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SOME OBSERVATIONS ON THE RELATIONSHIPS BETWEEN HIGH TIDE LEVELS AND COASTAL RESOURCES IN CUMBERLAND BASIN

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Relationships between high-tide levels in Cumberland Basin and the dykes, aboiteaux, and saltmarsh communities were observed during exceptionally calm conditions. During the large tide of 20 June 1978, the high-water levels reached +6.89 m to +7.37 m above mean sea level. During the small tide, which followed on 26 August 1978, the corresponding elevations were +4.39 m to +5.01 m above mean sea level. Saltmarsh communities extended as high as +6.83 m above mean sea level during the indicated growing season. Further study concerning the distribution controls of local halophytes is suggested. Additional related observations, on stream controls and a drowned forest of scientific interest, are included.

Introduction

Cumberland Basin is one of several potential areas for Fundy tidal power development, and as such is commonly referred to as "A8". Although studies concerning the mega-tidal behavior in this area continue, the implications of altered tides because of barrage construction are not well understood.

Most of the tidal marshlands surrounding Cumberland Basin are protected now from all but the highest levels of seawater by dykes and aboiteaux. The earliest dykes were constructed 3 centuries ago, their remnants being diminutive compared with the modern machine-made earthen dykes. The modern dykes around Cumberland Basin are built to a nominal elevation of +8.4 m above Geodetic (Survey of Canada) Datum*, giving freeboard protection from normal high tides of about 0.6 m. The aboiteaux on the tidal streams with their one-way 'flapper gates' also are now built with modern equipment to provide freshwater drainage to about 1.8 m below the backshore surface.

Inside the dykes and aboiteaux there are extensive tracts of arable land, divided into various administrative and/or co-operative units known as Marsh Bodies. The Marsh Bodies are distinguished officially by common names and number codes. Outside the dykes, saltmarsh communities stabilize and protect some parts of the intertidal zone. Elsewhere, foreshore sediments and exposed bedrock contribute to the high suspended sediment load of Cumberland Basin.

The slopes of the intertidal zone and backshore vary greatly around the Basin and are being studied in detail by the Chignecto Research Group of Mount Allison University. Certainly, on the shallow gradient vegetated slopes, a hypothetical change in the tidal regime could have a measurable impact on the distribution of saltmarsh communities. It is also possible that an altered tidal regime could affect the freshwater discharge through the aboiteaux.

The primary objective of this study is to begin an investigation of the magnitude of a tidal change which probably could be tolerated by the coastal resources of Cumberland Basin.

**Geodetic Datum is considered here to be equivalent to contemporary mean sea level, a universal reference.*

Methods and Techniques

My basic assumption is that the contemporary distribution of plant communities, dykes, and other features of Cumberland Basin has a definite relationship to the present tidal regime.

An assessment of the contemporary elevations of coastal resources began with an examination of the Marsh Plans held by Maritime Resource Management Service (M.R.M.S.) in Amherst, N.S. Typical spot elevations were noted for land surfaces inside (and sometimes outside) the dykes which are recorded directly on the Marsh Plans. Additional comments by members of the Engineering Division of M.R.M.S. were also noted.

The most current survey values for monuments in the area were obtained from Land Registration and Information Service (L.R.I.S.), Summerside, P.E.I. These data were used in planning a field program, as well as in the final computations. Furthermore, members of the Chignecto Research Group of Mount Allison University offered an opportunity for this work to be integrated with their field studies; these included systematic tidal observations around Cumberland Basin during a large tide on the 20th of June and during a small tide on the 26th of August. These tides were predicted to be close to the extreme high tidal levels for 1978 and should be related to the uppermost limits of the saltmarsh communities.

In the course of the tidal observations, the uppermost water levels were marked by stakes. During the large tide, 12 different sites were marked (Fig 1). Ten different observations were available for the small tide, a reduction reflecting manpower limitations.

The elevations of the high water markers were tied by spirit levelling to the nearest survey monuments of known elevation. Under the time constraints, it was not possible to run 2 completely independent (check) lines for all the markers. Therefore, 2 distinct lines were levelled simultaneously using the same instruments and the respective values were computed as 2 separate lines. All the computed metric elevations for the high water markers are presented here as the means of 2 independent or quasi-independent observations. The field observations were initially made in English units, estimated to the third decimal of a foot, and averaged in the technique of "three-wire levelling".

Several survey lines were very short, but the longest exceeded 5 km linking Bore View Park at Lower Maccan to a reference at Lower River Hebert. Whenever convenient, observations were made on the limits of the lower marsh communities (e.g. *Spartina*). In addition, a spur line was levelled across the upper marsh (e.g. *Juncus*) surface east from the Fort Beausejour station for several reasons: 1) to collect a sequence of typical elevations of the permanent marsh surface; 2) to obtain the elevations of the brackish ponds on the marsh surface where some waterfowl feed; and 3) to ascertain the contemporary elevations of the stumps in the drowned forest (Fig 1).

Observations

High Water Levels

It was particularly remarkable and fortunate that both sets of tidal observations were made under conditions of *minimal* wind influence. The calm water surfaces made accurate placement of high water stakes feasible. The figures thus indicate the *least levels* to be achieved during extreme tides. (Because of fetch, etc., slightly windy conditions would probably raise these levels measurably). The high water levels are given in Table I.

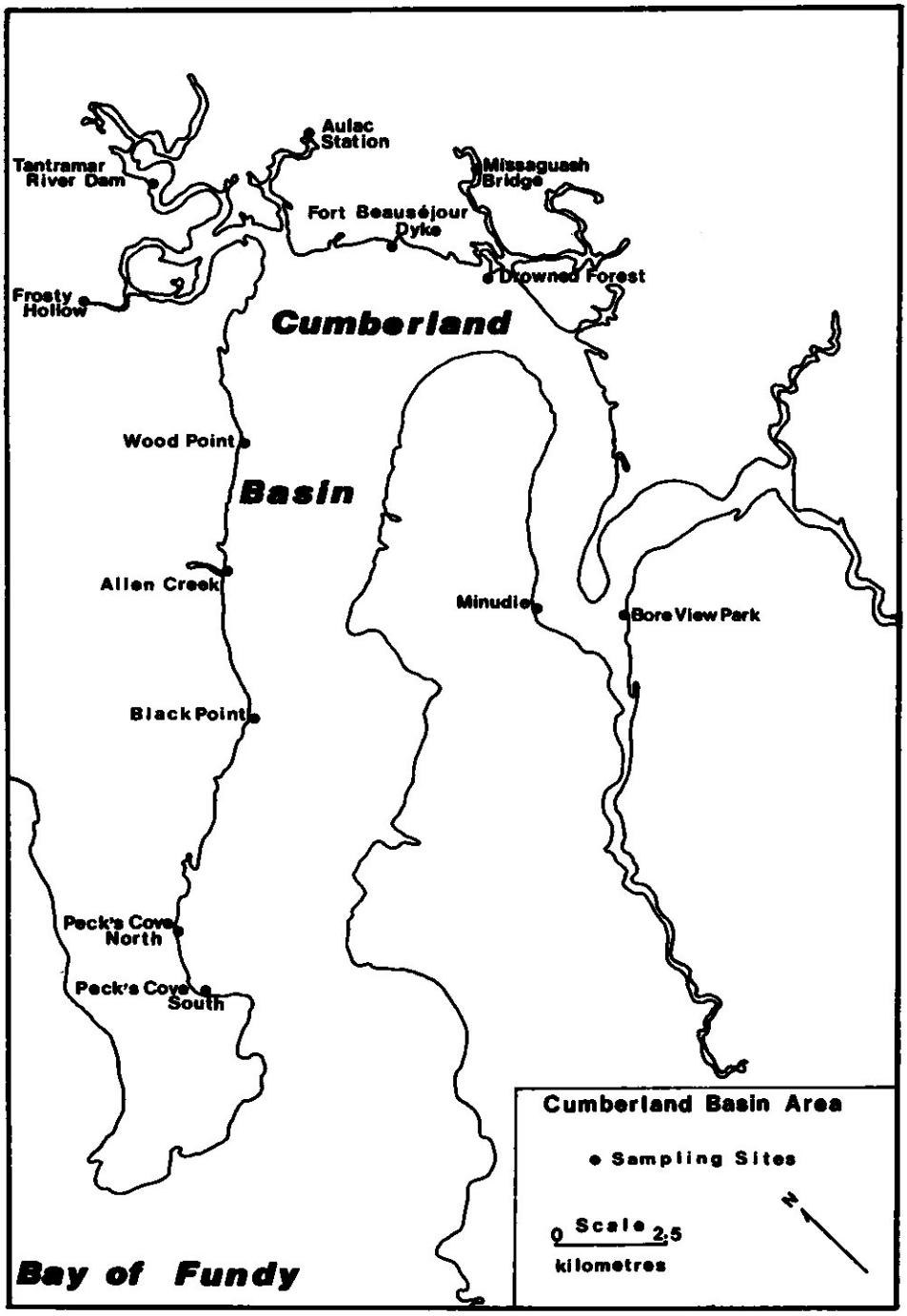

Fig 1. Map showing the locations of sites discussed in text.

Table 1: Observed mean high tide levels, Cumberland Basin, 1978 (meters above mean sea level/Geodetic Survey of Canada Datum). Elevations derived from twelve levelling traverses.

Station	Large Tide (20 June)		Small Tide (26 August)	
	Mean	SD	Mean	SD
Peck's Cove South	6.89 m	0.00	4.44 m	0.00
Peck's Cove North	6.74 m	0.00	4.39 m	0.00
Black Point	6.94 m	0.03	4.46 m	0.05
Allen Creek	6.97 m	0.01	4.56 m	0.01
Wood Point	7.03 m	0.00	4.57 m	0.01
Frosty Hollow	7.35 m	0.01	5.09 m	0.02
Tantramar Dam	7.30 m	0.01	4.82 m	0.00
Aulac Station Dyke	7.10 m	0.03		
Fort Beausejour Dyke	7.10 m	0.01	4.73 m	0.01
Missaquash Bridge	7.12 m	0.02	4.81 m	0.01
Minudie*	7.31 m	?		
Bore View Park	7.37 m	0.01	5.01 m	0.01

*Minudie value provided by Chignecto Research Group.

Each high water stake has a corresponding elevation relative to mean sea level. Each stake can be used as a local reference datum for ascertaining the elevations of proximal saltmarsh communities.

Salt Marshes

All of the large tide high water levels were observed to exceed the elevations of the saltmarsh communities. Observations are available for the crest and foot of various *Spartina* marsh communities and one large *Juncus* marsh at Fort Beausejour Dyke. The observations on saltmarsh communities are indicated in Table II.

Aboiteaux and Tidal Dams

Most of the former tidal streams debouching into Cumberland Basin now have control structures to prevent tidal water from "back-flooding" the channels.

The stream controls have dimensions as small as 0.3 m x 0.3 m or may be even larger than the Tantramar River Dam with two sluices each 4.6 m x 4.9 m.

Most of the aboiteaux are top-hinged in such a manner that once the tide falls, the freshwater can drain out simply because of the head developed behind the gate. The vertical sliding gates at the Tantramar River Dam are, however, electrically operated by an attendant who monitors the freshwater impoundment regularly. The sill elevation of the sluice at this dam is at -4.6 m mean sea level. Freshwater discharge begins during ebb tide when sea water levels fall below -1.6 m. (C. Desplanque, in verb.). Discharge continues as sea water levels fall below the sill at -4.6 m.

Drowned Forest

On the intertidal slope near the mouths of the Missaquash and LaPlanche Rivers lies a drowned forest. In the event that this scientific site would be rendered inaccessible for interested parties and future research, some elevations were

Table II: Observed saltmarsh levels, Cumberland Basin, 1978 (meters above mean sea level/Geodetic Survey of Canada Datum). Elevations derived from single observations near high tide markers.

Location	Upper Limit		Lower Limit
Peck's Cove			4.38 m
Wood Point	5.78 m		4.53 m
	6.72 m		
	5.84 m		
Fort Beausejour Dyke	6.06 m		
	5.80 m		
	5.69 m		
	5.75 m		
	5.62 m		
	5.70 m		
		Tidal Pond 5.49 m	
		Tidal Pond 5.72 m	
		Old Dyke 6.25 m	
Bore View	6.66 m		5.42 m
	6.79 m		5.04 m
	6.83 m		4.87 m
	6.45 m		5.37 m
	6.37 m		4.59 m
			4.34 m

Table III: Observed elevations of Drowned Forest Stumps, Cumberland Basin, 1978 (relative to mean sea level/Geodetic Survey of Canada Datum). Elevations are derived from single observations in a loop traverse with a total closure error of 0.05 m.

Ground Elevation adjacent to selected stumps:		
-0.28 m	-0.24 m	-2.07 m
-0.35 m	-0.36 m	-1.69 m
-0.57 m	-1.24 m	-0.41 m
-0.46 m	-0.91 m	

determined for this drowned forest. A short spur line was extended from the Fort Beausejour Dyke line to ascertain the appropriate elevations presented in Table III.

In general, the stumps lie now on a winnowed gravel surface. The root crowns are firmly lodged in the substrate and are commonly believed to be in situ. They are found slightly below mean sea level in this locality (-0.24 m to -2.07 m).

Discussion and Conclusions

The results of spirit levelling from L.R.I.S. monuments to appropriate high water stakes and saltmarsh communities have been tabulated.

It can be seen in a comparison of the observed high water levels and upper marsh

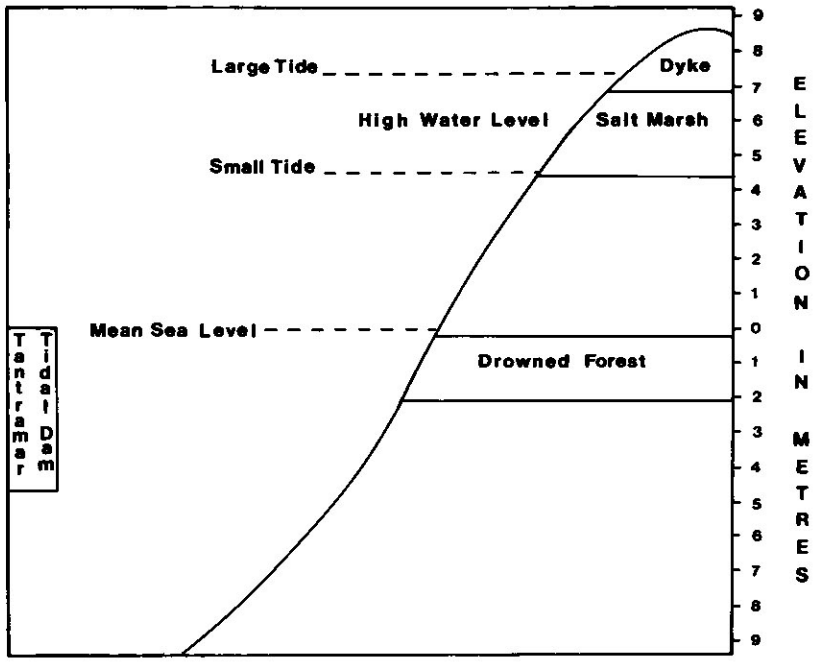

Fig 2. Hypothetical shore profile showing vertical relationships of subjects discussed.

limits that the large tide high water level exceeded the observed growth limit by at least 0.31 m. Under more typical conditions, the high water levels are probably higher because of the local meteorological and hydrographic conditions. Precisely how much this flushing could be altered without substantial vegetational repercussions is undetermined; the requirements of the halophytes in this locale should be studied further.

With regard to stream drainage and water control, apparently the lowest sluice sill on Cumberland Basin is that of Tantramar River Dam at -4.6 m elevation. Provided that the low tide falls below that depth, freshwater drainage could probably be effected properly.

The continued access to the drowned forest in Cumberland Basin is of importance. Because the tree stumps in question lie between -0.24 m and -2.07 m, they would be rendered inaccessible only in the most severe and catastrophic tidal alterations.

The relationships of the salt marshes, Tantramar River Dam, and drowned forest to the dykes and tides are illustrated (Fig 2).

It can be seen that a change of a few decimetres would not be expected to have extensive implications for the resources discussed herein.

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