Tides in Canadian Waters

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Contents

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Preface

The periodic rise and fall of the water along ocean coasts is a phenomenon familiar to all of us. Even those who have never been to the seashore have heard enough about the tides to know that they follow a rhythmic daily pattern. We also know that the tide has a profound effect on navigation and harbor construction.

It seems therefore surprising that the knowledge of tides, and the forces causing them, is of very recent origin. One of the reasons for this is that the tides in the Mediterranean - the cradle of Europe's ancient civilizations - are too small to be readily noticeable. Another is that the mechanism of tides can be understood only through knowledge of astronomical forces and the shape of the world's oceans, knowledge which was not acquired until modern times.

Canada, with its far-flung Arctic Archipelago, has more than 100,000 miles of seacoast, and it has also some of the most interesting and peculiar tides. For the guidance of ship captains and fishermen, the Canadian Federal Government began to study the tides along the eastern and western seaboards before the turn of the century, a job that has been tremendously expanded and refined by the Canadian Hydrographic Service of the Department of Mines and Technical Surveys, which is the Federal Government agency charged with charting the navigable waters of Canada.

Tidal Forces

The main forces that cause our ocean tides are the pull of the moon and the pull of the sun. Of these, the pull, or attraction, of the moon is the more powerful, about twice that of the sun. The tidal rhythm is therefore generally in tune with the apparent rotation of the moon around the earth, or the "lunar day" of 24 hours and 50 minutes.

The pull of the sun and the pull of the moon always affect two sides of the earth at the same time: on one side, the waters of the ocean are drawn away from the earth; on the other, the earth is drawn away from the water. The pull, and the resultant high tide, are naturally strongest when the attractions of the moon and the sun are added together; this occurs both at full and at new moon. The tides are least when the pull of the sun is counteracting that of the moon, or when the sun and moon are, so to speak, at right angles in relation to the earth; this occurs during the first and last quarter of the moon (Figure 1).

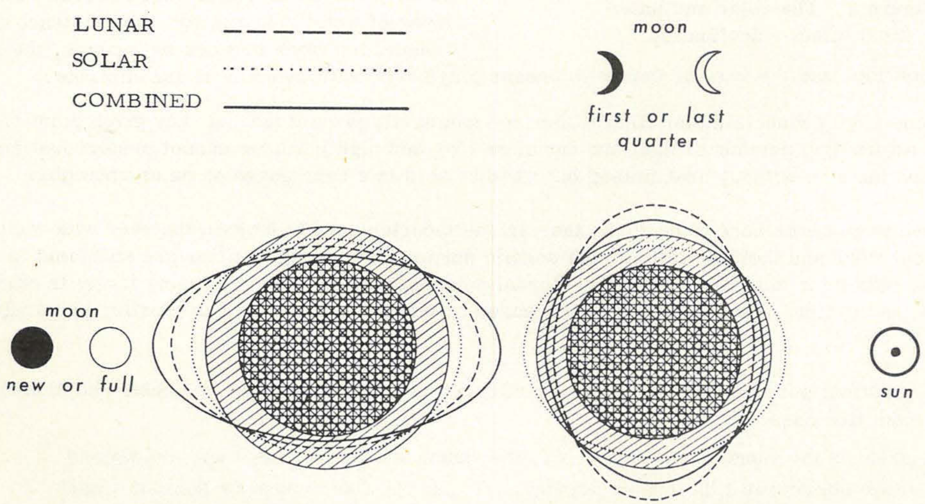


Figure 1. The solar and lunar tidal effect - phase of the moon.

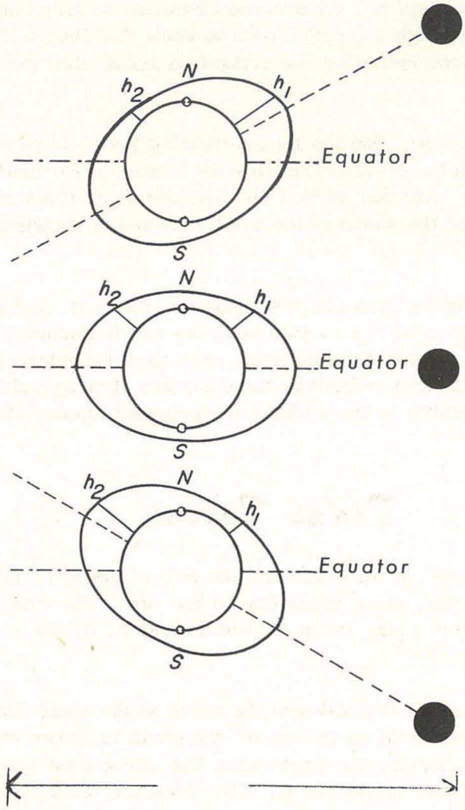


Figure 2. The solar and lunar tidal effect - declination.

The attraction of the moon and sun also varies with the distance of these two bodies from the earth, since both the four-week revolution of the moon around the earth, and the annual revolution of the earth around the sun follow an elliptical course. The point where the moon is nearest to the earth is called perigee; the point where it is farthest is called apogee. The force of the moon's attraction increases during perigee, and decreases by an equal proportion during apogee.

But this is not all. The apparent revolutions of moon and sun around the earth are not always along the plane of the equator, and therefore their tide-producing force at any given point on the earth does not repeat itself equally twice every lunar day. There tends to be sometimes one stronger and one weaker pull (Figure 2, h_1, h_2).

Add to this the fact that the tide does not respond to the phases of the moon immediately, but often after a delay of several hours or days, due to physical features of the various oceans and that the rotation of the earth causes a slight east-west displacement of ocean waters apart from the tidal movement, and you will have an idea of the multitude and complexity of the cosmic forces at work upon the tides.

Complicated as all these variables may seem, they are nonetheless quite regular and predictable, and entirely susceptible to mathematical calculations. Ideally, the results of such mathematical formulas should give the exact times and ranges of all tides all over the globe. This would be so if the entire earth were covered with an even layer of water. In reality, the existence of continental barriers between the oceans, the irregular shapes of coastline, and the varying depths of oceans play havoc with theoretical assumptions.

To use a very much simpler illustration, we can safely predict that at any given point on earth there will be alternating periods of light and darkness (day and night); but we cannot predict just how much light will reach the spot without first finding out whether it is in a deep gorge or on an open plain.

There is no space here to describe the various theories used to explain the very wide variations of astronomical tides and their deviation from cosmic norms. The irregularities are sufficient to cancel out, at times, either the diurnal or the semi-diurnal component of the tide-producing force; in others, the height as well as the time of the tide may be increased or diminished out of all proportion by purely local conditions.

For practical purposes, as far as any particular coast is concerned, two basic questions present themselves to the tide observer:

a) How great is the range of the tide, i.e., the difference between high and low water?

b) Are there one or two tidal cycles per day, i.e., is the tide diurnal or semi-diurnal?

When we look for answers to these questions we soon find, from observations, that at only a few locations are the tides strictly diurnal, or strictly semi-diurnal. For example, although both high and low tide may occur twice within 24 hours, thus appearing semi-diurnal, the first high tide may be considerably greater than the second high tide.

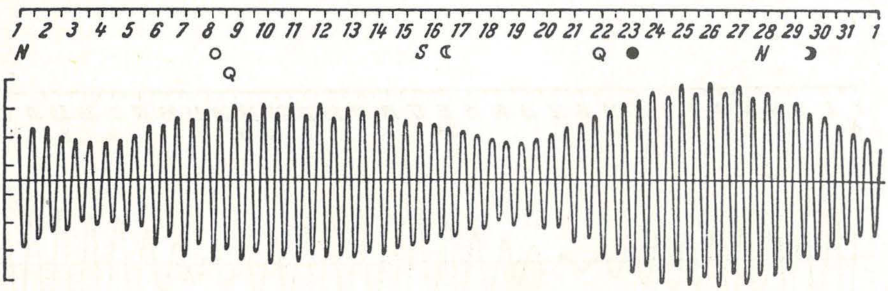
For the sake of classification, we can divide tides into four groups: semi-diurnal; mixed, mainly semi-diurnal; mixed, mainly diurnal; diurnal.

The rise and fall of the tide in each of these groups can best be understood from the following graphs, each covering a period of one month.

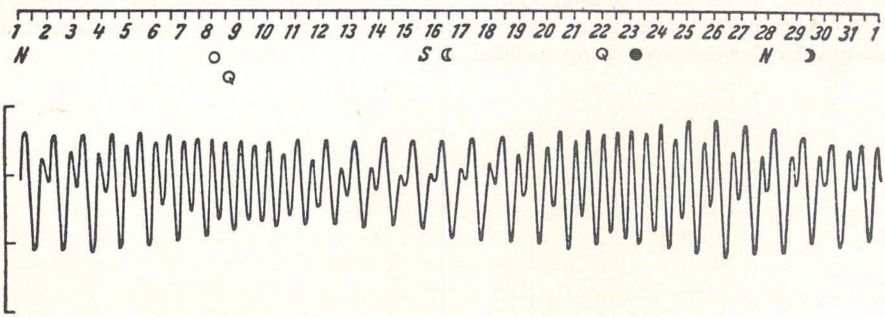
Semi-duirnal: two high waters and two low waters daily of approximately the same height; the interval between the transit of the moon and the occurrence of high water is nearly constant.

Symbols: ● New ☽ First quarter S Max. decl. south Q At equator

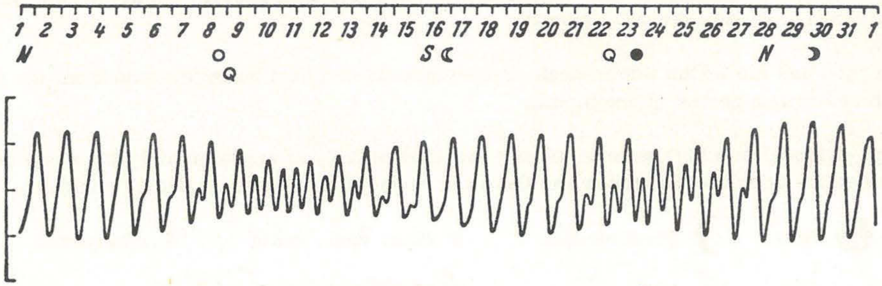
○ Full ☾ Last quarter N Max. decl. north



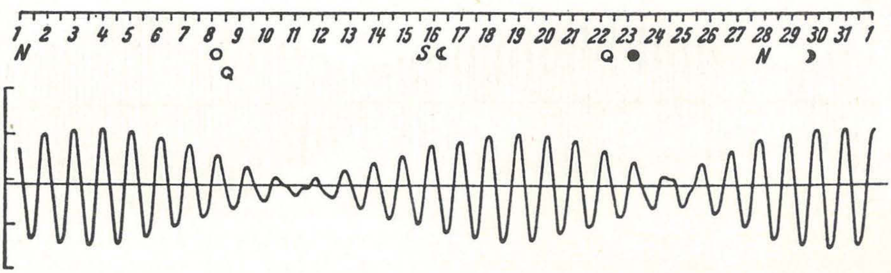
Mixed, mainly semi-diurnal: two high waters and two low waters with inequalities in height and time reaching the greatest values when the declination of the moon has passed its maximum.



Mixed, mainly diurnal: occasionally there is only one high and one low water a day, following the maximum declination of the moon; at other times there are two large inequalities in height and time, especially when the moon has passed over the equator.



Diurnal: one high and one low water a day.



Although astronomical factors must definitely be taken into account in tidal calculations, no accurate predictions of the tides at any given coastal point can be made without a long period of careful observations on the spot. The descriptions of Canadian tides that follow are derived from the data compiled by the Canadian Hydrographic Service over many decades.

Canadian Tides

East Coast

South Coast of Newfoundland, Southeast Coast of Nova Scotia, and the Bay of Fundy (Figures 9, 10, 11)

Along the Atlantic coast from Cape Race to Cape Ray, Nfld., across to Glace Bay, N.S., and along the shores of Nova Scotia and New Brunswick, the tide is semi-diurnal. High water occurs almost simultaneously along all coastal points from Placentia Bay, Nfld., to Shelburne, N.S. The tidal range is not very great, the difference between high and low water seldom exceeding six feet. Around the southern end of Nova Scotia, there are rapid changes both in the time at which high water occurs and in the range of the tide.

The most remarkable tide not only in Canada, but probably anywhere in the world, occurs in the Bay of Fundy, where the tidal range reaches over 40 feet (Figures 3, 4). This is due entirely to a peculiar combination of geographical factors.

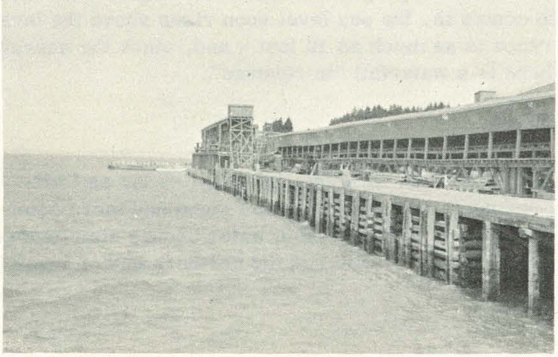


Figure 3. High water at Walton, N.S.

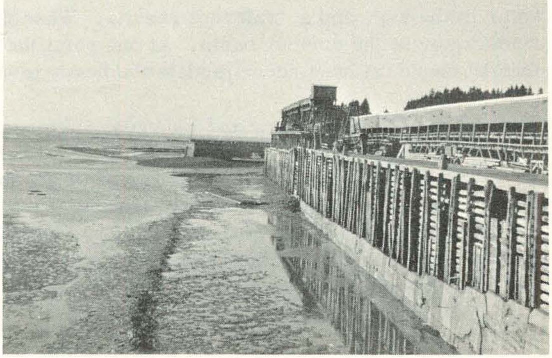


Figure 4. Low water at Walton, N.S.

In the Petitcodiac River, which empties into the Bay of Fundy at Moncton, N.B., the tide comes in as a "bore", i.e., as an almost vertical head of water which may be as high as four feet or as low as a few inches (Figure 5). This strange phenomenon is caused by the current of the river and by friction.

Figure 5. The bore at Moncton, N.B.

At Saint John, N.B., the cycle of tide and river current creates the famous Reversing Falls (Figures 6, 7, 8). This feature is caused by a narrow gorge a short distance upstream from the mouth of the St. John River. At low tide, the river level in a basin above the gorge is some 14 feet higher than the water in the bay, and a waterfall results. When the tide comes in, the sea level soon rises above the level of the water in the upriver basin. At one point the difference is as much as 12 feet - and, since the narrow channel cannot at once accommodate the heavy inflow, there is a waterfall "in reverse".

East Coast of Newfoundland and Labrador (Figures 9, 10, 11)

Along the east coast of the Island of Newfoundland, and along the Labrador coast as far as Cartwright, the tide is mixed but mainly semi-diurnal. Farther north it tends to become more and more semi-diurnal, being entirely so at Cape Chidley, Labrador's northernmost point. High water occurs simultaneously along the two coasts, and the tidal range is about three feet. However, towards the northern end of Labrador (Davis Strait) the range increases considerably.

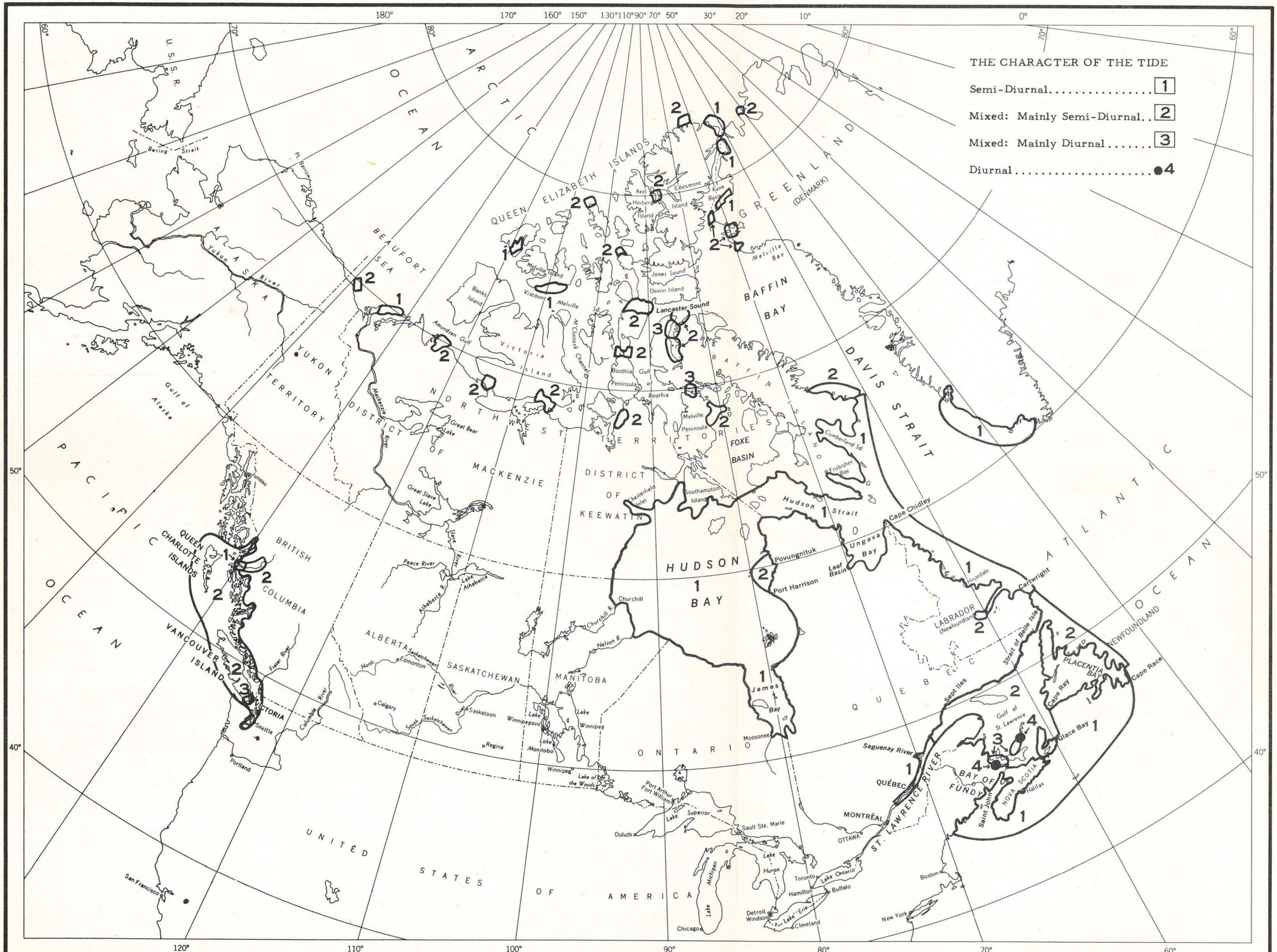

THE CHARACTER OF THE TIDE
Semi-Diurnal 1
Mixed: Mainly Semi-Diurnal 2
Mixed: Mainly Diurnal 3
Diurnal 4
ARCTIC OCEAN
PACIFIC OCEAN
ATLANTIC OCEAN
QUEEN ELIZABETH ISLANDS
GREENLAND (DENMARK)
BAFFIN BAY
DAVIS STRAIT
BEAUFORT SEA
YUKON TERRITORY
DISTRICT OF MACKENZIE
NORTHWEST TERRITORIES
DISTRICT OF KEEWATIN
HUDSON BAY
FOXE BASIN
BRITISH COLUMBIA
ALBERTA
SASKATCHEWAN
MANITOBA
ONTARIO
QUEBEC
LABRADOR (Newfoundland)
NEWFOUNDLAND
NOVA SCOTIA
BAY OF FUNDY
ST. LAWRENCE RIVER
QUEEN CHARLOTTE ISLANDS
VANCOUVER ISLAND
UNITED STATES OF AMERICA
U.S.S.R.
ALASKA
Lancaster Sound
Hudson Strait
James Bay
Ungava Bay
Gulf of St. Lawrence
Strait of Belle Isle
PLACENTIA BAY
Cape Race
Cape Chidley
Churchill
Port Harrison
Povungnituk
Moosonee
Saguenay River
QUÉBEC
MONTRÉAL
OTTAWA
Halifax
Saint John
Glace Bay
Sept Iles
Cartwright
Hopedale
VICTORIA
Seattle
Portland
San Francisco
Toronto
Boston
New York
Chicago
Duluth
Sault Ste. Marie
Port Arthur
Fort William
Winnipeg
Regina
Saskatoon
Edmonton
Calgary

Figure 9

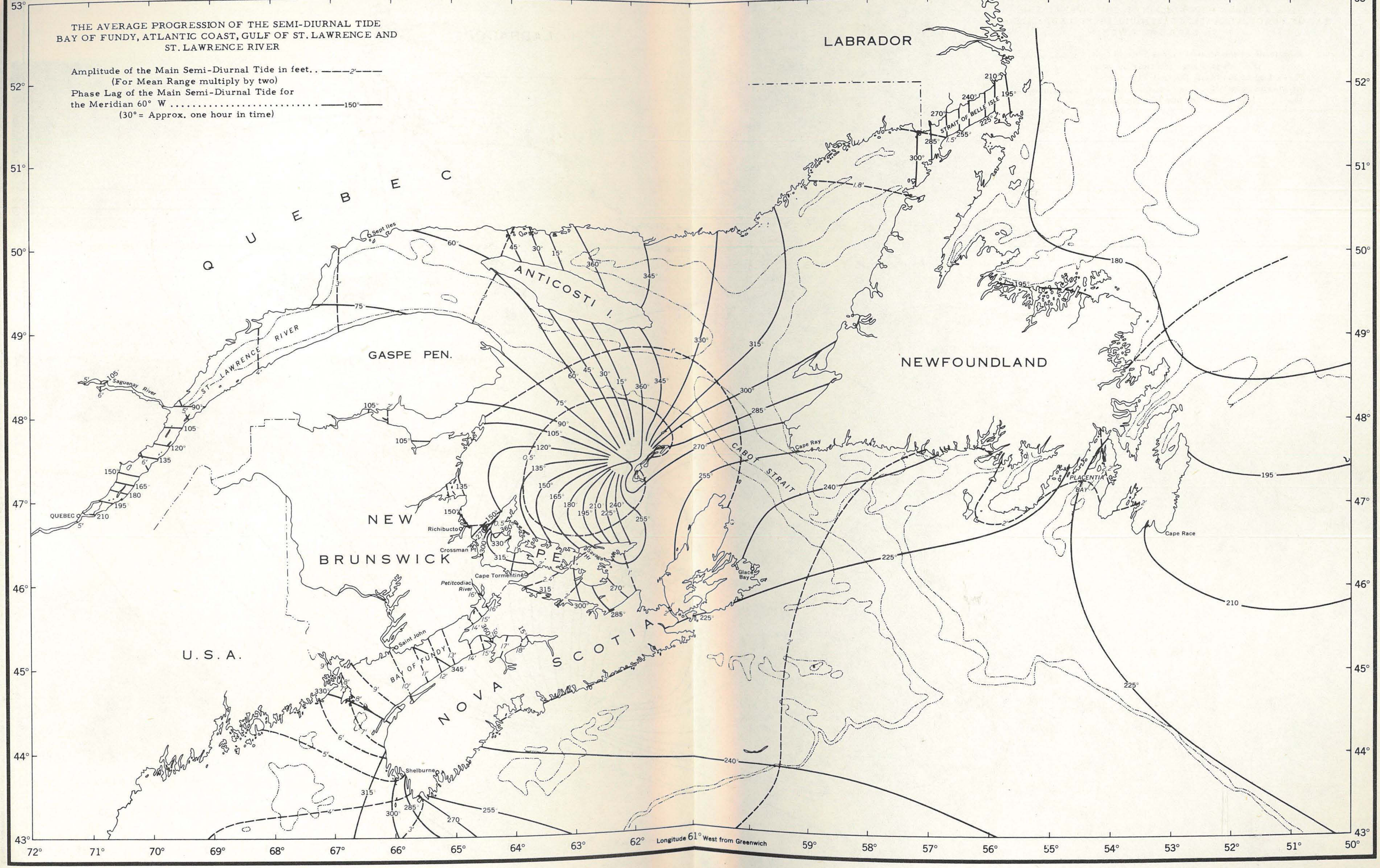

THE AVERAGE PROGRESSION OF THE SEMI-DIURNAL TIDE
BAY OF FUNDY, ATLANTIC COAST, GULF OF ST. LAWRENCE AND
ST. LAWRENCE RIVER
Amplitude of the Main Semi-Diurnal Tide in feet. . ——2'——
(For Mean Range multiply by two)
Phase Lag of the Main Semi-Diurnal Tide for
the Meridian 60° W .... ——150°——
(30° = Approx. one hour in time)
LABRADOR
QUEBEC
ANTICOSTI I.
GASPE PEN.
ST. LAWRENCE RIVER
Saguenay River
Sept Iles
QUEBEC
NEWFOUNDLAND
NEW BRUNSWICK
P.E.I.
NOVA SCOTIA
U.S.A.
BAY OF FUNDY
CABOT STRAIT
STRAIT OF BELLE ISLE
PLACENTIA BAY
Cape Ray
Cape Race
Glace Bay
Saint John
Shelburne
Richibucto
Crossman Pt.
Cape Tormentine
Petitcodiac River
Longitude 61° West from Greenwich

Figure 10

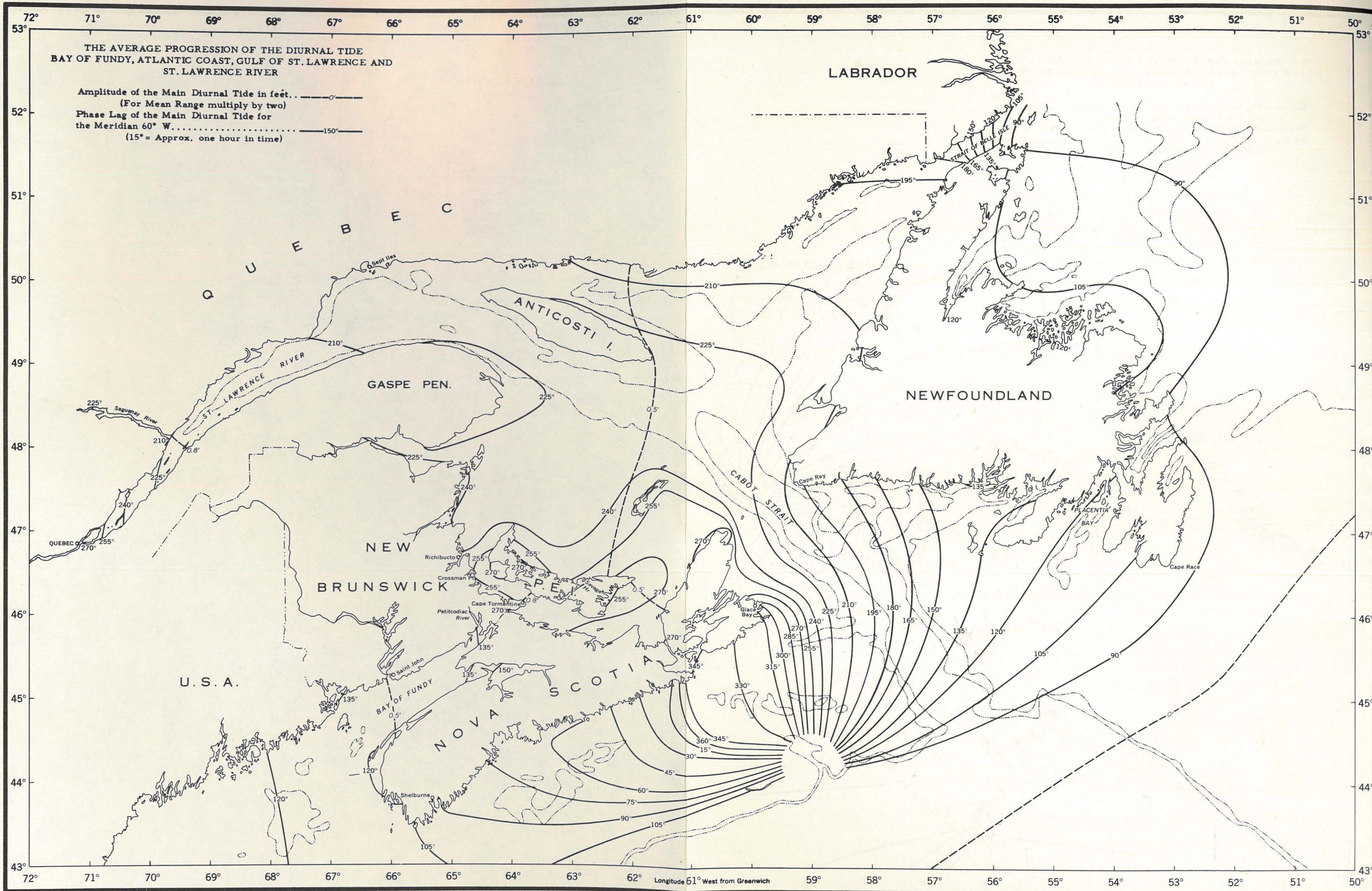

THE AVERAGE PROGRESSION OF THE DIURNAL TIDE
BAY OF FUNDY, ATLANTIC COAST, GULF OF ST. LAWRENCE AND
ST. LAWRENCE RIVER
Amplitude of the Main Diurnal Tide in feet
(For Mean Range multiply by two)
Phase Lag of the Main Diurnal Tide for the Meridian 60° W.
(15° = Approx. one hour in time)
LABRADOR
QUEBEC
ANTICOSTI I.
GASPE PEN.
ST. LAWRENCE RIVER
Saguenay River
NEWFOUNDLAND
CABOT STRAIT
STRAIT OF BELLE ISLE
NEW BRUNSWICK
P.E.I.
NOVA SCOTIA
BAY OF FUNDY
U.S.A.
PLACENTIA BAY
Cape Race
Cape Ray
Glace Bay
Sept Iles
QUEBEC
Richibucto
Crossman Pt
Cape Tormentine
Petitcodiac River
Saint John
Shelburne
Longitude 61° West from Greenwich

Figure 11

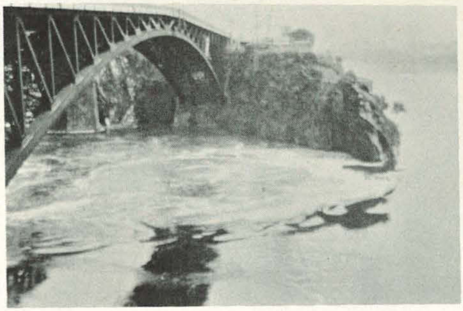


Figure 6. High tide.

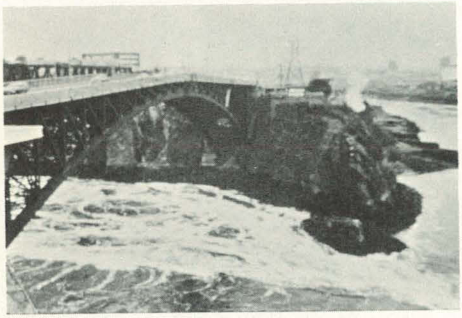


Figure 7. Low tide.

Figure 8. Mid tide.

The Reversing Falls at Saint John, N.B.

Gulf of St. Lawrence (Figures 9, 10, 11)

The tide propagated through Cabot Strait and Belle Isle Strait into the Gulf of St. Lawrence is of a mixed type, but mainly semi-diurnal, except along the coast between Cape Tormentine and Richibucto, N.B., and near Savage Harbor, P.E.I., where diurnal inequalities dominate. At the southern tip of the Magdalen Islands and near Crossman Point, N.B., the tide is entirely diurnal, only one high and one low tide occurring every day. The range of the tide throughout the gulf is less than eight feet.

St. Lawrence and Saguenay Rivers (Figures 9, 10, 11, 12)

The tide, entering the Gulf of St. Lawrence from the Atlantic Ocean, is further propagated up the St. Lawrence River, and its effect is easily observable as far as Lake St. Peter, some 400 miles up-river from Seven Islands. The tidal cycle repeats itself twice daily, and, counting from Seven Islands, the crest of the tide takes about an hour to travel to the mouth of the Saguenay River, five hours to Quebec City, and ten hours to Lake St. Peter. The range of the tide increases from about seven feet at Seven Islands to twice that height at Quebec City, after which it diminishes, amounting to less than a foot at Lake St. Peter.

The tidal curve in the St. Lawrence River exhibits various peculiarities attributable to the narrowing and the slope of the river bed and to increasing friction, especially above Quebec City. One of these is that the tide, as in many other river estuaries, rises faster than it falls, i.e., the time from low water to high water is much shorter than the time from high water to low. Also, the high waters maintain almost the same absolute height, while the low waters show a considerable slope downstream (Figure 13). Above Quebec City, low water level is higher when the moon is new of full (at "spring" tide) than when the moon is in one of its quarters (at "neap" tide). This is a reversal of the normal process and is found only in tidal rivers.

St. Lawrence River from Lake St. Peter to Montreal

A slight semi-diurnal tidal effect can be observed on tidal gauges upstream from Lake St. Peter. The range is very small - less than six inches. It is interesting to note, however, that in each month there are several days when the daily mean values are below or above the monthly mean. These deviations correspond more or less to the phases of the moon (Figure 14).

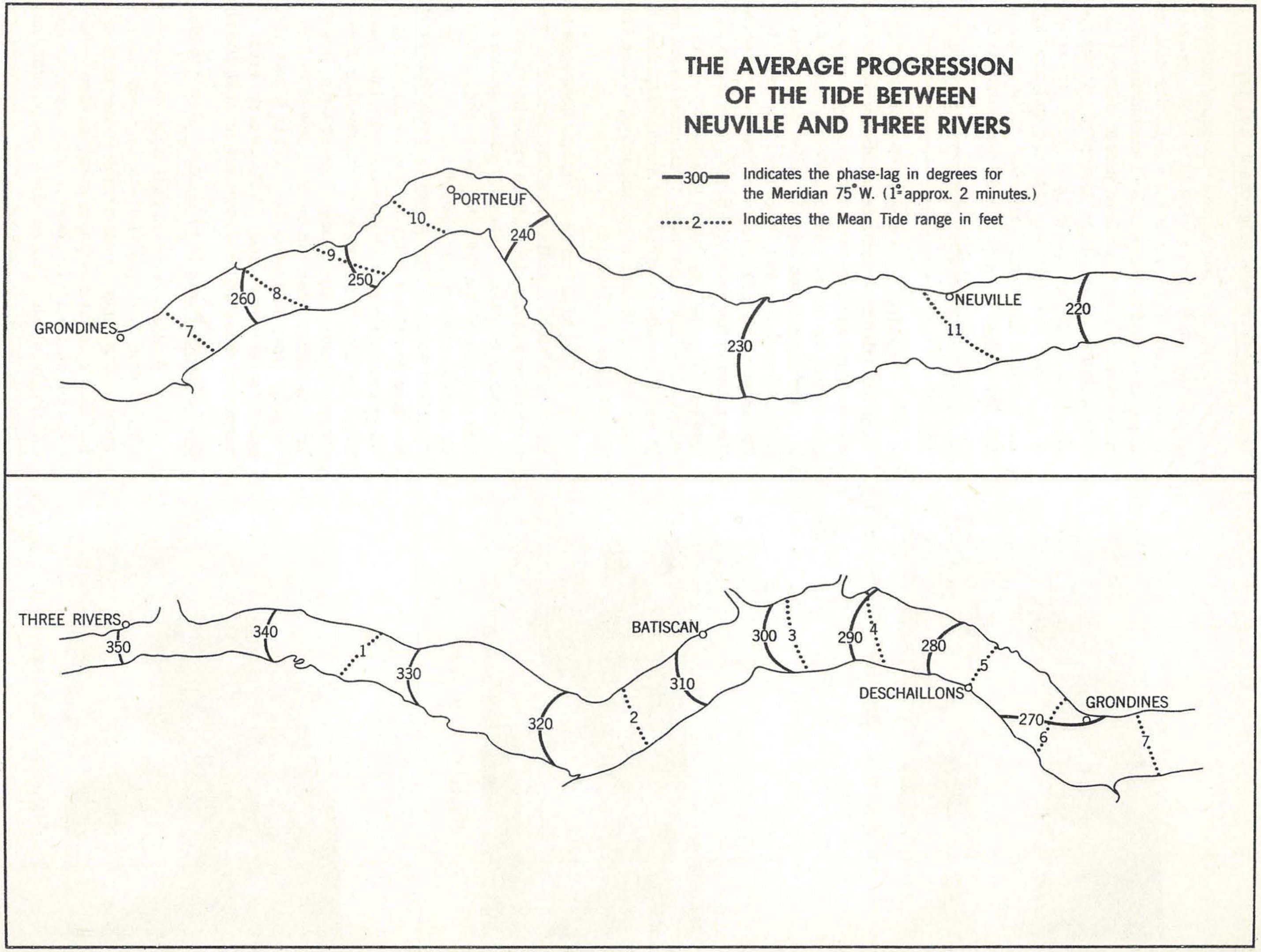
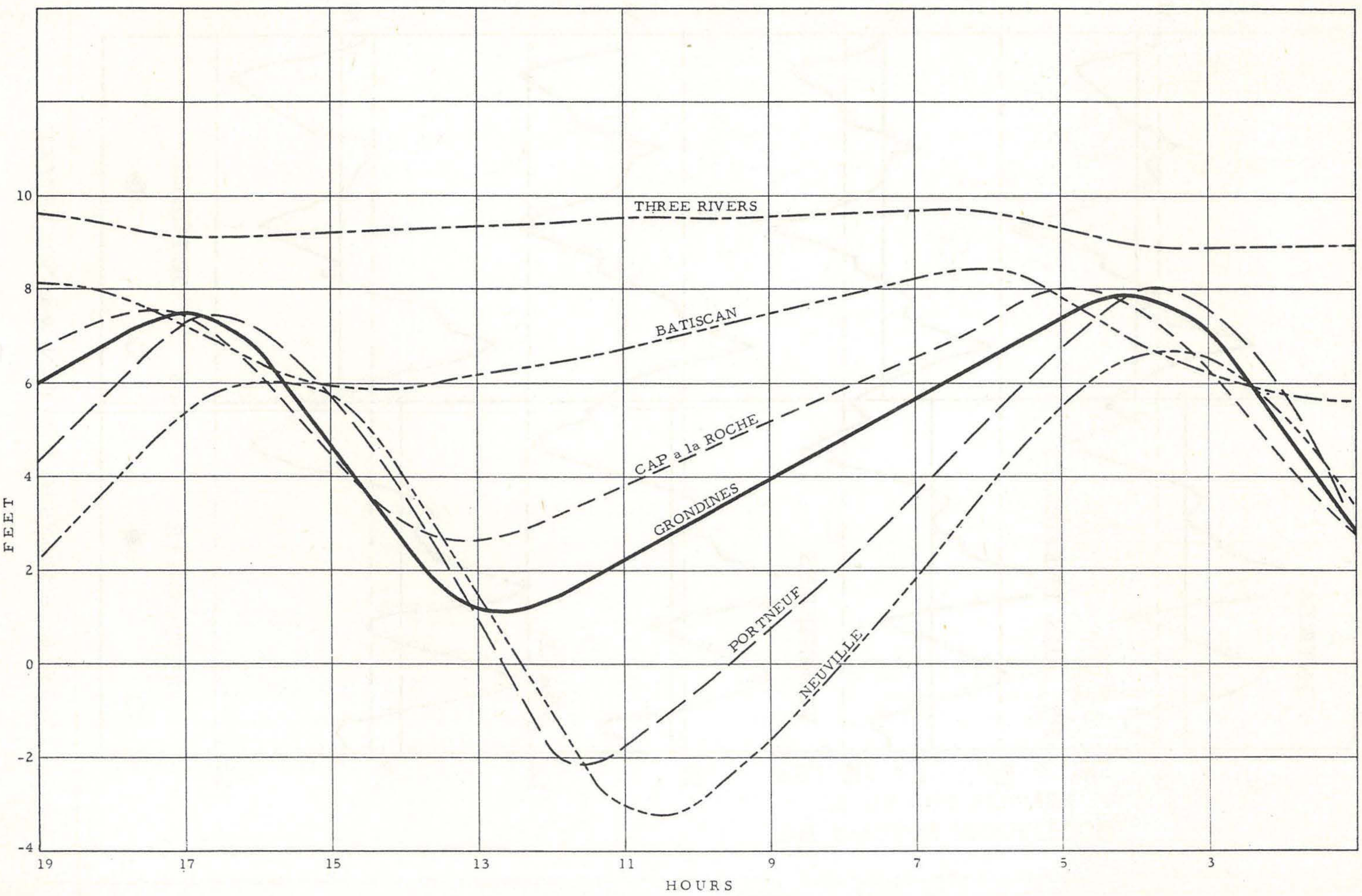
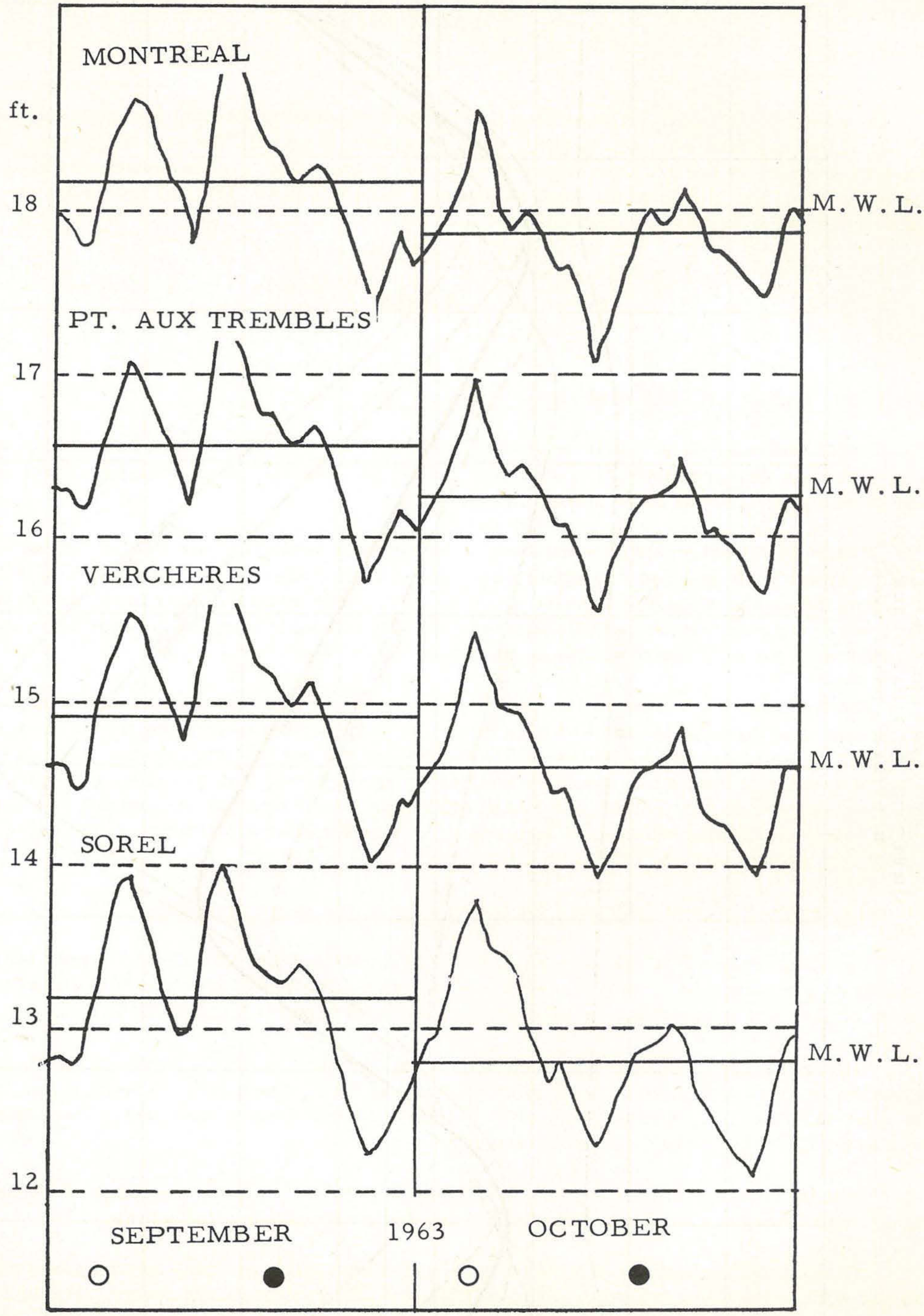

THE AVERAGE PROGRESSION
OF THE TIDE BETWEEN
NEUVILLE AND THREE RIVERS
—300— Indicates the phase-lag in degrees for the Meridian 75° W. (1° approx. 2 minutes.)
·····2····· Indicates the Mean Tide range in feet
PORTNEUF
NEUVILLE
GRONDINES
240
250
260
230
220
10
9
8
7
11
THREE RIVERS
BATISCAN
DESCHAILLONS
GRONDINES
350
340
330
320
310
300
290
280
270
1
2
3
4
5
6
7

FIGURE 12

ST. LAWRENCE RIVER
SIMULTANEOUS TIDAL OBSERVATIONS
NEUVILLE - THREE RIVERS





M.W.L. = MONTHLY MEAN WATER LEVEL

Figure 14

Great Lakes

Few inland waters are large or deep enough to be affected by the tidal forces of moon and sun, but a very small tide has been recorded on the Great Lakes (Figure 15). To the casual observer, the tide on the lakes is obscured by the more pronounced fluctuation of the water level in response to barometric pressure and wind, but gauges do show a tidal range of about 0.1 foot. This, of course, is too insignificant to affect navigation or harbor installations.

Arctic

Hudson Strait, Hudson Bay, and Foxe Basin (Figures 9, 16)

In this entire area the tide is semi-diurnal, except for the short stretch between Povungnituk and Port Harrison, on the northeastern coast of Hudson Bay, and Hall Beach, Foxe Basin, where the semi-diurnal rhythm is affected by large diurnal variations.

Hudson Strait serves as a communication between the open ocean and a large "inland" sea; also, it is much narrower at its waist than at either end. These factors affect the range of the tide in Hudson Strait, which, along the northern coast, increases from 18 feet to about 30 feet at Ashe Inlet, decreasing again to 16 feet towards Schooner Harbor. In Ungava Bay, the tide coming in from the Atlantic increases rapidly toward the end of the bay, reaching a mean range of 40 feet at Leaf Basin.

The tide setting into Hudson Bay describes a roughly circular movement, following the contour of the shoreline, starting from the northwestern end of the bay, moving south along the western shore, and almost petering out along the eastern shore. In the entrance to the bay, the average range of the tide is six feet, increasing to twelve feet along the western shore, after which it decreases gradually along the southern and eastern shores to about one foot at Port Harrison. The tidal rise and fall may sometimes be obscured, particularly near the head of James Bay, by weather effects which may cause the sea level to rise or fall by several feet.

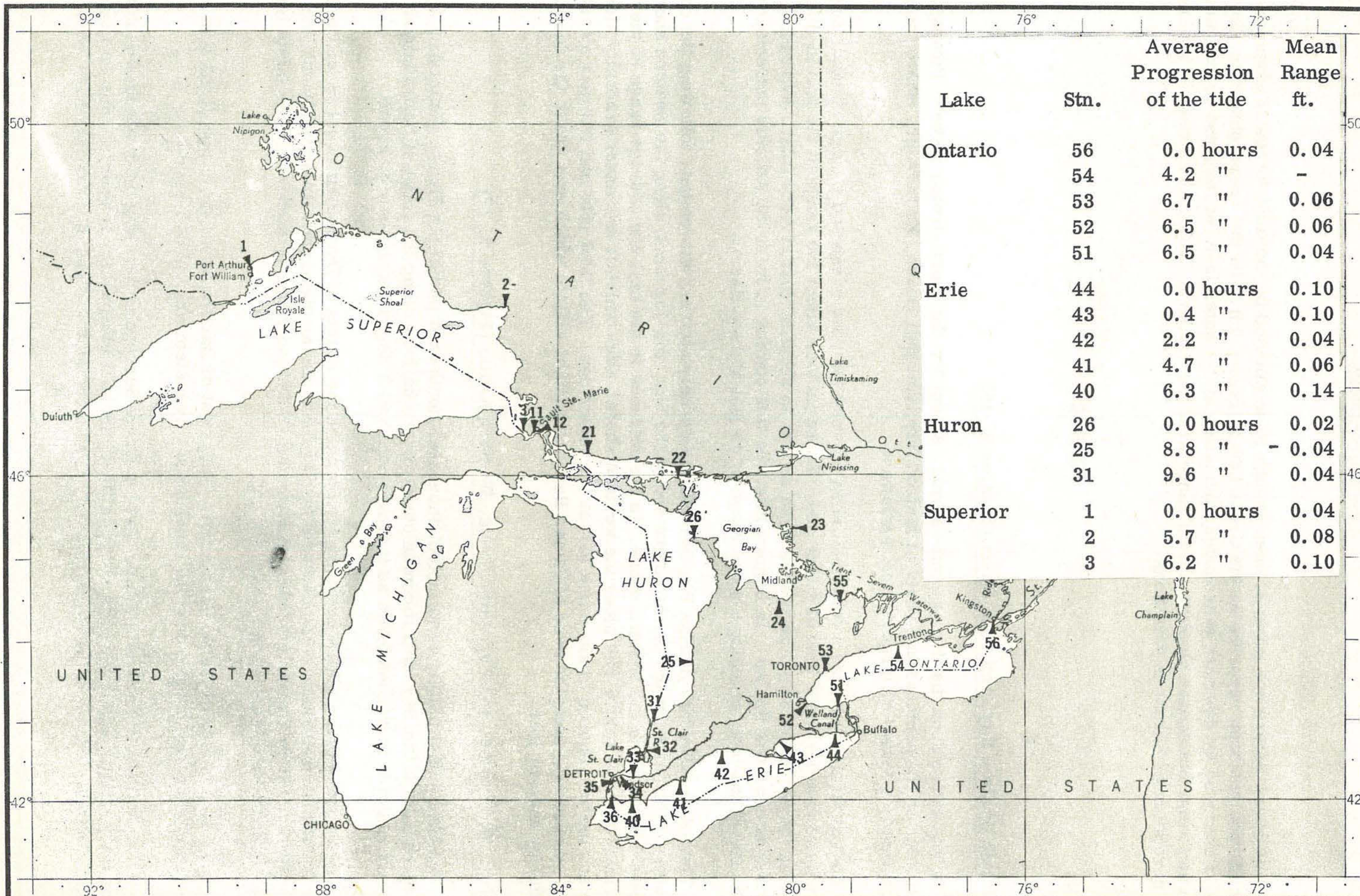
Davis Strait, Baffin Bay, and Lancaster Sound, Western Arctic (Figures 9, 17)

The tidal range which, as we noted, increases northward into Davis Strait, diminishes again as the tide moves on into Baffin Bay until it comes close to zero halfway along the coast of Baffin Island. From that point on, the tide increases again as it moves into Smith Sound and Lancaster Sound.

High water occurs almost simultaneously along the coasts of Davis Strait, but in Baffin Bay high water at the southern entrance coincides with low water at the northern end. In Smith Sound, the tidal range is about ten feet, and in Lancaster South, at Resolute, the mean range is four feet. The inlets leading off Lancaster Sound have a mean range under six feet.

In those portions of the western Arctic lying west of Barrow Strait the range of the tide is small, being no larger than the changes in water level caused by meteorological influences.

Although the Department of Mines and Technical Surveys is carrying on continuous exploration and surveying work in the Canadian Arctic, data on tides are still comparatively scanty. For this reason, the tidal characteristics shown on the map apply only to the few points where observations have been made.



Lake	Stn.	Average Progression of the tide	Mean Range ft.
Ontario	56	0.0 hours	0.04
	54	4.2 "	-
	53	6.7 "	0.06
	52	6.5 "	0.06
	51	6.5 "	0.04
Erie	44	0.0 hours	0.10
	43	0.4 "	0.10
	42	2.2 "	0.04
	41	4.7 "	0.06
	40	6.3 "	0.14
Huron	26	0.0 hours	0.02
	25	8.8 "	- 0.04
	31	9.6 "	0.04
Superior	1	0.0 hours	0.04
	2	5.7 "	0.08
	3	6.2 "	0.10

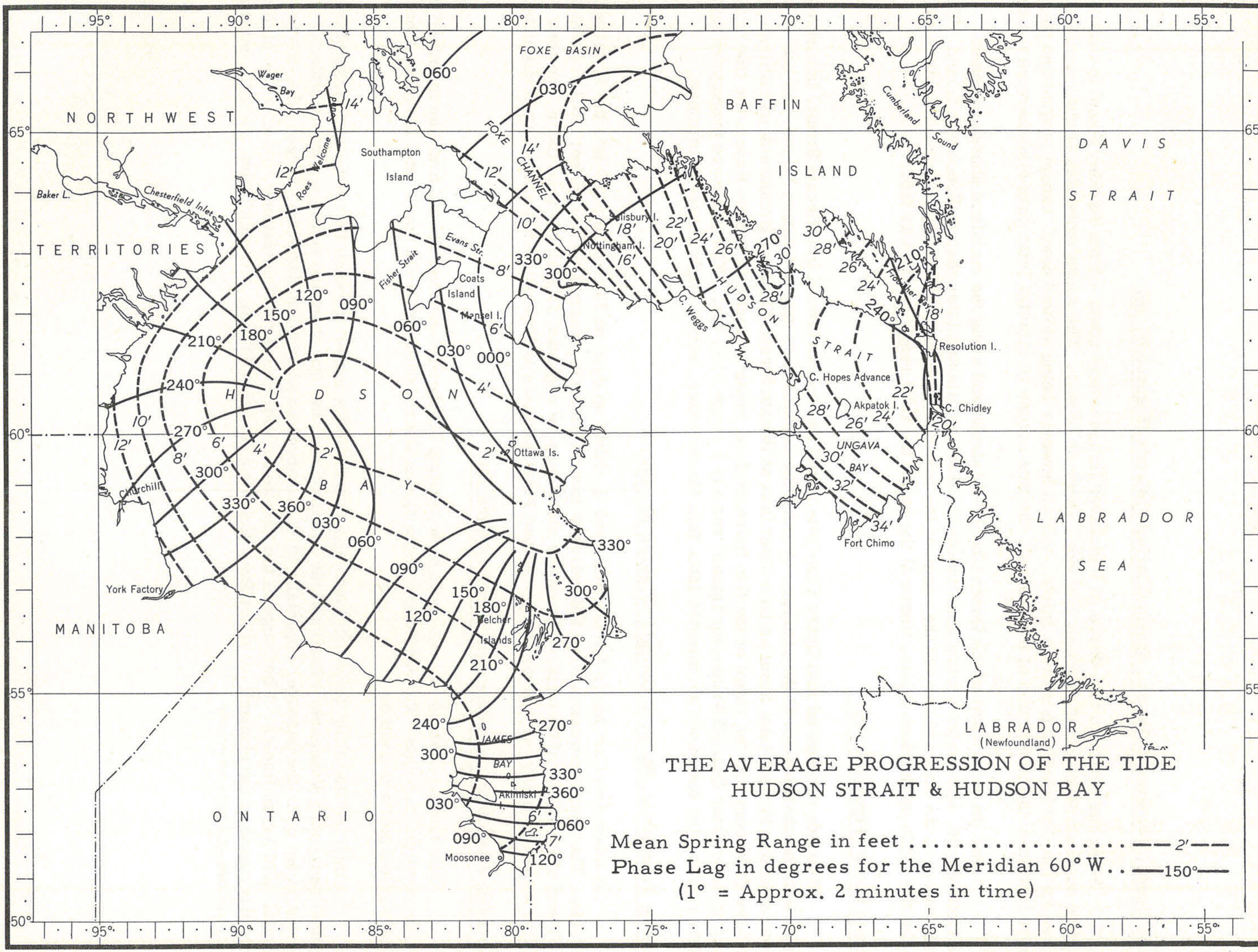

THE AVERAGE PROGRESSION OF THE TIDE
HUDSON STRAIT & HUDSON BAY
Mean Spring Range in feet .... 2'
Phase Lag in degrees for the Meridian 60° W. . 150°
(1° = Approx. 2 minutes in time)
NORTHWEST TERRITORIES
MANITOBA
ONTARIO
BAFFIN ISLAND
DAVIS STRAIT
LABRADOR SEA
LABRADOR
(Newfoundland)
FOXE BASIN
FOXE CHANNEL
HUDSON BAY
HUDSON STRAIT
UNGAVA BAY
JAMES BAY
Southampton Island
Coats Island
Mansel I.
Salisbury I.
Nottingham I.
C. Weggs
C. Hopes Advance
Akpatok I.
C. Chidley
Resolution I.
Frobisher Bay
Cumberland Sound
Fort Chimo
Ottawa Is.
Belcher Islands
Akimiski I.
Moosonee
York Factory
Churchill
Baker L.
Chesterfield Inlet
Wager Bay
Roes Welcome
Fisher Strait
Evans Str.

Figure 16

West Coast

West Coast of Vancouver Island, Queen Charlotte Islands (Figures 9, 18)

Along the northern two-thirds of Vancouver Island's west coast - from Barkley Sound to Cape Scott - the tide occurs almost simultaneously and has a range of 10 feet. The range increases slightly as the tide moves up into the island's numerous inlets, without however being slowed down, except at Quatsino Narrows where, owing to the restriction of the channel, the tide occurs 45 minutes later than elsewhere on the coast.

Along the west coast of the Queen Charlotte Islands and along the mainland shores of Queen Charlotte Sound, high water occurs simultaneously about 30 minutes later than at Vancouver Island. The shallowness of the sound increases the range of the tide along the mainland, an effect that is further enhanced as the tide rolls up the deep inlets, where at the heads the tidal range reaches 16 feet.

Hecate Strait (Figures 9, 19)

The tide propagated into Queen Charlotte Sound sweeps northward into Hecate Strait, increasing in range with the shallowness of the passage. Around the northeastern spit of Graham Island, the tide is slowed down, reaching Masset Inlet about an hour later than at Hecate Strait. On the mainland side of the Strait, both the time difference and the range of the tide increase from south to north; at Prince Rupert the tide arrives about an hour later than off Vancouver Island, and has a range of 15 feet. The tide wave propagated up the inlets reaches the end about ten minutes later than the entrance, with a slight increase in range.

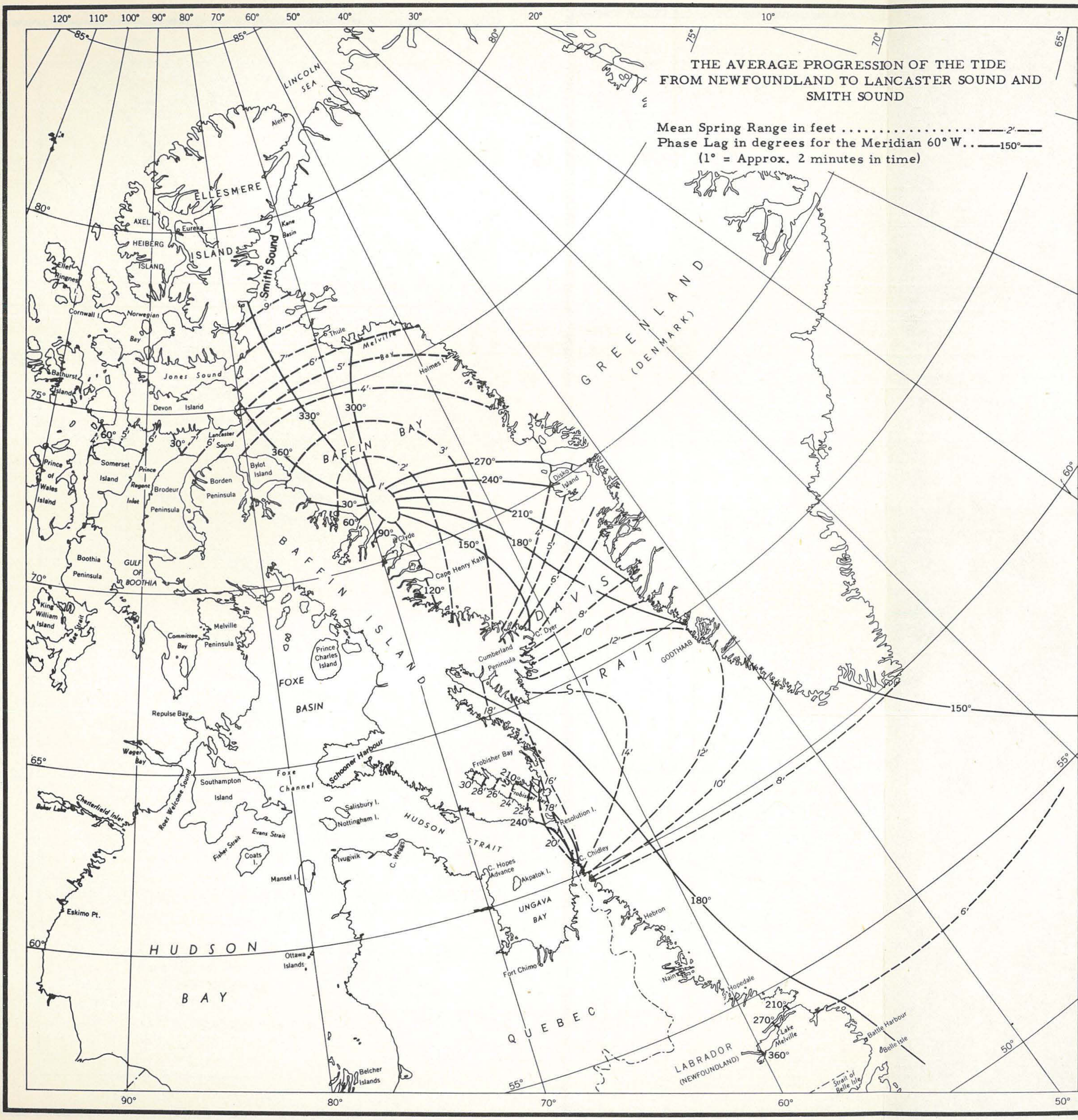
Juan de Fuca Strait, Strait of Georgia (Figures 18, 19)

It takes about six hours for the tide wave to travel up Juan de Fuca Strait and into the Strait of Georgia. The range increases from the entrance toward Victoria, where it is seven feet, to 12 feet at the north end of the Strait of Georgia. The entire strait may be regarded as a single tidal basin, the time difference between any point along its shores and Point Atkinson at Vancouver not exceeding 30 minutes.

Queen Charlotte Strait and Johnstone Strait (Figure 18)

This narrow, island-strewn passage separating northern Vancouver Island from the mainland is host to two tidal currents - the one coming from Queen Charlotte Sound in the north, and the other from the Strait of Georgia in the south.

Since the tide from the north takes about three hours longer to reach the narrowest parts of the channel separating Vancouver Island and the mainland than the tide from the south, a furious alternating current is set up in the passage, especially at such narrows as Seymour, Okisollo, Surge, Hole-in-the-Wall, Yuculta and Arran Rapids. The range of the "northern" tide shows wide variations, owing to the highly irregular shape of the channel: at Alert Bay, the mean range is 14 feet, at Knight Inlet, 16 feet, decreasing again as the channel narrows.



THE AVERAGE PROGRESSION OF THE TIDE FROM NEWFOUNDLAND TO LANCASTER SOUND AND SMITH SOUND
Mean Spring Range in feet
Phase Lag in degrees for the Meridian 60° W.
(1° = Approx. 2 minutes in time)
GREENLAND
(DENMARK)
BAFFIN BAY
DAVIS STRAIT
BAFFIN ISLAND
ELLESMERE ISLAND
AXEL HEIBERG ISLAND
Smith Sound
LINCOLN SEA
Kane Basin
Jones Sound
Devon Island
Lancaster Sound
Bylot Island
Borden Peninsula
Somerset Island
Prince of Wales Island
Boothia Peninsula
GULF OF BOOTHIA
Melville Peninsula
FOXE BASIN
Prince Charles Island
Cumberland Peninsula
Frobisher Bay
Resolution I.
C. Chidley
HUDSON STRAIT
Southampton Island
UNGAVA BAY
HUDSON BAY
QUEBEC
LABRADOR
(NEWFOUNDLAND)
Godthaab
Disko Island
Thule
Melville Bay
Battle Harbour
Belle Isle
Strait of Belle Isle
Hebron
Nain
Hopedale
Lake Melville
Fort Chimo
Belcher Islands
Ottawa Islands
Eskimo Pt.
Chesterfield Inlet
Repulse Bay
Wager Bay
Roes Welcome Sound
Coats I.
Mansel I.
Salisbury I.
Nottingham I.
Ivugivik
C. Hopes Advance
Akpatok I.
C. Dyer
Cape Henry Kater
Clyde
Schooner Harbour
Foxe Channel
Committee Bay
Alert
Eureka
Cornwall I.
Norwegian Bay
Bathurst Island
King William Island
Brodeur Peninsula
Prince Regent Inlet
Fisher Strait
Evans Strait
150°
180°
210°
240°
270°
300°
330°
360°

Figure 17

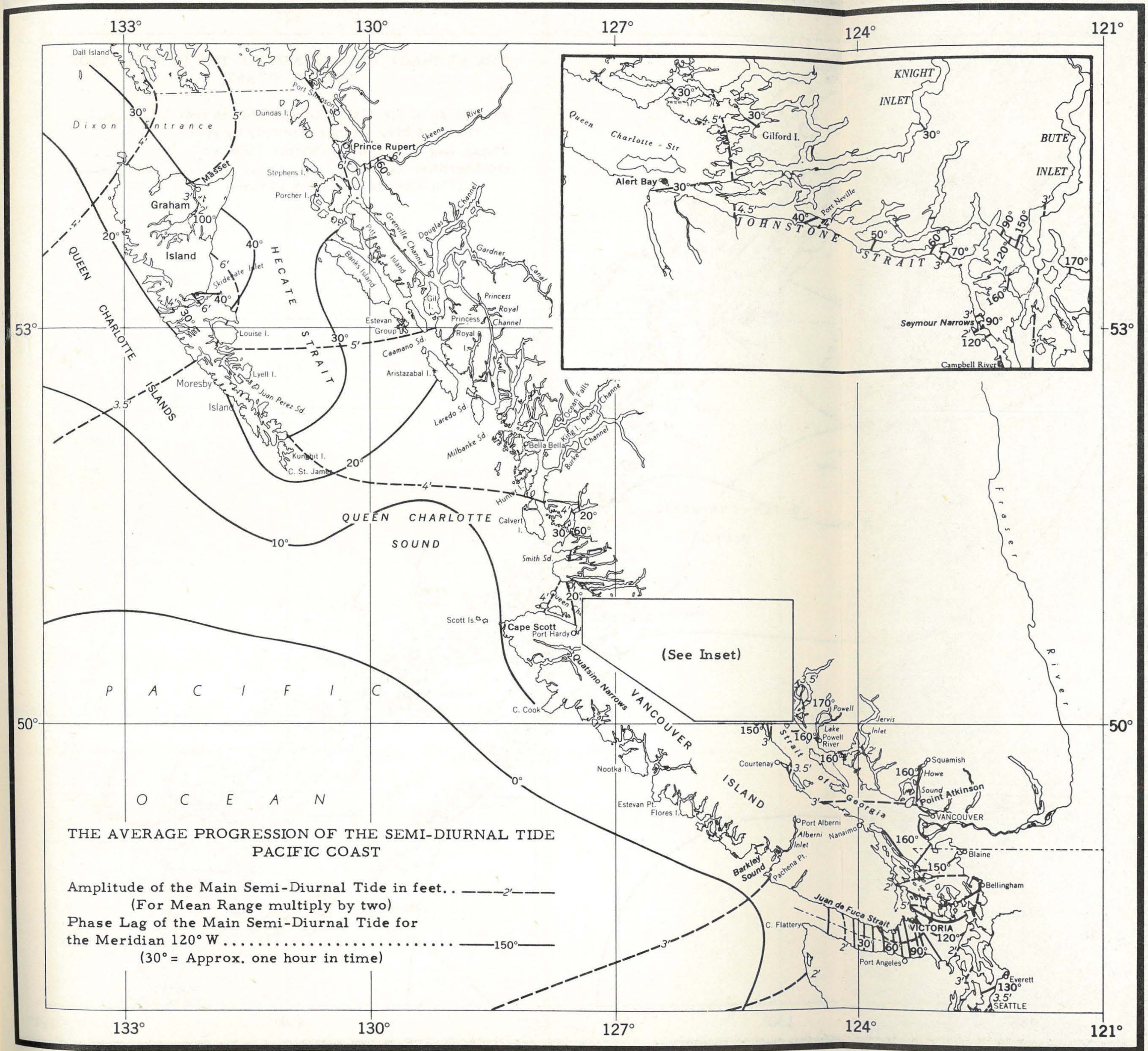
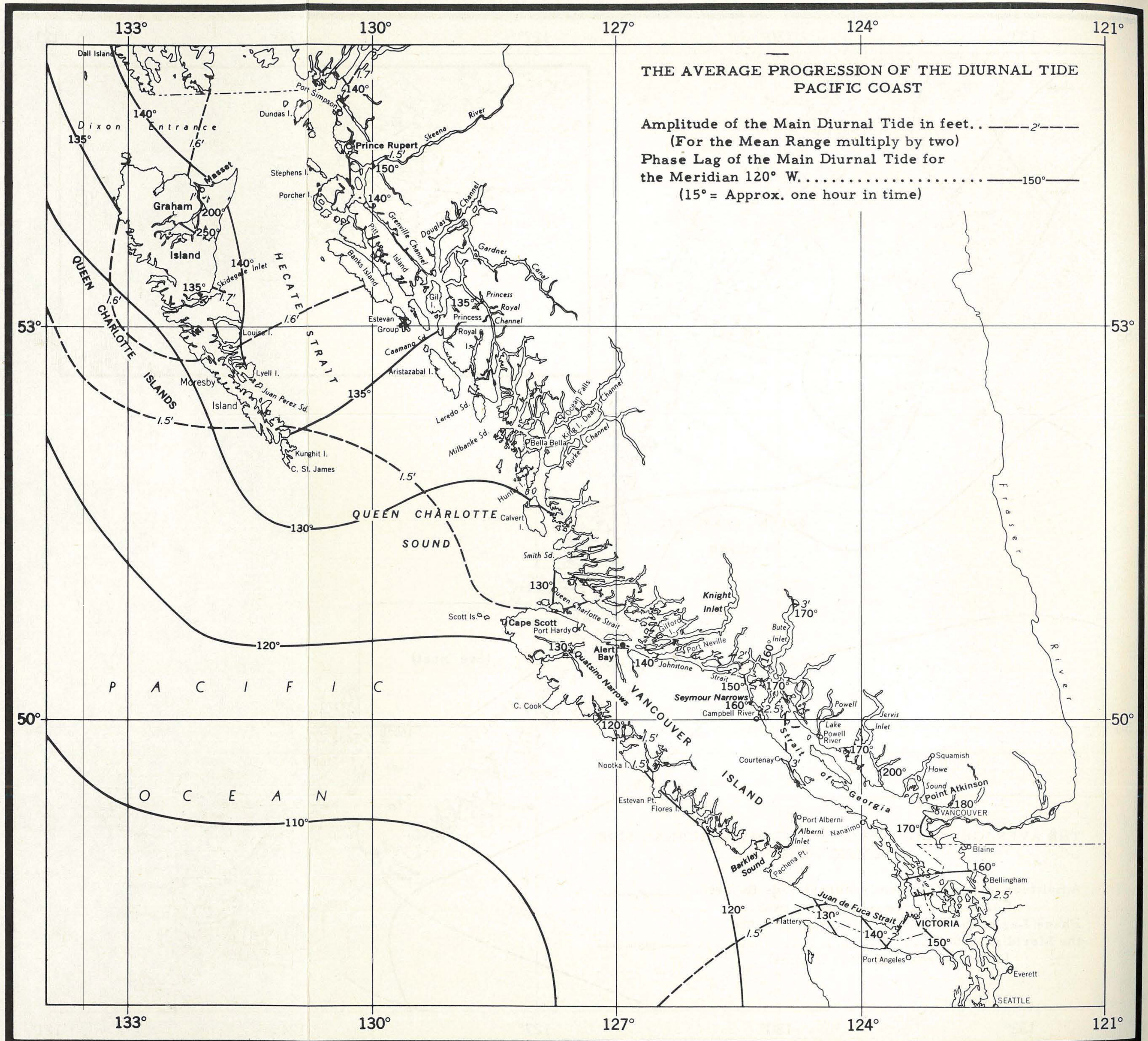
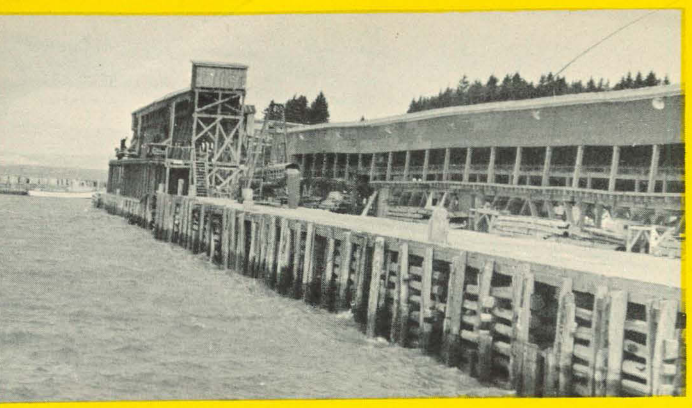
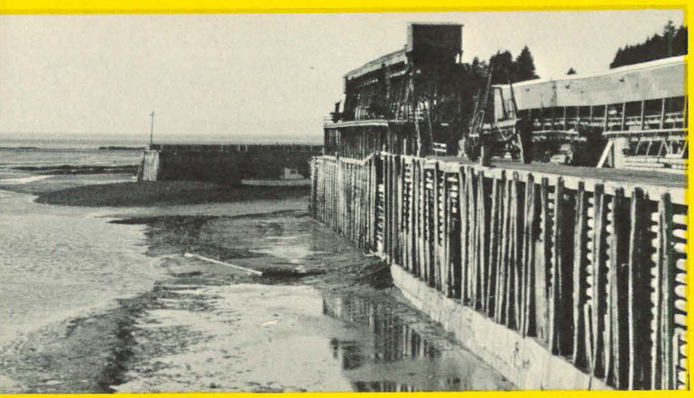
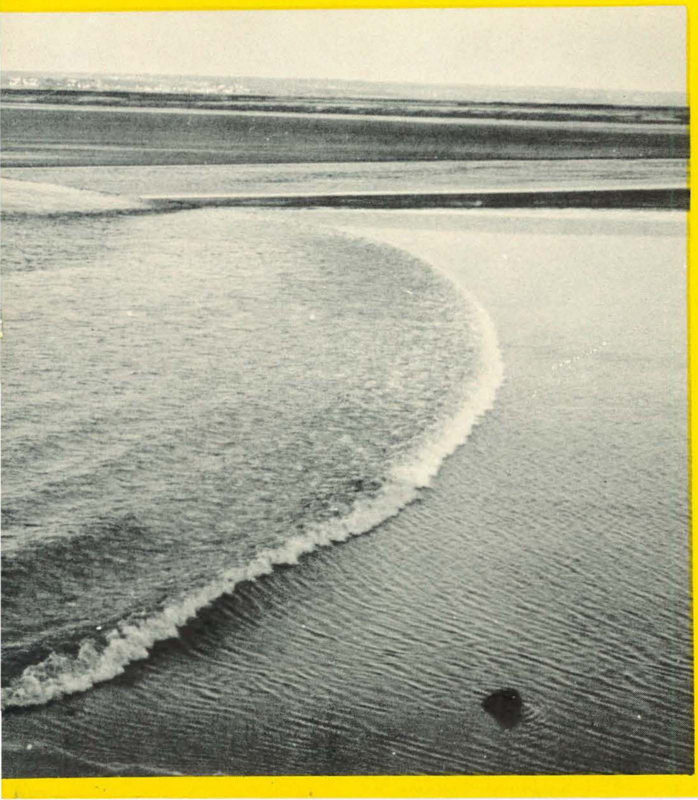

THE AVERAGE PROGRESSION OF THE SEMI-DIURNAL TIDE
PACIFIC COAST
Amplitude of the Main Semi-Diurnal Tide in feet. . ——2′——
(For Mean Range multiply by two)
Phase Lag of the Main Semi-Diurnal Tide for
the Meridian 120° W .... ——150°——
(30° = Approx. one hour in time)
133°
130°
127°
124°
121°
53°
50°
Dall Island
Dixon Entrance
Dundas I.
Port Simpson
Prince Rupert
Skeena River
Stephens I.
Porcher I.
Masset
Graham
Island
Skidegate Inlet
HECATE
STRAIT
QUEEN
CHARLOTTE
ISLANDS
Louise I.
Lyell I.
Moresby
Island
Juan Perez Sd.
Kunghit I.
C. St. James
Grenville Channel
Pitt Island
Banks Island
Douglas Channel
Gardner Canal
Princess Royal Channel
Princess Royal I.
Gil I.
Estevan Group
Caamano Sd.
Aristazabal I.
Laredo Sd.
Milbanke Sd.
Bella Bella
Ocean Falls
Dean Channel
King I.
Burke Channel
Hunter
Calvert I.
Smith Sd.
Queen Charlotte Str.
QUEEN CHARLOTTE
SOUND
Scott Is.
Cape Scott
Port Hardy
(See Inset)
Quatsino Narrows
C. Cook
VANCOUVER
ISLAND
Nootka I.
Estevan Pt.
Flores I.
Port Alberni
Alberni Inlet
Barkley Sound
Pachena Pt.
C. Flattery
Juan de Fuca Strait
VICTORIA
Port Angeles
Courtenay
Strait of Georgia
Nanaimo
Powell Lake
Powell River
Jervis Inlet
Squamish
Howe Sound
Point Atkinson
VANCOUVER
Blaine
Bellingham
Everett
SEATTLE
Fraser River
PACIFIC
OCEAN
KNIGHT
INLET
BUTE
INLET
Queen Charlotte Str
Gilford I.
Alert Bay
Port Neville
JOHNSTONE
STRAIT
Seymour Narrows
Campbell River

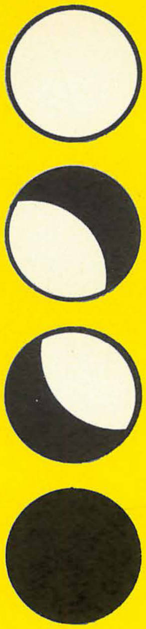
Figure 18

FIGURE 19


THE AVERAGE PROGRESSION OF THE DIURNAL TIDE
PACIFIC COAST
Amplitude of the Main Diurnal Tide in feet. . 2′
(For the Mean Range multiply by two)
Phase Lag of the Main Diurnal Tide for the Meridian 120° W. . . . . 150°
(15° = Approx. one hour in time)
133°
130°
127°
124°
121°
53°
50°
Dall Island
Dixon Entrance
Port Simpson
Dundas I.
Prince Rupert
Skeena River
Stephens I.
Porcher I.
Masset
Graham Island
Skidegate Inlet
QUEEN CHARLOTTE ISLANDS
HECATE STRAIT
Grenville Channel
Pitt Island
Banks Island
Douglas Channel
Gardner Canal
Gil I.
Princess Royal Channel
Princess Royal I.
Estevan Group
Caamano Sd.
Aristazabal I.
Louise I.
Lyell I.
Moresby Island
Juan Perez Sd.
Kunghit I.
C. St. James
Laredo Sd.
Milbanke Sd.
Bella Bella
King I.
Dean Channel
Ocean Falls
Burke Channel
Hunter I.
Calvert I.
QUEEN CHARLOTTE SOUND
Smith Sd.
Queen Charlotte Strait
Scott Is.
Cape Scott
Port Hardy
Alert Bay
Knight Inlet
Gilford I.
Port Neville
Bute Inlet
Johnstone Strait
Seymour Narrows
Campbell River
Quatsino Narrows
C. Cook
VANCOUVER ISLAND
Powell Lake
Powell River
Jervis Inlet
Strait of Georgia
Courtenay
Squamish
Howe Sound
Point Atkinson
VANCOUVER
Nootka I.
Estevan Pt.
Flores I.
Port Alberni
Alberni Inlet
Nanaimo
Barkley Sound
Pachena Pt.
Blaine
Bellingham
Juan de Fuca Strait
VICTORIA
C. Flattery
Port Angeles
Everett
SEATTLE
Fraser River
PACIFIC OCEAN
110°
120°
130°
135°
140°
150°
160°
170°
180°
200°
250°
1′
1.5′
1.6′
1.7′
2′
2.5′
3′

CANADIAN HYDROGRAPHIC SERVICE



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G. Dohler

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