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RADARSAT Report 82-12
Canadian Coast Guard Captain
Interviews-Interim Report
PHILIP A. LAPP LTD.

Interim Report on Task 1 of the Extension to the Radarsat Ice and Ocean User Requirement Study

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1. INTRODUCTION

This report summarizes the findings to date on the task to interview the Canadian Coast Guard icebreaker captains and support personnel on the role of ice information in making routing decisions for icebreaker operations. The interviews so far have been held in Dartmouth, St. John's and Ottawa. Most of them were conducted in the latter half of June just prior to the beginning of their summer shipping operations. Table 1 lists the individuals and their positions who have been interviewed to date.

1.1 Background

The interviews with the Coast Guard captains are considered to be a key element in the ongoing process to determine user needs for ice and ocean information. The active captains and others involved with icebreaking operations have the largest accumulated experience in operating ships in ice-covered waters. Accordingly it is crucial to obtain their views to provide insight into the needs, uses and the relative contribution of ice information in operational decision-making for icebreaking ships.

The task is an extension to the original Radarsat Ice and Ocean User Requirement Study conducted by Philip A. Lapp Ltd. for

TABLE 1

INTERVIEW LIST OF INDIVIDUALS AND THEIR POSITIONS

HALIFAX, N.S.

1. Captain W. Dancer - former captain Louis St. Laurent and Labrador
2. Captain V. Barry - relief captain on major icebreakers
3. Joe McKenna - chief officer Louis St. Laurent
   Bill Frampton - chief officer Tupper
4. Captain S. Gomes - captain Louis St. Laurent
   former captain John A. MacDonald
5. Captain W. Tanner - captain Louis St. Laurent
6. Mr. S. Gillis - adviser Ice Routing Operations Center
7. Captain I. Green - director CG Halifax Regional HQ
   - former captain Labrador, John A. MacDonald
   Sir Humphrey Gilbert
8. Captain Toomey - captain Pierre Radisson

ST. JOHN's, NFLD.

9. Captain Rodeneiser - captain Grenfell (Search and Rescue)
10. Captain Derford - captain Jackman (Search and Rescue)
11. Captain Piercy - captain Sir John Franklin
12. Captain McGarvie - former captain Cabot
    - relief captain on St. John's icebreakers
    - ice operations officer

OTTAWA

13. Captain R. Pierce - captain Sir Humphrey Gilbert

the project office which was completed in April of this year. It was originally intended to interview the captains as part of the survey of user requirements; however, approval from the Coast Guard came too late in the study for the task to be implemented. This interim report is submitted to the project office to coincide with the conclusion of phase A studies, so that at least some input from this important group is immediately available to the project office. Further interviews with additional captains and crew will be held upon the return of the icebreakers from their summer operations sometime in late October. A final report will then be submitted to incorporate the additional information.

1.2 Methodology

The interviews were based around discussion of several related topics of concern to the Radarsat Project.

(1) Brief the captain on the Radarsat project.

(2) Discussion of the present ice information system and the services and products provided by the AES Ice Branch.

(3) Review the proposed information products presented in Radarsat report 82-9 for their views on format and usefulness as well as any anticipated problems in their use.

(4) How the captain uses ice information to make operational decisions regarding the routing and conduct of his vessel.

(5) Other issues or points of interest raised by the captains.

To date, some 13 interviews have been conducted with various personnel including:

- 11 active and former icebreaker captains
- 2 chief officers
- 1 individual in the Ice Operations Center responsible for ice routing.

In general, none of these individuals had ever heard of the Radarsat project with the exception of 2 former captains now in shore positions in Dartmouth who had been briefed and interviewed for the original user survey. Thus it was necessary to spend some time on explaining the various aspects of the project. The discussion of their use of ice information for routing decisions was based on the next three topics listed above. Examples of the proposed information products which included some examples of SEASAT imagery were shown to the captains for their views.

A similar format will be followed in subsequent interviews unless the scientific authority or Radarsat Project office has any other particular topics or issues of concern that should be raised.

1.3 Report Organization

This report is presented under headings related to the primary objective of the task to determine the role of the present and proposed information products in routing decisions. Section 2 summarizes the comments made by the captains on the various ice and ocean information products with subheadings by product type. Overall preferences and general issues of concern about the products complete the chapter. Section 3 details the use of ice information in operational decision-making discussing the criteria used by the captains. Section 4 lists the conclusions and the impressions of the writers in assessing the statements by the captains to the context of the Radarsat project.

2. REVIEW OF INFORMATION PRODUCTS

During each interview the captain was shown examples of the proposed information products as presented in Radarsat report 82-9, "Information Products Required for Ice and Ocean Operations". This report discussed the form and characteristics of information products needed by the collective ice and ocean user community, and included 11 proposed products listed as follows:

(1) Ice imagery and interpretive charts
(2) Current ice analysis chart
(3) Ice ridge distribution chart
(4) Forecast ice concentration/thickness chart
(5) Forecast ice drift/pressure chart
(6) Iceberg location maps - nowcast and forecast
(7) Vessel location map
(8) Wave data charts - nowcast and forecast
(9) Sea surface temperature chart
(10) Ocean features analysis chart
(11) Ice accretion chart

Examples of products 1-6 were shown to the captains for their review and comment. Products 7, 9 and 10 were of minimal interest while product 11 was discussed in concept only, since no example was available.

Comments on the products from each captain could be classified under one of three responses:

(1) Product was desired for operational use
(2) The product was desired but the effort to produce it to be useful and timely was not worth it or there was a skepticism on its validity.
(3) The product was unnecessary or a duplicate of another product.

Table 2 shows the breakdown of responses for each product from the 13 interviews so far conducted. A few individuals had no comment to make on particular products and these are totalled separately.

Most of the individuals accompanied their responses with a number of caveats and/or conditions for their acceptance of the product or defined reasons for their lack of support. The responses in the table must be considered in light of these commentaries to obtain a better understanding of the results.

It is interesting to note that the imagery and interpretive charts as well as the current ice analysis chart were unanimously wanted. The lone negative response to the imagery was voiced by the captain of a search and rescue ice-strengthened ship, who believed his vessel would not get the required receiving equipment to obtain the imagery. The response to the current ice analysis chart was not surprising since all are familiar with it and have used the chart operationally for some time.

Opinion on the remaining products, once the no comment figures are discounted, is split on their usefulness and desirability. Virtually all the individuals stated the accuracy of the forecasts will have to be proven before much use is made of these products. Information on ice ridging beyond what is stated on the current ice chart was desired by some captains, but others questioned the level of effort required to produce the product and to keep it current. The principle of an iceberg distribution chart was supported by a majority of people, although its format and presentation should be changed.

TABLE 2

SUMMARY OF RESPONSES TO PROPOSED INFORMATION PRODUCTS

INFORMATION PRODUCT	DESIRED	DESIRED BUT EFFORT NOT WORTHWHILE OR SKEPTICAL ON VALIDITY	UNNECESSARY OR REDUNDANT	NO COMMENT
ICE IMAGERY/ INTERPRETIVE CHART	12	1	0	0
CURRENT ICE ANALYSIS CHART	13	0	0	0
ICE RIDGE DISTRIBUTION CHART	5	2	3	2
FORECAST ICE CONCENTRATION/ THICKNESS CHART	6	5	1	1
FORECAST ICE DRIFT/PRESSURE CHART	6	4	2	1
ICEBERG DISTRIBUTION CHART	7	2	1	3
WAVE FORECASTS	4	0	2	7

The wave nowcast and forecast charts were acknowledged to be important by some captains, but the majority had little to say about them.

The following subsections detail specific comments on each product.

2.1 Ice Imagery and Interpretive Chart

When the SEASAT imagery examples were shown to the captains, virtually all were impressed with the quality and detail available. If such a product could be delivered to the ship with comparable quality and timeliness, it would be very much wanted. All agreed that a latitude/longitude grid would be helpful in determining their position within the imagery. Two of the captains would also like to have a zoom and roam capability to focus in on specific areas. A few also wanted to have a scale indicator.

A majority of the captains wanted the interpretive chart with the imagery albeit for differing reasons. Some would like to have the chart in case the imagery was blurred on reception. Others wanted the chart so that they would not have to interpret the imagery themselves. The provision of an ice interpretive chart in the code which they already understand would reduce the time to integrate the information into their planning.

2.2 Current Ice Analysis Chart

This product generated the most comments mainly because it is presently the primary product of the ice information system.

All the captains and the ice operations center wanted to receive the chart. Most made the point that the present turnaround of information (in the neighbourhood of 24 hours) must be improved. Because of the long turnaround, the charts have been found to be less accurate because the ice situation has changed. The poor turnaround also makes detailed maps of ice conditions less useful. If the turnaround time cannot be reduced, then there should be much less emphasis on detail.

The current ice analysis chart as shown in RPO report 82-9 depicts the ice conditions using the old standard ice code. Since that time a new international code describing ice conditions known as the egg code has been introduced into the ice information service. The new code allows for a much more detailed description of ice conditions shown within an egg-shaped figure. This code has been internationally agreed to and was implemented in the spring of 1982 by the AES Branch. Most of the captains did not like the code but thought they would get used to it. Many expressed the opinion that the code would unnecessarily clutter the chart, and, if the reception was blurred, which it is sometimes, the chart would be far less useful. The detail of information was unnecessary in relation to its age according to the captains.

Three suggestions were made in regards to providing additional or different information on the chart:

(1) Specific locations of multi-year bits and floes, especially in areas in which such occurrences are unexpected.

(2) Better indication of specific floe sizes, especially in the channels of the Arctic Archipelago where the ships must decide in advance whether to go through the floes or negotiate around them.

(3) Better indication of the location and persistence of leads especially in nearshore areas.

2.3 Ice Ridge Distribution Chart

A major problem many captains had with this chart was that it would require a large effort to produce, and that the information would age rapidly given the dynamics of the ice. Most of the negative responses to the produce were for that reason. A couple of the captains expressed the view that ridge encounters were inevitable and that the product would not provide sufficient detail for individual encounters. One captain thought enough ridging detail was provided in the current ice chart and that the proposed product would be an unnecessary duplication.

Those captains that supported the idea of a ridge distribution product suggested some changes in the format and presentation. Most wanted the product to be more pictorial rather than a series of numbers which must be read and interpreted. Ridging density could be represented by contours or enclosed areas of high, medium and low ridging. A more pictorial presentation would be easier to use if the received chart was blurred.

One captain suggested the chart should include an indication of active versus old ridging areas.

2.4 Forecast Ice Thickness/Concentration Chart

Those captains who did not agree with the idea of such a product were skeptical of forecasts in general. They simply were not confident in the ability of the ice service to provide accurate forecasts. Acceptance of the product by supporting individuals were provisional on its accuracy which must be proven. As the accuracy of forecasts is demonstrated, the captains will rely on them more and more.

Forecasts durations should be 24 hours for the Gulf of St. Lawrence and up to 48 hours in the Arctic. These limits were set by the captains in regard to the conduct of their operations. For example, some of the icebreakers are supplied assignments every 24 hours so that planning of their routes and activities does not go beyond that time. The forecasts of ice concentration should be updated every 12 hours or so, according to some of the supporting captains. Ice thickness could be recalculated on a weekly basis. Most of the supporting captains liked the hatched format but felt the numbers depicting thickness should be eliminated.

2.5 Forecast Ice Drift/Pressure Chart

The same captains and individuals who were against the forecast concentration chart were of the same opinion for this product. Almost all individuals agreed the parameters were extremely important to know for a ship operator, but the means to predict pressure events and dangerous ice movements was better determined by assessing the on-site conditions and drawing upon past experiences, according to the dissenting captains.

Those captains who wanted the chart thought it would be a very important product for their operations, if it was accurate. The inaccuracy of this forecast product, if followed by the captain could have more serious consequences than a wrong forecast of ice concentration. Pressure was deemed to be a primary concern of most of the captains. Pressured ice can stop the advance of even the largest icebreakers and can seriously hamper their operations by trapping ships in the ice or in harbours for example.

The presentation of the information as high, medium and low pressure areas along with drift vectors was an acceptable presentation to the supporting captains.

2.6 Iceberg Distribution Chart

A majority of captains desired some form of an iceberg distribution chart. The problem with the proposed chart format was that it would be difficult to interpret without considerable study so it would be less useful in its numeric form. A further concern was raised on its usefulness should the chart be blurred on reception and the numbers cannot be read. Some captains would not trust the line delineating zero icebergs; one captain suggested there should also be a limit of visibility line for the presumed boundary.

Dissenting captains claimed the product and its probable turnaround would not be very useful since the icebergs will have moved. Like the ridge product, the effort to collect and process the information would not be worth the effort since it ages so rapidly. As well, icebergs are a hazard to be dealt with on an individual rather than collective basis. Close vigil and ship radar would minimize collision more effectively than a dated strategic overview of all icebergs, in the view of some individuals.

2.7 Wave Data Charts

Only a few of the captains mentioned the METOC wave charts in the conduct of their operations. In some cases, such as the search and rescue vessels, their operations are limited in open water to within 50-100 miles of the shoreline. They do not need to use the charts because of their limited operations area and their search and rescue function which is to get to the site of the emergency as quickly as possible.

There was general satisfaction with the wave charts in format and information content. One captain wanted forecast information on heavy swells which he would avoid since the icebreaker is optimized in its design to transit in ice.

2.8 Overall Issues of Concern

The issues regarding the provision of information products in general included concerns regarding:

1) The number of information products
2) The transmission and reception of the products on ship
3) Timeliness

Some of the captains expressed the opinion that there were probably too many information products to be able to use them all effectively in an operational manner. The time to receive a chart by facsimile takes approximately 18 minutes. If six or seven products were to be received, the transmission/reception would take up to 2 hours of the day which would hamper their activities. One solution might be to receive the charts earlier in the day, but this would require overtime for the radio operator and, given budgetary restrictions, this may not be possible to implement.

A second difficulty with the large number of products which is experienced now is the variable quality of the received charts at the ship end. Some charts arrive blurred and fuzzy so as to make them virtually unreadable and useless, or sometimes the current chart is not received at all.

The last overall concern related to the turnaround of the information products commented upon earlier in this report. Faster turnaround is vital to keep the information accurate.

3. USE OF ICE INFORMATION IN OPERATIONAL DECISION-MAKING

As one captain said, "The use of ice information by icebreaker captains does not lend itself to categorical statements. Much depends on the environmental circumstances at the time and the skill, experience and common sense of the commanding officer".

When the writers attempted to probe the captains on how they make use of the provided ice information, the answers were almost as numerous as the number of captains. Each has his own unique style of operation and importance he places on the various information sources at his disposal. For ice-breaker operations, there are few set procedures primarily because every situation is unique and discretion is left to the captain.

3.1 Factors Used by the Captains

When planning the activities and routing for the day, most captains first consider the capabilities of the ship at their command. The following parameters of the ship must be weighed against the prevailing ice conditions:

1) available horsepower
2) type of propulsion system
3) maximum speed
4) hull strengthening

Available horsepower and hull strengthening are two key factors in assessing the icebreaker capability to deal with a given set of ice conditions. For example, the captain of the Pierre Radisson a river class icebreaker, would consider breaking through large second year floes whereas he would try to steer around large multi-year floes, chiefly because of the ship capability. Smaller icebreakers obviously take fewer chances and cannot handle heavier ice conditions, so their deployment and function are more limited. A small icebreaker may be tasked to clear a harbour where ice conditions are presumably less severe while a heavy icebreaker would remain in the main ice body escorting ships.

The next point of consideration is the mission or assignment of the ship. If the function is to escort another vessel, the captain must know the latter's ice capability, available power as well as its captain's familiarity with local conditions and procedures. One captain said the stopping capabilities of the escorted vessel were important because the icebreakers can stop very fast. Thus a ship would have to follow the icebreaker far enough away to be able to stop to avoid collision, but as well the forward progress must be slow enough to ensure the escorted vessel benefits from the broken ice track. If the ice is pressured, this track may close quite quickly and so the escorted vessel must closely follow the icebreaker. In such a case the speed would then have to be reduced to allow sufficient stopping distance between the ships.

Whether the escorted ship is foreign or domestic is also important. Foreign vessels are usually less knowledgeable about environmental conditions and have less capability in ice, while domestic ships are better equipped and the masters more familiar with conditions in the area.

The ship's mission is also defined in terms of the geographic location and the ultimate destination. Distances in the Arctic are generally much greater so there is a need to obtain information over a wider geographic area and projections over a longer timeframe. Progress is slower in the Arctic than in the Gulf of St. Lawrence, particularly for the heavier icebreakers which engage the more difficult ice conditions.

In the Gulf of St. Lawrence, icebreaker operations are far more controlled than in the Arctic. The ice operations center (IOC) in Dartmouth is responsible for deploying and directing icebreaker operations as well as to recommend routes in the Gulf for the winter shipping season. The icebreakers must adhere to the set routes and generally do not deviate from them unless an unescorted ship is trapped in ice away from the recommended routes. The IOC receives ice and weather information from AES which it then uses to create its own forecast of ice conditions. Based on these projections, the IOC will adjust the routes as necessary to take advantage of favourable conditions, provided these conditions will persist. In the Gulf it takes some 48 hours to redeploy the icebreakers, so the center tries to stick with a route as long as possible to minimize disruptions.

Routing decisions in the Gulf are made on the basis of prevailing winds, ice concentrations and past experience. Operations from previous years have determined for the most part the preferred routes at differing times of the year. Decisions on whether to go north or south of Anticosti Island would be an example. Prevailing winds and ice concentrations determine high pressure and probable heavy ridging areas which are to be avoided.

Ship routing in the Arctic is left much more to the discretion of the individual captains. If a commercial vessel accompanies an icebreaker, then the IOC does not route the vessel. Responsibility for escorting and routing is switched to the icebreaker. Most captains in their decision-making process first consider the ship and its itinerary as mentioned before. Environmental information on ice and weather is then consulted. It is at this point that the style and experience of the captain determines the procedures to be followed. There are essentially five sources of information at his disposal:

(1) ice charts
(2) weather charts and forecasts
(3) helicopter reconnaissance
(4) information from other ships
(5) captain's experience and knowledge of local conditions

The degree to which each is used is highly dependent on the captain. Most consider the ice charts to provide an overview of the ice conditions and think that excessive detail is not necessary for its intended purpose. One captain gets the ice observer to colour code the ice chart in differing colours depending upon ice conditions. Difficult areas are coloured blue for example while easier areas are yellow. The captain then plans his route to avoid blue areas and steer into yellow ones whenever it is possible. In essence, the captain is simplifying the information and putting it into a form which he can use practically. Some of the charts transmitted from the aircraft during a tactical support mission can be used for quite detailed routing because the information is recent and it is detailed according to some of the captains.

Most of the captains rely on helicopter reconnaissance when one is available for the detailed, mile-by-mile routing. Usually the ice observer and the chief officer go on the helicopter. The function of the ice observer ranges from confirming ice observations made by the chief officer (who also recommends routing) to actually performing the recommended routing function. Most of the captains see additional benefit in sending the chief officer to obtain experience in examining and recommending routing through the ice, as well as in observing the ultimate routing decisions made by the captain.

Captains on the smaller icebreakers and ice strengthened search and rescue vessels apparently rely more on ship reports plus tactical reconnaissance from larger icebreakers. One captain estimated he saved 1½ day's sailing by communicating with an icebreaker ahead who had been through the area.

Virtually all of the captains said that the information provided to them must be weighed against their previous experiences and plain common sense. For example if there is a nearshore lead with an on-shore wind, it is highly probable the icefield will close the lead in a short time. The icebreaker would then steer a course further away from shore within the icefield so that if and when it moves towards shore, the ship will have sufficient bathymetry to avoid grounding.

Such decisions require a prediction of the incoming weather conditions, since many dangerous ice situations are created in part by unfavourable winds. A majority of captains said weather information was very important; some thought it of equal importance to ice information. The parameters of greatest interest are the location of high and low pressures to determine expected wind direction as much as speed. Despite this information most captains will combine this knowledge with the local wind conditions to judge in their own minds what will occur.

Several captains expressed concern that future provision of comprehensive ice information may be to the detriment of the mariner, especially if it replaces sound principles. The tendency for less experienced mariners may be to put too much emphasis on the information in making routing decisions. Should something go wrong, the information may be blamed when in fact the difficulty may be caused by a lack of common sense.

3.2 Dangerous Ice Situations

Most captains concurred that the most dangerous situation for ships operating in ice-frequented waters was when concentrations of ice are 2-3 tenths and lower. There is the greatest potential for ship damage to occur in these ice conditions. This is due to the tendency for ships to increase speed in such conditions when in fact the speed should be decreased. Should a ship impact with a multi-year ice floe at high speed, the ship will be damaged. One captain said an ordinary ship travelling at only 4 knots in open water would have a hole punched in it on impact with an ice floe. The same captain said he slows down his ship when in low ice concentration conditions. In heavier ice concentrations the ships go slower and so the threat of impact damage is reduced.

All the captains acknowledge the hazard of icebergs and growlers to the ship's safety. The danger is analagous to low ice concentration situations where a ship colliding with an iceberg could sustain heavy damage. When the icebreaker is in an area known to have icebergs, a visual watch is instituted and the ship's radar watched closely. Virtually all the captains expressed the view that they would not change their mode of operation with the proposed iceberg distribution chart in hand. This is primarily due to the nature of iceberg encounters which are individual and widely scattered ice features. The ship would take appropriate action only when the iceberg or growler is spotted. The speed of the ship would be reduced somewhat to minimize damage from impacts with growlers. The exception to these procedures would be for night operations or in fog conditions. In these cases, the ship would slow down to the limits of visibility and stopping distance of the icebreaker.

If the ship were outside the line of zero icebergs as depicted on the iceberg distribution chart, the captains would still maintain a constant vigil but continue with normal open water ship operations. Ship operations would be unaffected whether or not the ship was within the iceberg zone.

3.3 Commercial Shipping vs Icebreaker Objectives

Several icebreaker captains distinguished the operation of icebreakers from that of commercial vessels in the use of ice information. The commercial captain is tied to a schedule for his ship while the icebreaker operates under no such deadlines. According to the captains, these differing objectives lead to different attitudes towards ice and weather information. The Coast Guard captain's role is to ensure the safe passage of escorted vessels and to minimize any potential damage to his icebreaker or any other ship. For these reasons, the captain has a need to obtain proper ice information to help him meet this goal. The primary goal of a commercial ship operator however is to get the cargo to its destination within an allowed time period. Ice presents an obstacle which may not allow the achievement of that goal by delaying his arrival. According to one icebreaker captain, escorted commercial ships often lose time in continuous ice cover conditions which leads to the commercial captain trying to make up time in areas of more open water and low ice concentrations. He gave one example where an escorted commercial ship went ahead of the icebreaker in Hudson Bay in low ice concentrations and requested the icebreaker to speed up. The captain recognized the danger of ice impacts from the increased speed and advised the commercial ship to slow down which it did.

The skills and common sense of the commercial ship captain and his use of ice information may be curtailed in an effort to meet a tight schedule.

The commercial operator may also accept the incidence of ice damage to the ship as a cost in meeting the schedule whereas the Coast Guard captain avoids any damage wherever possible. The commercial captain could be tempted to sacrifice some basic mariner's principles to meet the schedule because if he doesn't do so, the company may replace him with someone who will. One of the Coast Guard captains gave an example for tankers operating in the Gulf of St. Lawrence. It is a policy within one company that the captain must try to negotiate through the ice when ready to leave a port even when ice conditions would likely entrap the ship and even if it was known the situation would improve within a day or two. The commercial operators are willing to take the risk of the possible trapping of their ship in the hope that for most cases the ship will get through and keep the schedule.

Such obsession with a schedule by commercial operators may in some cases lead to a reduced interest and use of ice information by these vessels, to their possible detriment.

4. CONCLUSIONS

1. From the interviews held with the Coast Guard captains so far, it appears that the actual role of strategic information plays in the operation of individual icebreakers is perhaps overestimated by outside observers. The degree of impact of the information provided by the current ice chart varies considerably between captains. It seems however that the majority of captains rely chiefly on the tactical reconnaissance provided by an on board helicopter, if it is on the ship. The experience of the captain is perhaps the key element in determining the degree of utilization of ice chart information. Many of the captains have worked on and commanded icebreakers for many years in all the operating areas so they know what changes in the nature of the ice cover can occur under a given set of local conditions. However, many of these captains are approaching the end of their careers and will be replaced by younger, much less experienced individuals. Without an equivalent base of experience, it is probable that the new captains will rely more on the information products in their routing and operational decisions.

2. The greatest beneficiary for improved ice information would appear to be the Coast Guard Ice Operations Center. Their operation is more strategic in nature. They have responsibility for a wide geographic area and have a primary routing function to perform which would be ably assisted by better and more current ice information.

3. The provision of better quality and more timely ice information to mariners should not overshadow the importance

of mariner's skills and common sense when it comes to making routing and operational decisions. It is probable that the ship master will never solely rely on the information and forecasts to make his decisions.

4. The extent of use of current ice information by CCG captains varies with each one and does not lend itself to definitive statements. However, the elements employed by the captains can be grouped under the following headings:

a) Ship horsepower and icebreaking capability
b) Type of mission or assignment
c) Captain's past experience
d) Common sense
e) Ice information - strategic and tactical
f) Geographic location
g) Ship itinerary and destination(s)
h) Weather forecast
i) Commercial vs government vessel

Each of these factors has a different weighting between captains although the first two are considered before all the others by all the captains. It can be seen then that ice information, that of a strategic nature that could be supplied by Radarsat is one of many factors, albeit a very important one. As concluded earlier, the weightings for routing and operational decisions will likely shift towards ice information with future less experienced captains.

5. REFERENCES

1. Radarsat Project Office (1982), "Information Products Required for Ice and Ocean Operations", Radarsat Project Report 82-9, Philip A. Lapp Ltd., May 1982.