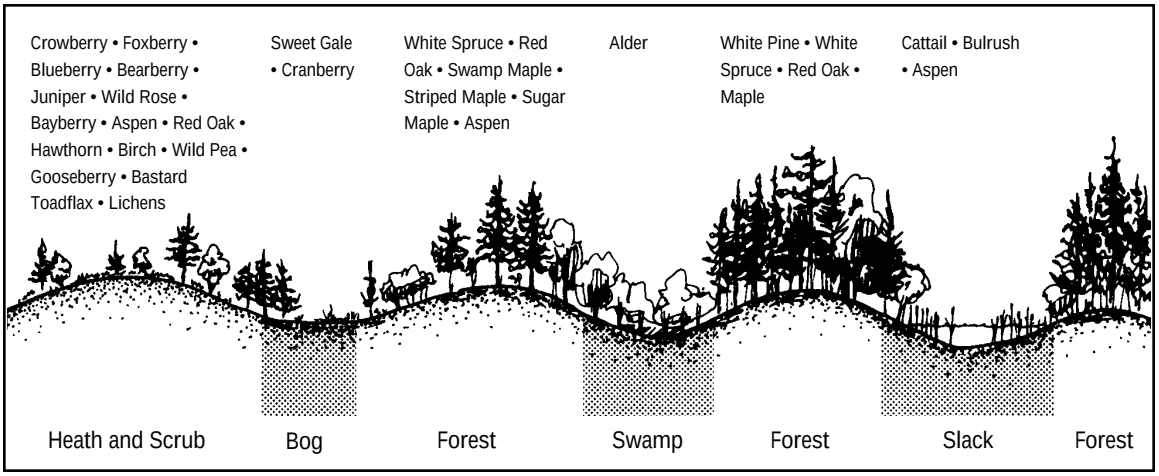

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Plate H2.6.2: Freshwater Cattail marsh in a slack between wooded dune ridges inland from Pomquet Beach, Antigonish County (sub-Unit 521b). The photograph corresponds to the cross section at the far right of Figure H2.6.1. Photo: D. Davis

