The Tide in Eastern and Western James Bay

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ABSTRACT. The tide in eastern and western James Bay is reconstituted for the summers of 1947 and 1950, using recent cotidal charts, and the predictions are compared with some observations carried out during those years. The predictions and the observations are found to agree in general, thus confirming the validity of the cotidal charts.

RÉSUMÉ. *La marée dans l'est et dans l'ouest de la baie de James.* A partir de diagrammes de marée récents, l'auteur reconstitue la marée dans l'est et dans l'ouest de la baie de James pour les étés de 1947 et 1950, et il compare ces "prédictions" à quelques observations menées pendant ces années-là. Il trouve ainsi que les prédictions et les observations concordent en général, ce qui confirme la validité des diagrammes de marée.

РЕЗЮМЕ. *Приливы в восточной и западной части залива Джемс.* С помощью новой методики котидальных карт воссоздана картина приливов в восточной и западной части залива Джемс в летний сезон 1947 и 1950 годов, и полученные результаты сравниваются с данными наблюдений, проведенных в тот же периоц. Обе категории данных хорошо согласуются, что подтверждает применимость методики котидальных карт.

Two papers by Manning (1950, 1951), contain some recordings of tides in James Bay which are now reviewed on account of the renewed interest in that area. The 1950 recordings are in the form of times and heights of high and low water, while those of 1947 consist of time lags between local high water and high water at Churchill, Manitoba. Cotidal charts for the major constituents were drawn recently for James Bay using a tenuous set of observations, a one-dimensional model and much speculation (Godin 1972). Fig. 1 shows the cotidal chart elaborated for the tidal constituent M_2. Similar charts have been drawn for S_2, N_2, K_1 and 0_1. Since the location of the points of observation is clearly indicated by Manning, it has been found possible to deduce the local values of the major tidal constituents at these points from the new charts (see Table 1) and hence obtain in retrospect the times and heights of high and low water. The calculation, not difficult with the aid of modern computers, has enabled "predictions" to be made for the year 1950 which may be compared with the material collected by Manning for the east coast of James Bay. If the times and ranges of the observed and predicted tides agree (and we shall soon see that there does exist a considerable measure of agreement), the validity of the cotidal charts will be confirmed — at least for the east coast. We cannot follow the same procedure for the 1947 observations since these concern time lags only, and so we have to resort to a comparison of the observed time lags with those for M_2

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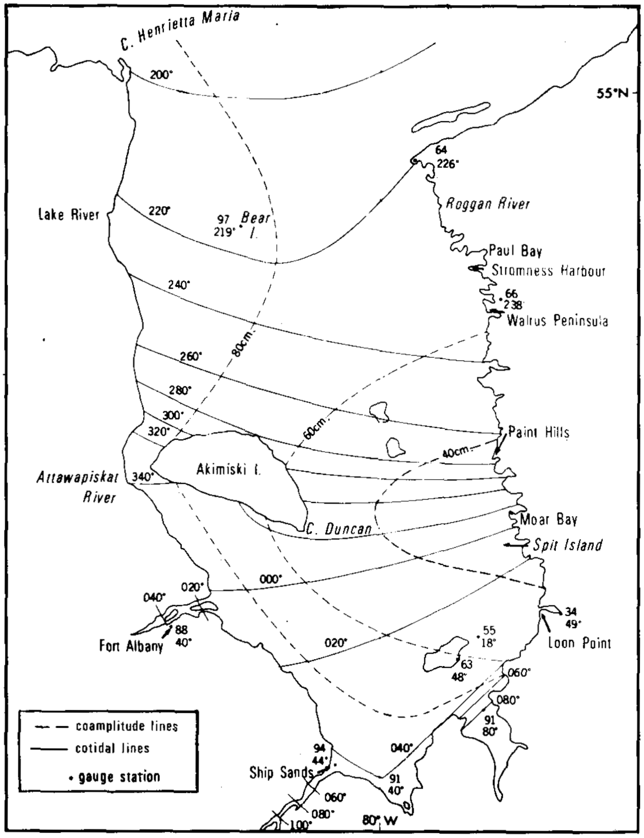

FIG. 1. Cotidal chart for M_2. The cotidal lines labelled in degrees of phase delineate zones of simultaneous occurrence of high water. The coamplitude lines delineate zones of equal amplitude. The observed amplitude and phase of M_2 has been entered where measurements are available.

TABLE 1. Amplitude and phase of the major tidal constituents* at the localities where the tide was observed by Manning in 1950, deduced from cotidal charts.

Locality	M_2 cm.	M_2 deg.	S_2 cm.	S_2 deg.	N_2 cm.	N_2 deg.	K_1 cm.	K_1 deg.	O_1 cm.	O_1 deg.
Roggan River	70	224	25	290	18	194	00	000	00	000
Paul Bay	74	232	23	305	15	208	3	105	2	025
Stromness Harbour	66	230	20	302	14	204	4	102	3	022
Walrus Peninsula	62	235	17	317	11	216	6	108	4	035
Paint Hills	30	275	5	038	3	270	8	121	6	060
Spit Island	38	005	9	108	7	320	11	142	6	082
Loon Point	47	035	7	137	4	344	12	144	6	102
Moar Bay	25	342	4	100	3	310	9	144	6	078

* M_2, S_2, N_2: major semidiurnal components of the tide due to the moon, the sun and the variable distance of the moon.

K_1, O_1: diurnal components of the tide due to the declination of the orbits of the moon and of the earth.

implied by its cotidal chart. We then find that the records of the 1947 observations conflict with the presumed lags in the case of northwestern James Bay, that the two sets agree in the case of southwestern James Bay, and that the observed lags on the western side of Akimiski Island imply a situation which is quite reconcilable with conditions in that area, but which seems too speculative for inclusion in the cotidal charts.

Let us concentrate first on the observations made in the summer of 1950 in eastern James Bay. In Table 2 are listed the predicted and observed times and

TABLE 2. Time and height of high and low water, and range of the tide, predicted and observed (excluding Moar Bay) Eastern Standard Time.

Station and Date	Time		Height (cm.)		Time		Height (cm.)		Range (cm.)	
	Pred.	Obs.	Pred.	Obs.	Pred.	Obs.	Pred.	Obs.	Pred.	Obs.
Roggan River										
1950										
12 Aug.	0703	0700	56	—	1313	1330	−59	40	115	xxx
13	0741	0810	69	146	1350	1445	−72	27	141	119
14	0817	0900	81	152	1426	1500	−83	−6	164	158
15	0854	0935	90	177	1503	1530	−92	9	182	168
16	0931	0950	97	201	1541	1530	−98	9	195	192
Paul Bay										
22 July					1314	1340	78	210		
23	0756	0810	−72	46	1413	1420	70	216	142	180
24	0903	0920	−64	49	1523	1510	65	210	129	161
25	1019	0950	−60	55	1639	1615	65	210	135	155
26	1136	1115	−63	58	1750	1710	71	219	134	148
27					1852	1820	80	—	—	—
28	0727	0720	79	223	1946	1925	89	244	—	—
29	0816	0835	88	241	1423	1440	−87	82	175	159
30	0901	0920	93	238	1507	1530	−92	67	183	171
31	0942	1010	95	232	1548	1620	−93	52	188	180
2 Aug.	1059	1140	88	213	1704	1740	−85	27	173	186
3	1135	1220	80	213	1742	1810	−77	18	157	195
5	1251	1325	61	198	1901	1930	−57	40	138	158
6	1335	1400	51	207	0721	0740	−52	43	103	164
Stromness Harbour										
25 Aug.	1209	1230	−55	70	1822	1820	68	186	123	116
26	0704	0735	65	152	1308	1330	−62	18	127	134
Walrus Peninsula										
27 Aug.	1405	1410	−57	27	2014	2040	72	180	129	153
28	0853	0910	65	174	1452	1530	−62	34	127	140
Paint Hills										
29 Aug.					2251	1930	33	30		
30	0522	0740	−37	6	1142	1300	28	58	65	52
31	0602	0800	−35	21	1219	1330	31	76	66	55
1 Sept.	0639	0900	−33	40	1254	1330	33	79	66	39
Spit Island										
3 Sept.					1705	1705	45	76		
4	0553	0700	26	67	1128	1210	−24	18	50	49
Loon Point										
5 Sept.					1931	1940	49	73		
6	0850	0920	31	110	1419	1355	−19	55	50	55

heights of high and low water, as well as the range, for the given date and locality, omitting the evening tides. The times are directly comparable, but otherwise only the ranges, since there was presumably no vertical control. The stations utilized were Roggan River, Paul Bay, Stromness Harbour, Walrus Peninsula, Paint Hills, Spit Island and Loon Point. Readings were also taken at Moar Bay, but these could only be presented in the form of a graph, for reasons which will be explained later.

The stations are listed in geographical sequence from north to south; the observations were of variable duration, being most prolonged at Paul Bay and of minimal duration at Spit Island and Loon Point. But even the readings taken at the latter two locations are of value since they bear out the general consistency of the observations and the predictions. We note that there is an increase in the semidiurnal ranges between Cape Jones and Fort George which is consistent with the one-dimensional model and the recordings. We see that, except in the case of Paint Hills, the predicted and observed times approximate closely. The ranges vary more, but we must remember that they are small everywhere and easily altered. Predicted and observed ranges approximate closely on the average.

The only problem station in Table 2 is Paint Hills where there exist systematic discrepancies in the times. The first and subsequent morning recordings could be disregarded, since the extrema occurred at times which were either too late or too early for campers to observe, but even the midday recordings disagree. The values deduced for the tidal constituents at Paint Hills are taken from the cotidal charts using methods identical to those for the other stations. Since even the minimal number of recordings for Spit Island and Loon Point are consistent with those for the other places, there is no reason why the same approach should not work for Paint Hills, and so no explanation can be offered for this discrepancy. The two-hour delay at Paint Hills may be due to the very sheltered position of the observation spot, but Manning notes simply that it was "south" of Paint Hills Islands. Figures 2(a) and 2(b) show the reconstituted tides at Paint Hills and Moar Bay respectively during the period of the 1950 observations. The same procedure was followed for the other stations supplied by Manning.

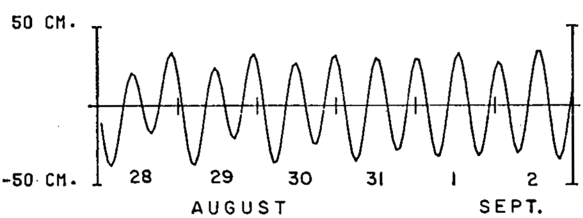

FIG. 2(a). Reconstruction of the tide at Paint Hills.

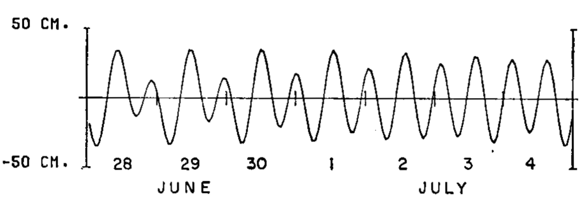

FIG. 2(b). Reconstruction of the tide at Moar Bay.

The 1950 data for Moar Bay are presented in graphical form because no definite high or low water could be detected at that locality. Quite accidentally, Manning had chosen in Moar Bay the point where the tides are at their smallest in James Bay. They have an amplitude of about one foot (30 cm), with occasional strong diurnal inequalities which reduce the intermediate amplitudes to about 0.5 foot (10 to 15 cm.) (see Figure 2(b)). It is understandably a very difficult task to try to maintain a record of such slight fluctuations in level by means of a graduated staff. It is equally difficult to compare the observations with the predicted change in level during the interval 28 June — 15 July, 1950. It was finally decided to superimpose the recorded figures on the predicted time and height of high and low water joined by straight lines (Figure 3). The task of comparison is hampered by the absence of a reference level and the fact that the graduated staff was moved twice. An arbitrary datum has been chosen which locates the observations within the range of the predictions. During the last two days the staff was moved two miles away, and in that portion of the curve two possible representations of the observations are shown.

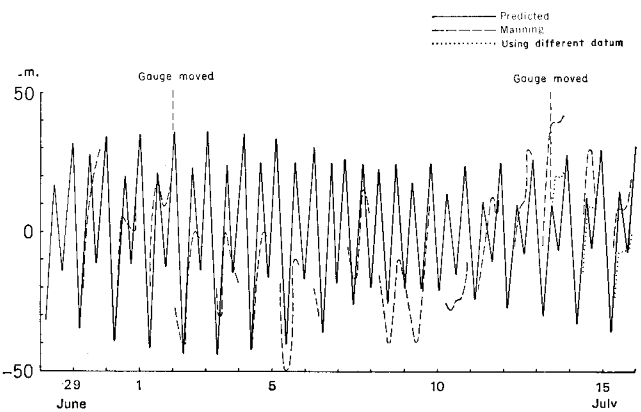

FIG. 3. Manning's observations at Moar Bay superimposed on the predicted times and heights of high and low water joined by straight lines.

We see that the record compiled by Manning does not totally contradict the predictions. Some extrema are missing, and it may be presumed that the staff was not watched continuously and that some of the fluctuations escaped the observer — for instance on 29 June and 13 July. At other times the record follows the predicted fluctuations in the main, except in the case of the interval of 8-11 July when the levels were definitely lower. We suspect that even a mechanical maregraph would have produced similar results in an area such as Moar Bay where the tide is so small and fickle.

We may conclude from the 1950 data collected by Manning that the cotidal charts represent the tide quite adequately on the eastern shore of James Bay.

On the western shore of James Bay tidal observations were carried out at Fort Albany and Ship Sands. Unfortunately however the sites chosen were cut off from the body of James Bay by sand bars, and so the recordings made at them were not representative of the tides of James Bay proper. The observations by Manning at other sites are of potential interest since they could add some information on tidal movements along the western shore. Table 3 lists some time

TABLE 3. Time lags (hours) between high water at Churchill and local high water.

Station	Observed	Suggested by the M_2 cotidal chart
Little Cape	6.25	
Cape Henrietta Maria	8.75	11.1
Lake River	10.5	11.9
Lat. 53°45′	11.5	12.8
Swan River	11.75	13.8
Houston Point	12	13.8
Cape Duncan	16	15.7
Fort Albany	18.25	18.0
Long Ridge Point	17.5	17.3
North Point	17.75	17.4
Ship Sands	19.5	19.0

lags observed by Manning along with those suggested by the M_2 cotidal chart. The table indicates that the observed lags in northwestern James Bay are considerably smaller than those suggested by the chart. From Cape Duncan onward to southwestern James Bay the two sets of lags agree. The only way to ascertain the cause of the discrepancy in the northwestern section would be to install a couple of temporary gauges in that area, but for the present the lags quoted by Manning cannot be considered reliable. For instance he suggests 6.25 hours for Little Cape, but if we look at the tidal information on M_2 for Churchill, York Factory and Winisk (Flagstaff Point), which is reliable, we note that the lags are 239° and 83° (Zone +5) respectively, implying a lag of 7 hours for Winisk. Little Cape lies 70 miles to the east of Winisk and therefore cannot have a lag of 6.25 hours; it should be something like 8 hours. Another dubious value is the one quoted for Lake River, namely 10.5 hours. Bear Island, which is located scarcely 45 miles east of it and which is surrounded by deep water, has a reliably recorded lag of 11.7 hours; it is therefore hard to believe that the tide should reach a neighbouring coastal point surrounded by shallows an hour earlier. By implication the lag at Cape Henrietta Maria should be larger than the value quoted by Manning. For the present it therefore seems reasonable to retain the cotidal chart for M_2 in the northwestern portion of James Bay as it stands.

There is no problem in southwestern James Bay where the observed and suggested lags agree and where everything looks correct intuitively.

No mention has yet been made of the lags observed by Manning south and west of Akimiski Island. He finds 21 hours at the mouth of the Attawapiskat River and 18.75 hours on the south coast of Akimiski. These lags are much larger than those indicated by the M_2 chart, but they are plausible. It is quite possible that in that area of shallows and constrictions the tide can be considerably retarded and conform to Lower's description (1915).

Mr. F.G. Barber suggested this investigation and Mr. J.F. Taylor wrote the necessary computer programs.

REFERENCES

GODIN, G. 1972. The tides of James Bay. *Canada, Department of the Environment, Marine Sciences Branch. MS Report* no. 24.

LOWER, A. R. M. 1915. A report on the fish and fisheries of the west coast of James Bay. Appendix to *Annual Report, Department of Naval Service, Sessional Paper* no. 39a, pp. 29-67.

MANNING, T. H. 1950. Notes on the tides along the south Hudson Bay and West James Bay coast. *Arctic,* 3: 95-100.

————. 1951. Remarks on the tides and driftwood strand lines along the east coast of James Bay. *Arctic,* 4: 122-130.