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Title

Incidence of Ice and Icebergs in the Entrances to the Gulf of St. Lawrence and along the South Coast of Newfoundland

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ATLANTIC OCEANOGRAPHIC GROUP

INCIDENCE OF ICE AND ICEBERGS IN THE ENTRANCES TO THE GULF OF ST. LAWRENCE AND ALONG THE SOUTH COAST OF NEWFOUNDLAND

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Map of the Eastern Gulf of St. Lawrence and approaches.

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INTRODUCTION

The presence of drift ice in shipping lanes creates a very serious navigational hazard. This is particularly true in narrow straits where the ice tends to be jammed by strong currents. Because of this jamming in the straits, navigation is usually restricted for some time after the inner waters have become clear of ice.

Observations of the ice distribution have been made along the coasts by lighthouse keepers, and offshore by aerial reconnaissance and shipboard observations in an attempt to keep navigators suitably informed of the ice hazards. An attempt is made herein to bring together information available for the Strait of Belle Isle, Cabot Strait and the south coast of Newfoundland. The descriptive information is in many instances quoted from the work cited whereas reports of sightings have been summarized or presented in tabular form. The information pertaining to currents or general circulation, average ice conditions, and in some cases, ice conditions in recent years, is grouped under such headings.

STRAIT OF BELLE ISLE

I. Currents in the Strait of Belle Isle

A - Dawson, W. B. 1913. The currents in the Gulf of St.

Lawrence. Dept. of Naval Service, Ottawa.

"The current in Belle Isle Strait is primarily tidal in its character. While under the control of the tide alone, it will turn regularly and run with equal strength in each direction, the flood setting westward and the ebb eastward. But in addition to this tidal fluctuation, the water has almost always a tendency to make through the Strait in one direction more than in the other. While the tidal fluctuation goes on uninterruptedly, the water is thus making a continuous gain to the westward, or to the eastward, as the case may be. This over-balance in one direction we may term the element of dominant flow which is superimposed upon the usual tidal fluctuations. It gives rise to much complication, as it is large in relation to the strength of the tidal streams especially at the neaps when these are weak."

Further aspects of the currents and related phenomena discussed in detail by Dawson are: Tidal currents in the central part of the Strait, practical indications of the direction of the dominant flow, velocity of the current, currents off the eastern end of the Strait and currents at the western end.

B - Huntsman, A. G., W. B. Bailey and H. B. Hachey, 1954. The general oceanography of the Strait of Belle Isle. J. Fish. Res. Bd. Can., Vol. 11, No. 3, pp. 198-259.

"Water movements in the Strait of Belle Isle, on the basis of temperature, salinity and density distributions

involve at times (a) a progressive inward movement of water of Arctic and sub-Arctic origin on the north side, (b) a progressive outward movement of Gulf of St. Lawrence water on the south side, and (c) a dominant outward flow of Gulf water. A dominant westward flow of water into the Gulf was not observed during the short period of observation (July 1923), however, the conditions observed on August 16 indicated that there had been a predominant movement westward earlier."

The results of current measurements in the Strait of Belle Isle over a 72-hour period are summarized as follows:

"(a) On the north side of the Strait, the westerly currents were much stronger than the easterly currents. Over a double tidal period there was a residual trend of nine miles (16.7 km.) per day.

(b) On the south side of the Strait, the easterly currents were much stronger than the westerly ones. Over a double tidal period there was a residual easterly trend of eight miles (14.8 km.) per day."

II. Average Ice Conditions

A - Newfoundland Pilot, 1952. Canadian Edition, Dept. of Mines and Technical Surveys, Ottawa, pp. 21-22.

"Thin sheet ice makes its appearance in the Strait between the 15th and 25th of December, and at about the beginning of the year, ice several miles in extent and from 3 to 10 feet (0.9 to 3.0 metres) in thickness passes between the coast of Labrador and Belle Isle, and drifts into the

Strait.

Icebergs do not arrive in any great number until after the beginning of April, but from that time until September, or even October, they are numerous and sometimes very large. June and July are the worst months, but bergs have been sighted in the Strait in recent years during April and December. The greater number of the bergs enter between Belle Isle and Labrador, and pass slowly through the Strait, frequently grounding and breaking up, the broken ice drifting towards the northern shore. It is stated that no bergs ever come ashore on the Newfoundland side. Bergs from 150 to 200 feet (45.7 to 61.0 metres) high, and about a cable in breadth have been seen. Some of the bergs ground, while others change their position, no berg drawing more than 30 fathoms (54.9 metres) can reach the western end of the Strait without breaking up, and only the smaller bergs pass through. These are occasionally seen as far westward as Greenly Island and as far southward as Rich Point. The bergs are much more numerous in some seasons than in others, 200 bergs and large pieces of ice were counted in the Strait in August in one year, whilst only half a dozen were seen in the following August. With westerly winds the Strait is often clear of bergs. The bergs are a considerable source of danger to shipping during the prevalent thick fogs.

After May strings of heavy ice drift in with easterly winds and cause great obstruction, but with light winds these strings do not enter the Strait, which may be clear and remain so after April. Between about the 10th of June and the end

of the month, these strings of heavy ice usually fail.

The first steam vessels enter the Strait between the 7th of June and the 25th of July, and the last pass outward between the 11th of November and the first week in December.

Exceptionally early passages of the Strait were made in 1936 (21st of May) and 1937 (25th of May). It has been recorded that on some occasions the Strait has become closed by ice, after having been open and vessels have then had to pass southward of Newfoundland. In May 1937, the Strait of Belle Isle was clear of ice by the 20th but the route eastward was blocked by heavy impassible field ice." Details of average ice conditions in selected harbours near the Strait of Belle Isle are given in Appendix A, while details of dates of opening and closing for sea-going vessels at Quebec, in the Saguenay River, and in the Strait of Belle Isle are given in Appendix B.

B - Ice Atlas of the Northern Hemisphere, 1946.
H.O. Publ. No. 550, Hydrographic Office, U.S. Navy, Washington, D. C.

The Ice Atlas of the Northern Hemisphere (H.O. 550) gives monthly ice conditions in and the approaches to the Strait of Belle Isle, in chart form and grades the ice into four types depending upon the class of ship that may penetrate it.

In summary form this publication lists the first appearance of drift ice on January 1st approximately with the average data of the closing of navigation on December 20th. The drift ice disappears on the average on or about June 20th. The

Strait may be clear as early as April and remain so. First steamers enter the Strait between June 7th and July 25th, the last pass through between November 11th and 26th.

C - Huntsman, A. G. 1930. Arctic ice on our eastern coast. Bull. XIII of the Biological Board of Canada, Toronto.

This paper may be obtained from the Fisheries Research Board of Canada, Dept. of Fisheries, Ottawa.

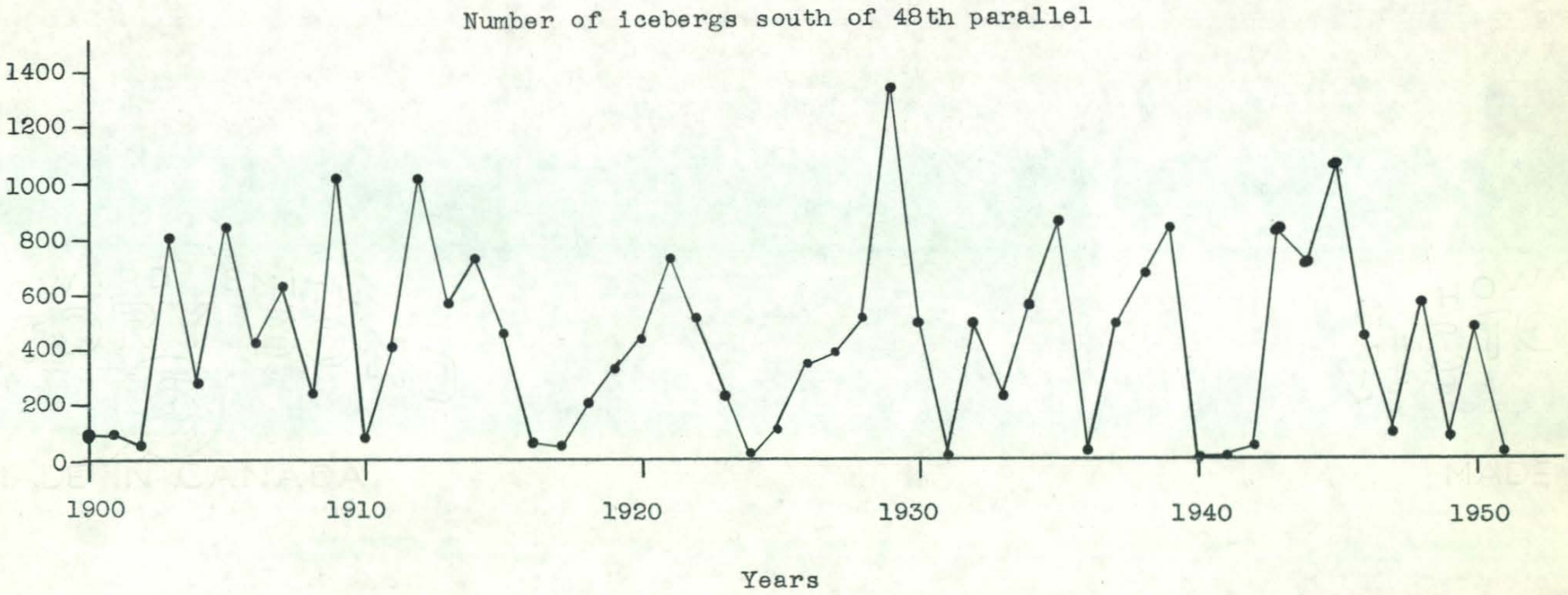
This publication deals with general ice conditions in our eastern coast with some emphasis on ice distribution in 1923. It is known now that the early twenties were the coldest years experienced in the last three decades (up to date).

D - According to lighthouse keepers on Belle Isle, only 10 to 20% of icebergs present off the Labrador Coast may enter the Strait of Belle Isle. These icebergs are located near the Labrador Coast and have access to the northern entrance between Belle Isle and the mainland.

The number of icebergs that flow south of the Strait of Belle Isle to south of the 48° parallel varies from year to year. This may be an indication of incidence of icebergs in the Strait. The following graph has been extracted from H.O. 1400, May 1956, U.S. Navy Department, Washington, D.C. 1955.

III. Annual Ice Conditions in the Last Decade

This is a summary of ice observations extracted from the "International Ice Observation and Ice Patrol Service in the North Atlantic Ocean". U.S. Coast Guard Bull. No. 32 to


Number of icebergs south of 48th parallel
1400
1200
1000
800
600
400
200
0
1900
1910
1920
1930
1940
1950
Years

40 inclusive:

1942 - February end - no ice sighted at Belle Isle

March 1-10 - heavy field ice occasional opening to SE.

March 11-20 - string slab ice among heavy ice, start to clear from the east - few bergs from the east, 4 bergs (11th).

March 21-31 - Strait opening (half open by 29th)

April 1-15 - Open water (on north side, 8th)

April 16-30 - 9/10th open water (27th)

May 1-10 - Ice moving in and out (3 bergs, 6th)

May 11-20 - Scattered floes (15th), small medium bergs on the south side.

May 21-31 - Clearing. West end clear (26th).

June 1-10 - Pack ice and bergs

June 11-21 - 6 bergs on 17th. Several bergs (18th and 19th).

Dec. 14 - No ice.

Dec. 30 - Blocked by chop ice.

1943 - January - Pancake ice.

February 13 - Complete coverage except for few wind leads.

March

April 17 - Pack ice, little open water

May 16 - Pancakes, some open water and bergs

May 27 - Packed solid north side, looser floes south side.

June 1-10 - Loose pack south side, numerous bergs

June 11-20 - Numerous bergs.

June 21-30 - Numerous bergs, 40 bergs (29th)

1943 - July 1-10 - Large number of small bergs

July 11-20 - Large and small bergs

August - Bergs in number

September - Occasional bergs

October - 3 bergs (20th)

1944 - February - Solid pack to 9/10 pack

March

April 28 - Heavy floes with open water eastern entrance.

May 1-10 - Solid pack, clearing to the west.

May 11-20 - Clear of pack by 20th. 17 bergs at eastern entrance.

May 21-31 - Strip of ice NW corner - 20 bergs by 25th.

June 1-10 - Bergs and growlers as many as 9 (4th)

June 11-20 - Loose pack, scattered bergs and growlers, 77 bergs (20th).

June 21-30 - Scattered bergs

July 1-10 - Scattered bergs and growlers

July 11-20 - Bergs in vicinity Belle Isle

July 21-31 - Up to 12 bergs in Strait (25th)

Aug. 1-10 - Up to 9 bergs vicinity Belle Isle

Aug. 11-20 - Scattered bergs vicinity Belle Isle

Aug. 21-22 - Up to 7 bergs in Strait

1945 - February

March 1-10 - Field ice 8/10 cover in Strait - bergs at the eastern entrance.

March 11-20 - Solid ice except about 2 miles west side.

March 21-31 - Closely packed, except NW corner

1945 - April 1-10 -

April 10-20 - Broken ice with stretches open water

April 21-30 -

May 1-10 - Heavy ice, 15 bergs off Belle Isle

May 11-20 - Field ice 3/10 in the Strait - 34 bergs in the Strait.

May 21-31 -

June 1-10 - Up to 30 bergs in the Strait

June 11-20 - 40 bergs NE entrance - scattered bergs in the Strait.

June 21-30 - Scattered bergs.

July 1-10 - Numerous 25-30 small bergs scattered east sector.

July 11-20 - 17 bergs in the Strait (14th).

July 21-31 -

August 1 - No bergs sighted from western approaches

1946 - January - Heavy field ice 10/10

February -

March 1-10 - 10/10 cover field ice.

March 11-20 -

March 21-31 - 7 bergs in Strait (29th).

May - Rapid retreat northward of field ice

June 1 - Opening of navigation.

1947 - March 11-20 - Broken patches field ice 5/10 - 3 bergs in Strait.

March 21-31 - Heavy winter ice 8/10 - 8 bergs in Strait.

April - Field ice, 13 bergs, 6 growlers (1st)

May - 26 bergs, 4 growlers (16th)

1947 - June 1-10 - Scattered bergs

June 11-20 - Up to 13 bergs, 3 growlers

June 21-30 - 4 bergs eastern sector

July -

August 14 - 3 bergs vicinity Belle Isle/Cape Norman

1948 - January -

February -

March -

April -

May -

June - 11 bergs eastern sector - scattered bergs north side (28th).

July - up to 5 bergs, several growlers eastern sector.

1949 - January -

February -

March 11-20 - 5 bergs eastern entrance

March 21-31 -

April -

May 1-10 - 6 bergs around Belle Isle (1st)

May 11-20 - 7 bergs around Belle Isle (12th)

May 21-31 -

June 20 - Floating field ice

September 17- Large berg in the center of the Strait

1950 - February 5 - Field ice, few leads

March -

April -

1950 - May -

June 1-10 - 3 bergs eastern sector

June 11-20 -

June 21-30 - Ice bergs scattered in Strait (3 large, 7 medium, 3 small), 4 growlers (26th) several outside Belle Isle.

July 1-10 -

July 11-20 - Numerous bergs north of Belle Isle - up to 4 large and 7 small bergs.

July 21-31 - Up to 5 large bergs (29th)

1951 - January - Field ice

February - Field ice

March - Field ice

April 19 - Up to 8 bergs, 2 growlers

April 29 - Scattered patches of field ice

May - Few bergs scattered

June 1-10 - Up to 10 growlers

1952 January - Pack ice 6/10 off Belle Isle

February -

March - 11 bergs eastern entrance (5th)

April - Pack ice in NE corner

May 1-10 - Up to 25 bergs eastern sector of Strait

May 11-20 - Up to 55 bergs eastern entrance - blocked with close pack (19th).

May 21-31 - Up to 20 bergs and many growlers

June -

July - Scattered bergs and growlers (7th)

September 7 - One berg

1952 - October - Occasional bergs

1953 - March 1-10 -

March 11-20 - Sea Ice

March 21-31 - Sea Ice, pancake ice

April 1-10 - Sea ice, pancake ice, loose in S.and W. close pack eastward.

April 11-20 - Sea ice, close pack Newfoundland side

April 21-30 - Sea ice, bergs in sight from Pt. Amour openings, up to 3 bergs and 7 growlers.

May 1-10 - Ice moving in and out near western end - 8 bergs off Pt. Amour.

May 11-20 - Up to 25 bergs and many growlers

May 21-31 - Up to 15 bergs and many growlers

June 1-10 - Up to 22 bergs and 16 growlers

July 7 - One berg

August 9 - Bergs N. and NNE. of Belle Isle

September 5 - 2 medium bergs

1954 - April 15 - Two bergs west coast Belle Isle - Ice pack off shore.

May 1-10 -

May 11-20 - Ice pack offshore closing in towards Belle Isle and Cape Bauld - 21 bergs near Belle Isle - close pack near western end.

May 21-31 - Heavy field ice - 30 bergs E. entrance, 50 bergs in Strait (29th).

June 1-10 - 102 bergs (10th)

June 11-20 -

June 21-30 - 42 bergs (23rd), 7 bergs (29th).

July 1-10 - Eastern end, up to 100 bergs - Strait, 11 bergs, 13 growlers, western end, 2 bergs.

1954 - July 11-20 - Few Bergs

July 22 - Several bergs

CABOT STRAIT

I. Currents in Cabot Strait

Dawson, W. B. 1913. The currents in the Gulf of St. Lawrence. Department of Naval Service, Ottawa.

"(a) Cape Breton Current - On the west side of this Strait for a width of some 18 miles from Cape North, there is a constant current flowing to the southeast. This is as constant in one direction as any current in the Gulf; as it is rarely checked under any conditions that occur. It is said, however, to be checked or reversed for a few days at a time by heavy southeasterly winds. Direction, speed and width - The most usual or dominant direction of this current is between SSE and ESE. Its speed is greater near Cape North where it may be as much as two knots. The width of the water flowing in the southeastward direction has been found to extend for twelve miles to the east of St. Paul Island. Farther out, in the middle of the Strait, the current was found to be quite indefinite in direction, and usually weak.

(b) Current off Cape Ray - On the eastern side of Cabot Strait there is usually a movement of the water to the northwest, or inwards toward the Gulf. This is a continuation of a general set westward which is felt along the south coast of Newfoundland, between St. Pierre Island and Cape Ray. Direction, speed and width - In steady weather, a current in

this inward direction is felt for a width of 10 or 15 miles from Cape Ray or even further. In the month of August, at an anchorage 13 miles west of this Cape, the speed was found to range from ½ knot to 1½ knots. The direction varied between west and north, the dominant direction being northwest. The change in direction was less regular in time than on the other side of Cabot Strait; no relation to the rise and fall of the tide could be made out.

(c) Drift of Ice - The Cape Breton current carries out much of the Gulf ice in the early spring; and this serves to afford an indication of its direction. There is evidence to show that the current off Cape Ray is by no means constantly inwards. As, however, the water off the south coast of Newfoundland usually remains open and free from drift ice throughout the winter, this is in itself an indication that the general movement is westward, as the Atlantic water must then be warmer than the Gulf water. It is also stated that icebergs off St. Pierre Island will make westward."

II. Distribution of Ice in Cabot Strait

A - Newfoundland Pilot, 1952. Canadian Edition, Dept. of Mines and Technical Surveys, Ottawa, pp. 17-18.

The waters south of Newfoundland may receive field ice from two areas. One from the east coast and the other from Cabot Strait.

From Cape Race this ice spreads south and southwestward over the neighbouring banks. There is no appreciable amount

of ice experienced southwest of the Shelf, and clear passage can regularly be found in the mouth of the deep Laurentian Channel leading toward Cabot Strait. In some years the ice spreads westward from Cape Race completely blocking the harbours on the south coast as far west as Miquelon.

"The Gulf of St. Lawrence even though it is comparatively open to the Atlantic and its water rather salty, is in winter regularly filled with ice from shore to shore. The entrance of very large amounts of ice with the Labrador Current, through the Strait of Belle Isle, explains this otherwise anomalous fact. The last place to fill up and the first to open is along the part of the comparatively warm inflow along the northern side of Cabot Strait, around Cape Ray, and northward to Bay of Islands on the west coast of Newfoundland.

The ice floes leave the Gulf more or less constantly past St. Paul Island and Cape North spreading south and southeast towards Sable Island. The ice, in heavy years, completely surrounds Sable Island for short periods, when the wind favours such drifts. This ice, as it leaves the Gulf consists of very heavy, tightly packed rafted ice and forms an impassable barrier to all navigation. Nearly every year in the spring, or from the middle of April to the middle of May, there is a great rush of ice out of the Gulf, causing a block between St. Paul Island and Cape Ray; this block which sometimes lasts for three weeks and completely prevents the passage of ships is known as The Bridge....".

"With favourable winds, when the fields cover the greatest

area, the ice spreads east-northeastwards toward the southern shore of Newfoundland, though seldom actually reaching the shore. Some also moves southwestward from Scatari Island, along the coast of Nova Scotia, though rarely drifting as far as Cape Sable. This last ice is always open and navigable, when it reaches Halifax. The outflow usually begins in February and continues through April, by which time there is a passable channel into the Gulf close to Newfoundland around Cape Ray, and some open water from there to Quebec. Details of average ice conditions in selected harbours near Cabot Strait are given in Appendix C."

B - Ice Atlas of the Northern Hemisphere, H.O. Publ. No. 550, Hydrographic Office, U.S. Navy, Washington, D.C. 1946.

The Ice Atlas gives average monthly ice conditions for the Cabot Strait area in chart form. These charts are the result of compilation of observations extending over three decades from 1911 to 1940. The average distribution, as seen from the charts could be summarized as follows:

The ice passing through Cabot Strait appears to originate in the Gulf of St. Lawrence. The circulation in the Strait is reflected in the concentration of ice along the Cape Breton side as compared with that on the Newfoundland side. The outflowing Gulf waters are choked with ice whereas the inflowing ocean waters are free of ice.

During the first month of the winter season, no ice is present in Cabot Strait, but by January a small tongue of

light ice that would not obstruct navigation is present in the Strait. A very large increase in the amount of ice takes place between January and February, and at this time it occupies most of the width of the Strait, with the thicker ice located along the Cape Breton side. There is some ice off the east coast of Cape Breton Island, and a tongue of ice extends as far south as Banquereau. The thickness of the ice decreases from north to south and from the coast to offshore.

The extent of ice in Cabot Strait is at a maximum in March and the thicker ice along the Cape Breton shore reaches its southern limit, around Scatari Island at this time. This heavy unnavigable ice is located offshore leaving the immediate coastal areas with thinner ice.

In April the total ice coverage is about the same as it was in March, however, the heavier ice has reached to the point where it now occupies only a narrow band across Cabot Strait between Cape North and Cape Ray.

From April to May the ice recedes to such an extent that the heavy ice is located in the Cape North-St. Paul Island area, and the Newfoundland side was almost free of ice. During the month of May all the ice disappears from the area.

No icebergs or growlers are normally present in the Cabot Strait area.

C - International Ice Observation and Ice Patrol Service in the North Atlantic Ocean. U.S. Treasury Dept., Coast Guard Bull. No.s 32 and 37. Examples of ice reports covering the Cabot Strait area during

some winter seasons since 1940 are given below as extracted from these U.S. Coast Guard Bulletins.

(a) Season of 1943 (Heavy Ice Year)

"The entire St. Lawrence area was open until well after the middle of December 1942, at which time a severe storm accompanied by low temperatures and dangerous icing conditions swept through the Gulf. During January the pack ice, augmented by locally formed winter-ice pushed through the Gulf and out through Cabot Strait. Patches of heavy field ice rafted by wind were reported at a position 30 miles southwest of the Miquelon Islands, January 24th. This ice came from the Gulf through Cabot Strait as no heavy ice had been passing Cape Race, the other possible course at that early date. The discharge from the Gulf came earlier and was heavier than on an average year.

Throughout the month of February heavy field ice drifting from the Gulf constantly choked Cabot Strait and occasionally closed in on the Newfoundland coast at Port Aux Basques, blocking that harbour. Heavy ice at times drifted south past Latitude 45°N. Except for a few days, about 4th to 7th February, vessels bound from Halifax to Argentia keeping south of Latitude 45°N. until east of Longitude 57°W. would have encountered no heavy ice.....

On February 17th loose strings of thin ice were reported in the vicinity of 44°N. 57°W. Slush and pancake ice were forming quite generally at that time in coastal waters east of Cape Race. This ice was formed only during a cold snap and was light and short lived compared to the heavier pack

drifting from the Gulf. Local ice rarely lasted more than a day or two in offshore waters. The prevailing westerly winds during February prevented ice from moving westward along the south coast of Cape Breton Island and Nova Scotia.

In March, heavy ice continued to push out of the Gulf through Cabot Strait. During the first half of the month the ice remained mostly north of a line from a position of Latitude 45°N. Longitude 60°W. to St. Pierre, but occasionally patches were blown almost to the Miquelon Islands and to within a short distance of the Newfoundland south coast. On March 17th loose stringy floes were observed extending from the direction of Cabot Strait to a position 46°15'N., 56°00'W. This ice lasted at least 3 days and was probably the beginning of the major ice movement from the Gulf during March, which culminated in patches of field ice reaching a position 44°20'N., 56°45'W. on the 26th. A short distance northeast of this position the ice pieces averaged 2 to 5 feet thick with hummocks to 6 feet above water. On March 28th, ice 30 feet thick was reported in a position of 45°10'N., 56°50'W. This heavier ice is believed to be the remnants of a huge rafted floe, one such as had been sighted off the east coast of Cape Breton Island on February 13th. In March, as in February, the westerly winds kept the ice from drifting west along the south coast of Cape Breton Island.

During early April, ice outside Cabot Strait slowly receded from its maximum extension of March but it opened up considerably. By the 19th the outer limits were again inside a line

extending from a position 45°N., 60°W. to St. Pierre. By the end of the month, no ice remained in Cabot Strait outside a line from Cape North to Cape Ray."

(b) Season of 1946 (Normal Ice Year)

"February

The St. Lawrence ice began to move out of Cabot Strait and on the 12th its eastern edge was reported about 50 miles northeast of Scatari Island. By the 27th close packed ice extended eastward from Cape Breton to the 58th meridian. Ice reports indicate that the southern limit was about 45°30'N.

March

The St. Lawrence ice coming out of Cabot Strait spread eastward during the first part of the month until by the 11th it had reached the 57th meridian between the 46th and 47th parallels. Between the eastern edge and Cape Breton Island, the southern edge fluctuated between 46°N. and 45°30'N. during this period. During the latter part of the month the eastern edge of the ice receded westward and the southern edge moved southward until at the end of the month it was at about latitude 45°N. between longitudes 58° and 60°W.

April

During the early part of the month the St. Lawrence ice coming out of Cabot Strait began to undergo rapid deterioration. The southwestern end of this ice moved to about the 61st meridian, 30 miles south of Cape Canso. As is usual, Cabot Strait cleared first along the Cape Ray side and during the second week in April, navigation into the Gulf along the

Cape Ray-Bird Rocks route was open."

(c) Season of 1951 (Very Light Ice Year)

i. "The Canadian Department of Transport discontinued aerial surveys in the Gulf of St. Lawrence on April 30, reporting all routes to rivers and maritime ports clear for navigation. The extreme eastern limits of scattered ice observed by this service during the entire season were sighted in early March from Heath Point, Anticosti to the Magdalen Islands, a marked difference from the normal."

ii. "Weather did exert considerable influence on the ice conditions during March, especially the field ice which might have developed into a threat to the northern tracks. A deep, stagnant cyclone south of Sable Island between March 9th and 13th produced east to southeast gales that all but destroyed the crop of field ice. This, followed by a Great Lakes low pressure system that moved south of Newfoundland and stalled between the 15th and 18th (southeast winds) and a central Labrador storm on the 21st (southerly gales), left the area south of Latitude 50°00'N. completely void of pack ice except for scattered remnants and loose strings.

The weather during the first half of April was characterized by a series of numerous, slow moving low pressure areas passing south and southeast of Newfoundland, thus, the prevailing winds were from the easterly quadrant for almost the entire period. Although this pattern was altered somewhat during the latter part of the month, with the passing of several storms north of the Strait of Belle Isle, the more

intense cyclones were still "northeasters" in the ice patrol areas. Since, during an average year, an equal number of storms pass north and south of Newfoundland, the track of most of these "lows" to the south during April was a marked departure from normal.

The influx of warm, moist air over the area during the first 3 weeks in May gave indications of a changing trend from winter to summertime conditions. The storms were less numerous and not as violent as in the preceding months. Pressure gradients showed a marked tendency to weaken and become ill-defined and by the end of the ice patrol season, southwest winds, with attendant fog, had established themselves in the Grand Banks.

Climatological records at both the U.S. Naval Station at Argentia, Newfoundland, and the U.S. Air Force Base at Goose Bay, Labrador, as well as observations from other sources indicate that the winter of 1950-51 was one of the mildest on record both from a standpoint of lack of snow as well as temperatures. What effect if any this had on the lack of bergs, is the subject of speculation at this time and will require further study before an evaluation can be made."

SOUTH COAST OF NEWFOUNDLAND

I. Currents off the South Coast of Newfoundland

Newfoundland Pilot, 1952. Canadian Edition, Dept. of Mines and Technical Surveys, Ottawa, p. 12.

"The currents off the southern coast of Newfoundland

between Cape Race and St. Pierre have almost invariably a rate less than one knot. As a rule they are irregular in direction, and having such a low rate of progression are readily influenced by the wind. In these currents the tidal element is almost invariably present in some form, more or less distinct, it is not therefore possible to maintain an arbitrary distinction between "Constant Currents" and "Tidal Streams" and the term "Current" is consequently used to denote all horizontal movement of the water.

Westward of Cape Race, the current frequently sets northwestward at the rate of about one knot in the offing, but it is variable in rate and direction, and affected greatly by the prevailing wind. It generally runs in upon the eastern side of the great bays indenting the southern coast of Newfoundland, and out their western side. In the offing, it is influenced by the winds, and near the coast it is influenced by the tidal streams."

II. Distribution of Ice

Field ice along the south coast of Newfoundland is subject to the winds. The ice originates from the St. Lawrence pack which may reach Cape St. Mary as it did in 1948. In general, coastal areas are clear most years and the St. Lawrence pack is usually confined in an arc from St. Pierre to Cape Breton. On occasion, drift ice may interfere with navigation at St. Pierre between February 15th and March 30th.

Drift ice along the south coast from Cape Ray to Fortune

Bay is scattered and normally it does not interfere with navigation even during March when the maximum coverage of ice is observed. Between Fortune Bay and Cape St. Mary, drift and shore ice is observed along the east shore of Placentia Bay of which at least fifty percent is generally navigable by heavily built vessels. From Cape St. Mary to Cape Race, more ice is encountered than in the central or western sectors of this coast. The ice originates along the east coast of Newfoundland and reaches a maximum in extent and thickness in February and March. The navigation is seldom interrupted at St. Mary's Harbour. Particulars of ice conditions at selected harbours along the south coast of Newfoundland are given in Appendix D.

III. Distribution of Icebergs

A - Ice Atlas of the Northern Hemisphere, H.O. Publ. No. 550, Hydrographic Office, U.S. Navy, Washington, D.C. 1946.

The average distribution of icebergs and growlers is given in the Atlas in the form of twelve monthly charts. These charts show that the sector west of Burin Peninsula is generally free of icebergs and growlers. Placentia Bay might receive at the most 10 bergs in May, and as many as 5 during April and June. In the area east of 54°W., from Cape St. Mary to Cape Race, the average number of bergs and growlers increases from 3 in March to 10 in April, 25 in May, and then gradually decreases to 3 in July and 1 in August. These average conditions are based on observations made over a 30-year period

(1911-1940).

B - International Ice Observation and Ice Patrol Service in the North Atlantic Ocean. U.S. Treasury Dept. Coast Guard Bull. Nos. 32-40 incl.

In recent years, the conditions have not changed much from what they were previously along the south coast at least. During the period 1942-54, icebergs were reported for only 5 years out of the 13 in the area west of 54°W. along the south coast of Newfoundland and on the banks to the south. In most instances the bergs were confined to the deep water just south of Cape St. Mary. On one occasion growlers were sighted off the eastern part of St. Pierre Banks, and on another, 4 were sighted on Green Bank.

Incidence of Icebergs (nil reports omitted)(west of 54°W.)

1943	-	5 in June
1947	-	1 in March
1950	-	3 in July
1953	-	numerous growlers in April
1954	-	19 bergs for the entire season

Number of bergs present in a given month in 1954

May	8
June	11
July	2

CONCLUDING REMARKS

It could be seen from the preceding that ice studies along our eastern coast have been principally descriptive. In the Gulf of St. Lawrence and in the approaches to the Gulf, the Strait of Belle Isle and Cabot Strait, the ice is an obstacle to navigation, consequently most of the work was performed in order to facilitate early opening and late closings of the navigation seasons. However, a recent paper by C. N. Foreward[1] shows the result of a study of ice distribution and its behaviour in the Gulf of St. Lawrence during March, April and May. The author considers the relative influences on the ice of the physical factors of the environment.

Foreward's study of physical factors of the environment is related to the break-up season, next step to be taken is the study of such factors in relation to the formation and maintenance of ice coverage.

A preliminary winter survey of oceanographic factors in the Gulf of St. Lawrence was made in February-March 1956, and it is hoped that the results will give some leads regarding the incidence and movement of ice in the entrance to the Gulf.

(1) Foreward, C. N. 1954. Ice distribution in the Gulf of St. Lawrence during the Break-Up Season. Geographical Bulletin No. 6, pp. 48-84. Geographical Branch. Dept. of Mines & Technical Surveys, Ottawa.

APPENDIX "A"

Ice Atlas of the Northern Hemisphere, U.S. Hydro Office 1946

H.O. Publ. No. 550.

Average ice conditions in selected harbours near the Strait of Belle Isle

Location	First Appearance of Drift Ice	Navigation		Final Disappearance of Drift Ice	Av. Annual number of days closed to navigation
		Av.Date Closing	Av.Date Opening		
Chateau Bay		Dec. 25 approx.	July 4 approx.		191 approx.
Red Bay		Dec. 15 approx.	May 25 approx.	June 20 approx.	160 approx.
St. Barbe Bay		Dec. 5	May 15		161

APPENDIX "B"

Dates of opening and closing of navigation for sea-going vessels at Quebec, in the Saguenay River and in the Strait of Belle Isle

Year	First Arrival		Passing through Strait of Belle Isle		Last Departure	
	At Quebec	In Saguenay River	First Westbound	Last Eastbound	From Quebec	From Saguenay River
1900				Nov. 4		
1901			May 21	Oct. 16		
1902			July 24	Nov. 4		
1903			Apr. 19			
1904			May 24	Nov. 10		
1905			June 5	Nov. 15		
1906			June 21	Nov. 24		
1907			June 10	Nov. 23	Dec. 4	
1908			June 1	Nov. 25	Nov. 27	
1909			May 20	Dec. 11	Nov. 26	
1910	April 9		May 20	Dec. 5	Dec. 2	
1911	April 27		May 10	Nov. 22	Dec. 8	
1912	April 28		June 10	Nov. 27	Dec. 12	
1913	April 14		June 26	Nov. 10	Nov. 30	
1914	April 28		June 27	Nov. 19	Dec. 4	Nov. 24
1915	April 29		June 27	Nov. 30	Dec. 11	Dec. 17
1916	May 1	April 25	June 9	Nov. 29	Dec. 11	Oct. 8
1917	April 29	May 1	June 30	--	Dec. 23	Oct. 28
1918	May 7	April 30	June 5	--	Dec. 30	Nov. 25
1919	April 19	May 2	July 4	Nov. 10	Dec. 16	Nov. 23
1920	April 29	April 30	June 27	Dec. 6	Dec. 12	Nov. 22
1921	April 19	April 28	June 16	Nov. 19	Dec. 13	Dec. 2
1922	April 23	April 19	June 10	Nov. 18	Dec. 10	Nov. 30
1923	May 2	May 11	July 2	Dec. 1	Dec. 7	Nov. 28
1924	April 17	April 24	June 16	Dec. 3	Dec. 4	Nov. 27

Year	First Arrival		Passing through Strait of Belle Isle		Last Departure	
	At Quebec	In Saguenay River	First Westbound	Last Eastbound	From Quebec	From Saguenay River
1925	April 13	May 1	May 25	Dec. 14	Dec. 19	Nov. 30
1926	April 25	May 10	July 3	Nov. 29	Dec. 23	Nov. 27
1927	April 16	April 24	June 5	Dec. 4	Dec. 6	Dec. 3
1928	April 19	May 14	June 7	Dec. 9	Dec. 11	Nov. 24
1929	April 19	May 1	June 22	Dec. 2	Dec. 23	Dec. 1
1930	April 19	May 6	June 18	Dec. 5	Dec. 23	Nov. 26
1931	April 14	May 1	June 7	Dec. 5	Dec. 15	Nov. 25
1932	April 7	April 24	May 29	Nov. 28	Dec. 22	Nov. 26
1933	April 9	April 25	June 24	Dec. 9	Dec. 13	Nov. 2
1934	April 26	April 30	June 18	Dec. 3	Dec. 8	Dec. 9
1935	April 12	April 25	July 3	Dec. 3	Dec. 12	Nov. 24
1936	April 12	April 1	May 26	Dec. 14	Dec. 15	Dec. 4
1937	April 15	May 1	May 24	Dec. 5	Jan.2/38	Nov. 30
1938	April 10	April 22	May 20	Dec. 1	Dec. 5	Nov. 22
1939	April 22	May 6	June 14	Dec. 13	Dec. 9	Nov. 20
1940	April 19	May 5	June 26	Dec. 1	Dec. 31	Nov. 21
1941	April 18	April 24	June 27	Nov. 24	Dec. 24	Nov. 25
1942	May 1	April 29	June 29	Oct. 29	Jan.3/43	Nov. 24
1943	May 13	May 11	July 4	Oct. 24	Jan.3/44	Nov. 24
1944	April 19	April 28	June 9	Oct. 31	Dec. 17	Nov. 17
1945	April 9	April 22	June 8	Nov. 1	Dec. 13	Nov. 12
1946	April 9	April 16	May 25	Dec. 5	Dec. 23	Nov. 26
1947	April 18	May 5	May 21	Dec. 3	Jan.13/48	Nov. 26
1948	April 19	April 24	May 27	Dec. 11	Dec. 26	Nov. 30
1949	April 7	April 17	May 18	Dec. 6	Dec. 8	Dec. 4
1950	April 13	April 27	June 13	Dec. 15	Dec. 25	Nov. 20
1951	April 10	April 14	May 9	Dec. 9	Dec. 16	Dec. 1
1952	April 8	April 12	June 19	Dec. 13	Dec. 24	Dec. 3
1953	April 1	April 10	May 16	Dec. 13	Dec. 29	Dec. 7
1954	April 14	April 5	June 10	Dec. 13	Dec. 20	Dec. 2
1955	April 8	April 6	May 18	Dec. 14	Dec. 18	Nov. 30
1956	April 1	April 2	June 5			

Data supplied through the courtesy of the Marine Signal Service of the Department of Transport, Quebec, P.Q.

Appendix "C"

Ice Atlas of the Northern Hemisphere U.S. Hydro. Office 1946. H.O. Publ. No. 550

Average Ice Conditions in Selected Harbours near Cabot Strait

Location	First Appearance of Drift Ice	Navigation		Final Disappearance of Drift Ice	Av. Annual No. days closed to navigation
		Av. Date Closing	Av. Date Opening		
Sydney, N.S.	Mar. 1	Jan. 10	Apr. 1	Apr. 10	81
Burgeo, Nfld.	Mar. 1	-	-	Mar. 22	Seldom closed
Port Aux Basques	-	-	-	-	Navigation seldom interrupted by ice. Harbour sometimes blocked by drift ice with SW wind in February and March.
La Poile Harb.	Fast ice appears approx. Feb. 10	-	-	Fast ice disappears Mar. 20	38 days seldom interrupted. Field ice rarely arrives and navigation has been impeded in only 6 spring seasons in 50 years.

Appendix "D"

Ice Atlas of the Northern Hemisphere, U.S. Hydro. Office 1946, H.O. No. 550

Average ice conditions in selected harbours near the Strait of Belle Isle

Location	First Appearance of Drift Ice	Navigation		Final Disappearance of Drift Ice	Av. Annual No. Days closed to Navigation
		Av. Date Closing	Av. Date Opening		
Burgeo Port	Mar. 1 approx.	-	-	Mar. 22 approx.	Seldom interrupted
Burin Harbour	-	-	-	-	Ice occasionally forms in severe winter between mid-February and mid-March, November
Fortune Bay	-	-	-	-	Seldom interrupted
Placentia Bay	Fast ice Feb. 5 approx.	Feb. 15 approx.	-	-	Navigation seldom interrupted.
Placentia Harb.	Fast ice Jan. 15, approx.	-	-	April 1 approx.	75 approx.
Ramea	-	-	-	-	Harbour only frozen over when northern ice is present and during a period of 20 years, this ice has arrived only 4 times, between the end of Feb. and mid-April.
White Bear Arm	-	Dec. 25 approx.	May 10 approx.	-	135 approx. Approaches sometimes encumbered with drift ice until July 15.