MAPPING AND STUDYING SEDIMENTARY AND VEGETATIVE ENVIRONMENTS IN A SALT MARSH IN THE SAINT JEAN ESTUARY, QUEBEC

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INTRODUCTION AND SITE DESCRIPTION

The study was conducted on a marsh on the south shore of Gaspe Bay in easternmost Quebec, Canada. The marsh of interest is located at the mouth of the Saint Jean River, protected from Gaspe Bay and the Gulf of Saint Lawrence to the west by the Douglastown Spit. The estuary is located in a mixed energy mesotidal portion of the coastline, in which the marine influence into the estuary is a near balance of wave and tide energy. This environment is characterized by the relative stability of the estuary, large ebb and flood tidal deltas, and "drumstick"-like spits caused by long-shore current action.

The goal of the project was to map the surficial sedimentary and vegetative zones on the marsh, and from there explain the evolution of the marsh/spit system. The Douglastown Marsh has distinctive regions of vegetation, from which the evolution of the salt marsh can be deduced. A topographic map of the marsh could also be produced; because of the low topography of the marsh, slight differences in elevation could provide important information on the evolution of the marsh.

FIELD AND LABORATORY METHODS

Mapping the vegetative and sedimentary regions was done using a combination of resources in addition to observations made in the field. Air photos of the estuary, the Magellan Global Positioning System, computer imaging programs, microscopes, and a Topcon GTS-2B infrared laser theodolite all were used in the production of a surficial map and a topographic map of the marsh.

Black and white air photos from the Canadian Geological Survey dating 1948, 1961, 1962, and 1976 were scanned into a Macintosh computer and compared to show differences in tidal channel migration. While working with GeoCanvas version 3.04, the 1976 air photo image was used as a backdrop/reference while drawing a map of the marsh showing the different stages in marsh evolution (Figure 2). Topographic data taken from theodolite readings were entered into MicroSoft Excel and Surface 3 computer programs to produce a contour map and a three-dimensional model of the salt marsh.

Shallow trenches were dug in several areas of the marsh that were representative of tidal flat, incipient, low, high, and mature marsh environments. These zones were determined by observation of differences in types of vegetation growing in the areas. Sediment samples were taken and later analyzed under a microscope to show variations in sediment colors, shapes, and sizes. This would provide clues to possible migration of the marsh, as well as provide information as to whether the sediments were of marine or fluvial origins.

Precise locations of the trenches that were dug were made using the Magellan GPS. The Magellan system also enhanced accuracy of the location of boundaries of the different vegetative and sedimentary environments on the marsh.

OBSERVATIONS

Since the estuarine environment is inhabited by plant species uniquely adapted to the brackish waters and daily inundations by the tides, vegetation provided a useful tool in identifying zones of different maturation levels in the marsh. The marsh was divided into areas of beach and dunes, tidal flats, low/incipient marsh, and high/mature marsh.

The beach and dune areas were inhabited mostly by *Ammophila breviligulata* (American Beach Grass) and *Lathyrus japonicus* (Beach Pea), common in sandy beach and dune environments. The low marsh was characterized by the growth of *Spartina alterniflora*, small patches of *Salicornia bigelovii* (Bigelow glasswort), and scattered *Limonium angustatum* (Sea-Lavender) plants. These types of flora are characteristic of intertidal zones exposed only

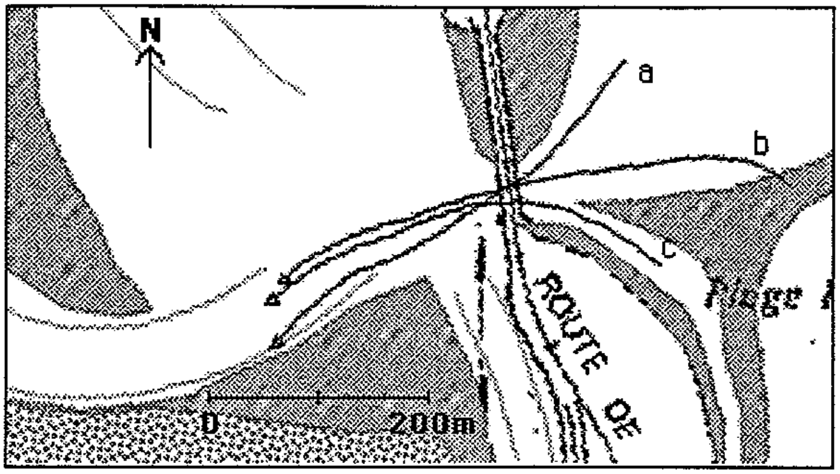
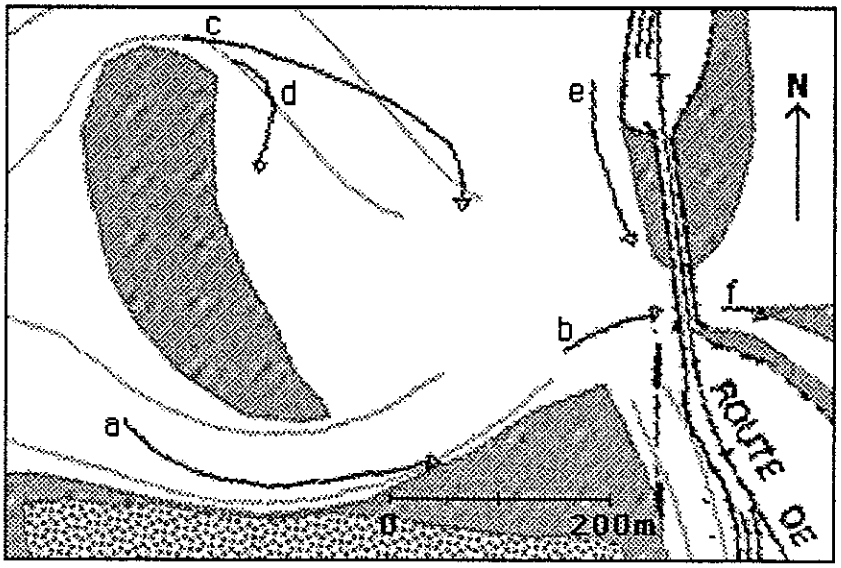


Figure 5. Buoy paths during flood tide

Figure 6. Buoy paths during ebb tide
There are high winds from the north



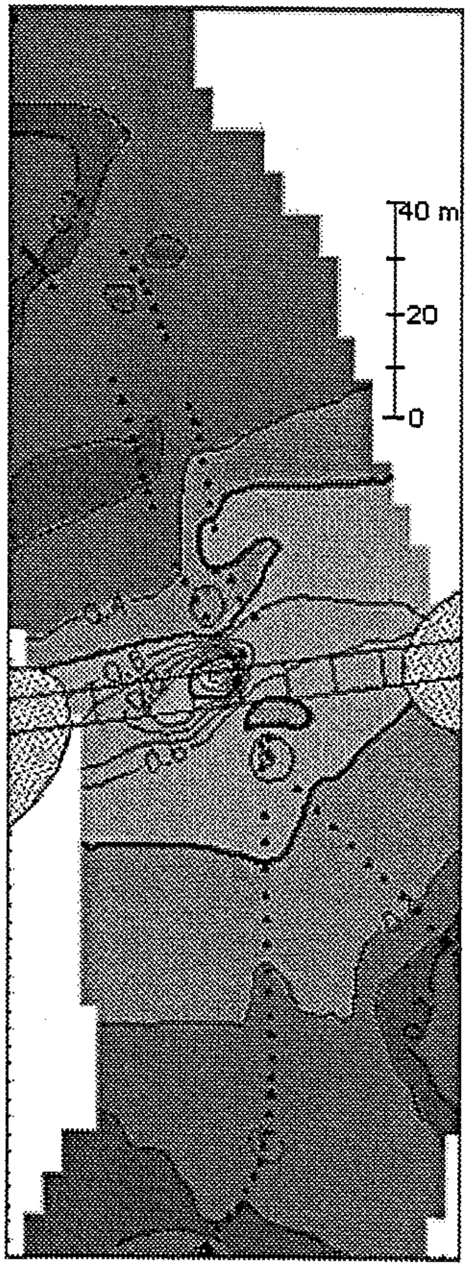


Figure 7. Velocity contours of flood buoys a and b. Contour interval is 0.1 m/s

at the lowest low tide. Large patches of *Spartina patens* were common in the high marsh, it being a variety of *Spartina* adapted to fewer hours of daily tidal inundation than *Spartina alterniflora*, and its presence marked a boundary between high and low marsh. *Potentilla anserina* (Silverweed) and greater numbers of *Salicornia* were found in the high marsh as well. Near the southernmost corner of the marsh, *Juncus gerardi* (Blackgrass) dominated the *Spartina*, and several young conifers had taken root. *Juncus* requires a more freshwater environment than does *Spartina patens*. The nature of this area suggests it is in a supratidal zone, bordering on having terrestrial characteristics. The tidal flats did not support any vegetation. Significant amounts of algae were scattered in both high and low marsh zones.

Other observations that helped determine the boundary between high and low marsh included the presence of dried salt-pannes in high marsh areas, and a greater number of displaced chunks of peat in the low marsh areas. The characteristics of a high marsh environment represent an area of greater stability, which could possibly turn terrestrial with increasing stability, as shown by the presence of conifers in the high marsh. The locations of the most stable high marsh and the locations of the low marsh suggest a northerly migration of the Douglastown Marsh.

Efforts to take sediment samples were hampered by the extremely high water level in the marsh and a lack of PVC tubing, so only shallow depths (less than 1m) could be reached. The sediments ranged from dominantly coarse sand in tidal flats to fine clay and silt in the high marsh. Most of the sand grains were angular to sub-angular. Sediment samples from tidal flats (Figure 2, sites D and E) yielded medium sized angular sand grains, with anoxic layers occurring at a minimum depth of 0.3m. No plant materials were found. Incipient marsh samples (Figure 2, site F) revealed a thin layer of clayey sub-angular to sub-rounded fine sand on top of angular anoxic medium sand, suggesting that what once was a tidal flat is now an emerging low marsh area. One areanceous foraminifera was found in a sample from a depth of about ten inches. Low marsh sediments (Figure 2, sites B and C) were mostly clayey sub-angular fine grained sand, rich in plant materials to a depth of 0.5m (Figure 1, site B). The samples taken at site C, although very close in proximity to B, yielded medium grained sand with natural wood chips (about 2.5" x 1.5"), pebbles, and even a few sparse cobbles. Both sites B and C are located at the cut bank of a tidal channel; B samples were taken from the bank, and C samples were taken at the edge of the channel at low tide. High marsh samples (Figure 2, sites A and G) yielded sub-angular to sub-rounded sandy clay. Plant materials were abundant to 18 inches at site A (Figure 1, site A), and were found through the entire sequence at site G, suggesting an extremely mature high marsh at the southern corner of the estuary.

Site G also yielded small (2mm x 2mm) possibly man-made square wood chips at a depth of six inches. This is evidence that logging and other human activities in the Saint Jean River area may have affected the amount and rate of sedimentation in the marsh/spit system. Carbon dating of the sediments and comparisons with local logging records may provide more accurate correlations.

Immediately to the east of sites B and C, on the beach side of the sand dunes, are what appear to be evidence for the location of a paleo-delta for the Saint Jean River. The area is marked by small (about 3m high) levee-like ridges directly east of a tidal channel that extends into the spit, and a semi-circular arrangement of logs that marked an old shoreline about 240m in length and 20m maximum width. This is easily seen in photographs, and is further confirmation of a northerly migration of the marsh.

RESULTS AND CONCLUSIONS

Various techniques can be utilized to develop an accurate map of the different vegetative and surficial sedimentary zones within the marsh. The tolerabilty of salt water by certain plants can be correlated with the migration of the marsh. A study of surficial sediments in the marsh show a trend towards silty/clay sediments in high marsh areas and coarse sediments in areas more often subjected to the energies of the ebb and flood tides. This is consistent with the observation that plant growth increases the rate of sedimentation by trapping suspended sediments. This leads to higher elevations of high/mature marshes, and can be seen on a topographic map of the marsh. The angularity of the sediments suggest a fluvial origin. Based on a combination of vegetative, sedimentary, and observational evidence, it is most probable that the Douglastown Marsh has been migrating to the north, with sediments dominantly supplied by the Saint Jean River. Thus, it is reasonable to conclude the Douglastown Spit has been migrating in a northerly direction as well.

More in-depth studies of the Douglastown Marsh could in the future yield a more accurate picture of marsh evolution. Coring into the marsh in addition to carbon-14 dating on the peat and core samples would give a much clearer account of the sedimentation rates in the marsh and how the marsh evolved to its present state. Further information about the migration of channels, and possibly even the Saint Jean River may also be obtained through coring data. Local records on logging, population growth, and rural settling and development along the Saint Jean River, in conjunction with knowledge on sedimentation rates in the marsh via coring and carbon-14 dating, may reveal how and how much the marsh has been influenced by human activities in the area. A combination of this data with present data on marsh evolution could produce a model demonstrating correlations between human activities upriver and changes in sediment deposition into the marsh.

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Figure 1. Sample of stratigraphic columns from high marsh (site A) and low marsh (site B). Note larger amounts of silt and clay in site A.

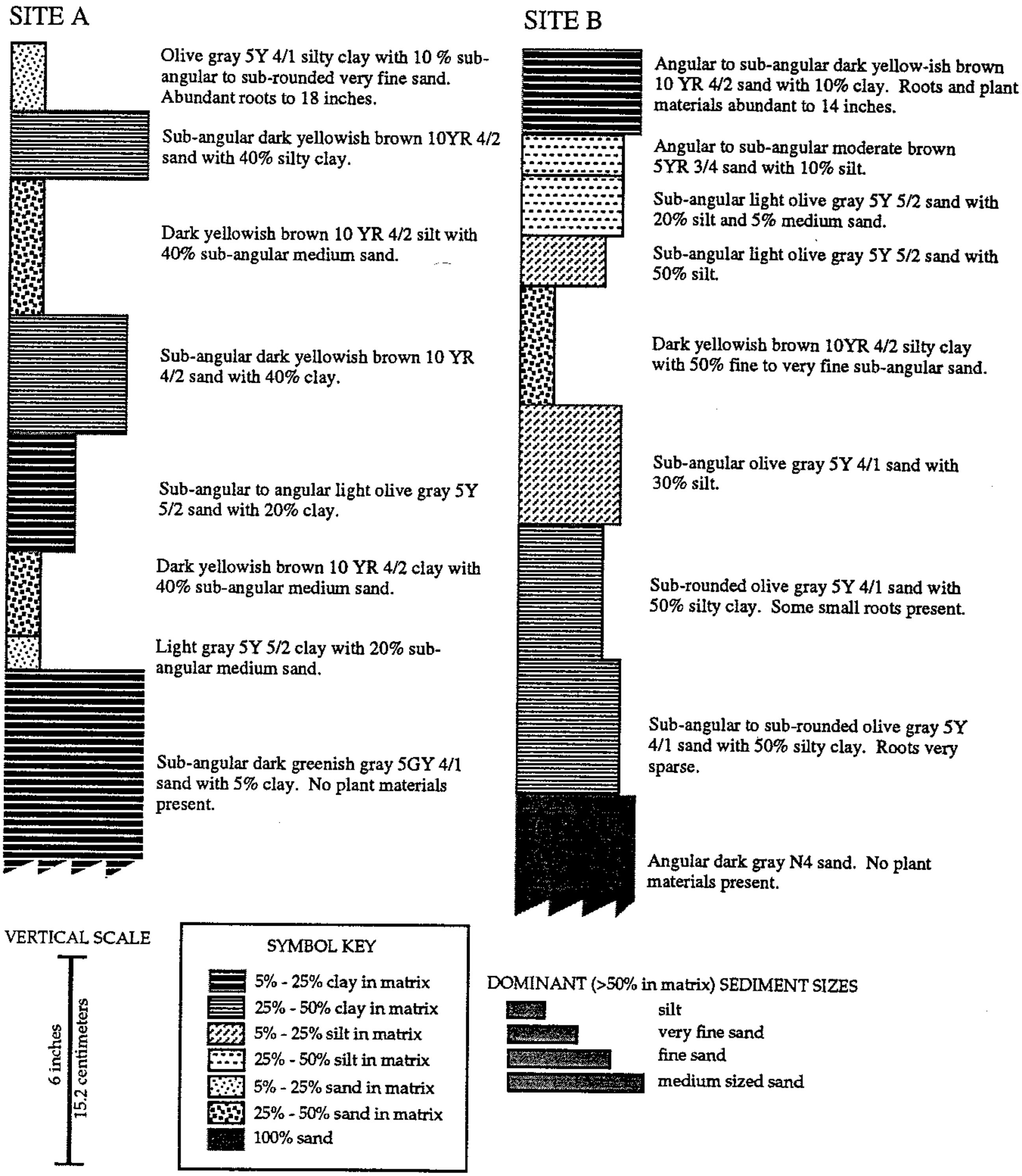
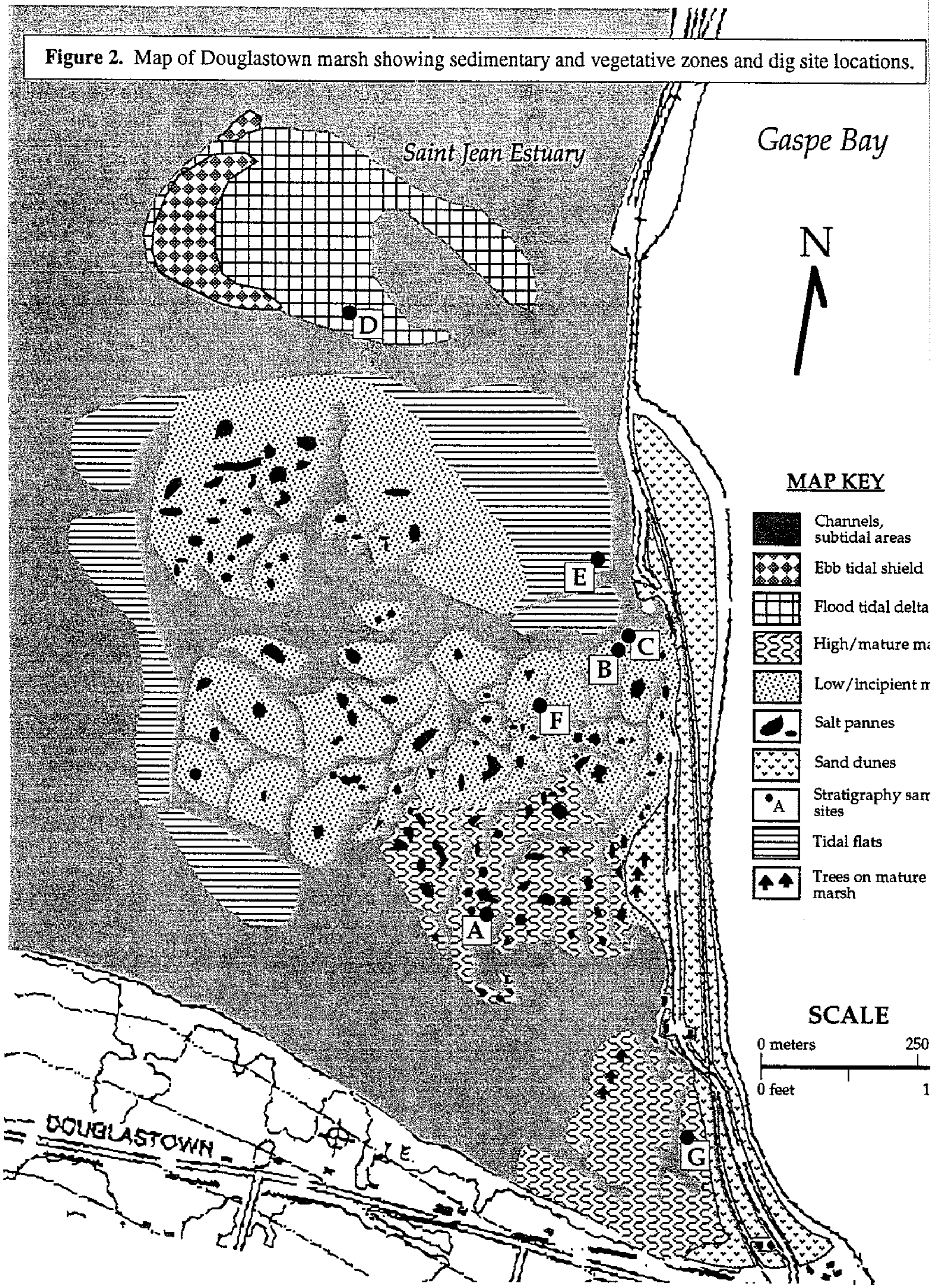


Figure 2. Map of Douglastown marsh showing sedimentary and vegetative zones and dig site locations.



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