

WINTER FLOW, ICE, AND WEATHER CONDITIONS OF
THE UPPER ST. LAWRENCE RIVER, 1971-81

VOLUME I: ICE COVER CHARTS

(PART A)

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ABSTRACT

The International Section of the St. Lawrence River between Kingston and the Moses-Saunders Power Dam near Massena is the outlet of the Great Lakes. This river is being utilized for hydro-power production and serves as the only navigation passage for shipping between the Atlantic Ocean and the Great Lakes. The river flow is regulated by the Power Dam, which is part of the St. Lawrence Project completed in 1959 as a joint venture of the United States and Canada. Planning for the winter flow regulation is closely related to the ice conditions in the river, which effect both the amount of power generated and the length of navigation season.

Due to interest in the effective utilization of the St. Lawrence, a number of agencies are engaged in collecting flow and ice data on the river. These data provide a valuable data base for ice modeling and management. In this four volume report, information on flow, ice, and weather conditions are assembled for winters between 1971 and 1981. Data for the four month period between December 1st and April 30th of each year are included. Major sources of data upon which this report is based are as follows:

<u>Agency</u>	<u>Data</u>
Power Authority of the State of New York, Massena	Water levels, discharge, and water temperatures.
St. Lawrence Seaway Authority, Cornwall	Ice thickness data.

<u>Agency</u>	<u>Data</u>
St. Lawrence Seaway Development Corporation, Massena	Ice cover mosaics, water levels, discharges, and water temperatures.
Ontario Hydro, Cornwall/ Toronto	Water temperature and ice thickness data.

The title and contents of each volume are:

- Volume I: Ice Cover Charts
 - Part A, 1971-76
 - Part B, 1976-77
- Volume II: Ice Cover Thickness
- Volume III: Water Level, Discharge, and Temperature
- Volume IV: Air Temperature and Precipitation

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CHAPTER I
INTRODUCTION

Ice cover charts provide useful information on the process of formation, evolution, and deterioration of the ice cover. These charts also provide quantitative estimates of sizes of open-water areas, which are important factors in the analysis of other ice and hydraulic parameters such as frazil ice production, hanging dam formation, and the variations of ice cover roughness. In this volume, ice charts for ten winters between December 1, 1971 and April 30, 1981 are included. These charts are compiled from ice cover mosaics made from aerial photographs provided by the St. Lawrence Seaway Development Corporation, U.S. Department of Transportation. Legends used for ice charts in this report are shown in Figure 1. Open-water areas are represented in two ways. The choice of symbols for an open-water area in each chart was made on the basis of clarity of the symbol. In a few cases, both symbols are used in the same chart. Boundaries are drawn to delineate the actual areal coverage of the air photo.

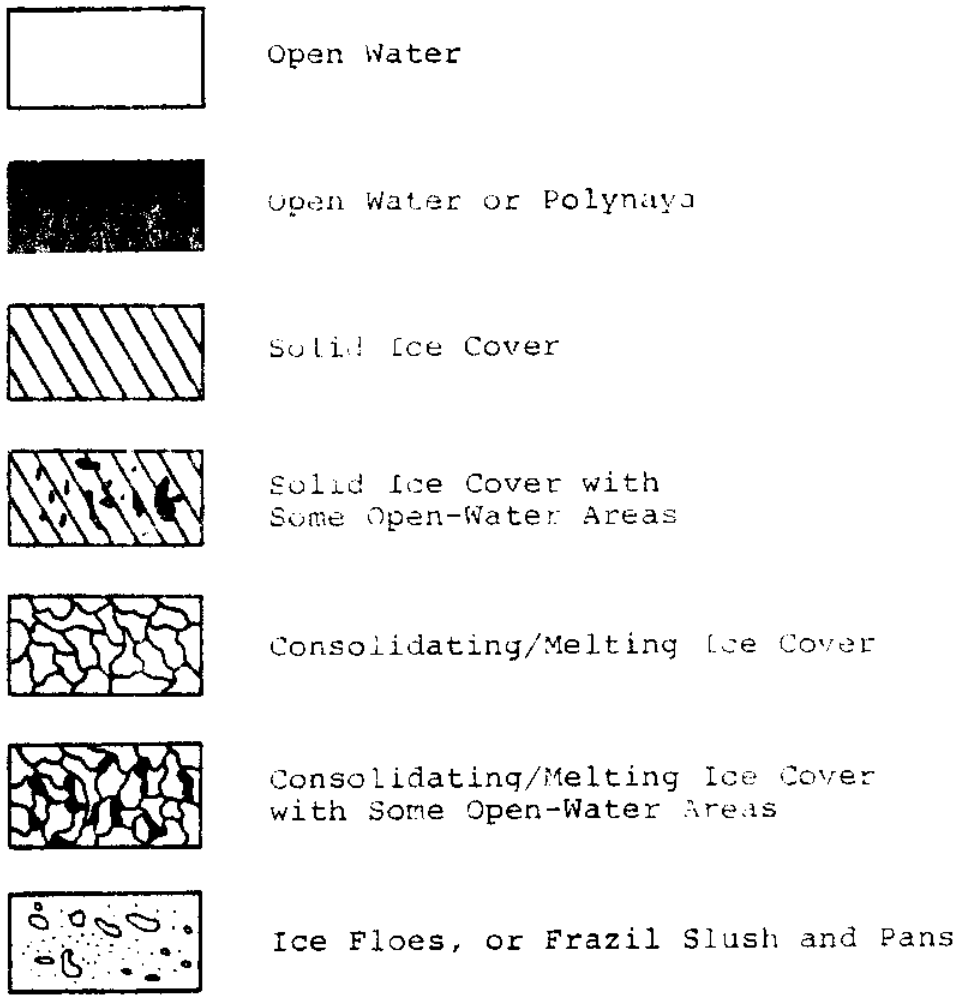


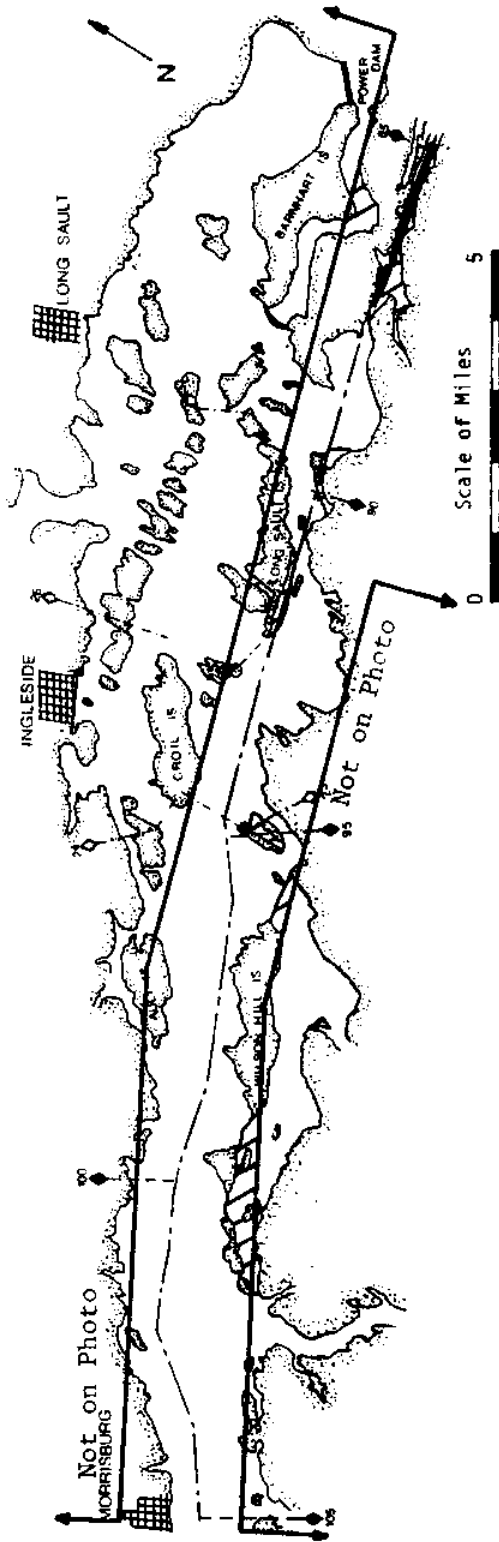
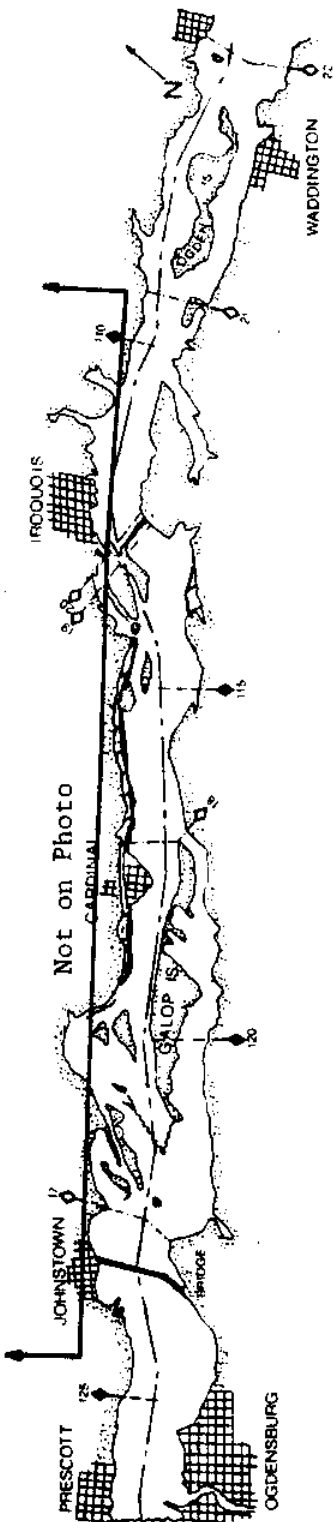
Figure 1. Symbols for Ice Charts

CHAPTER II

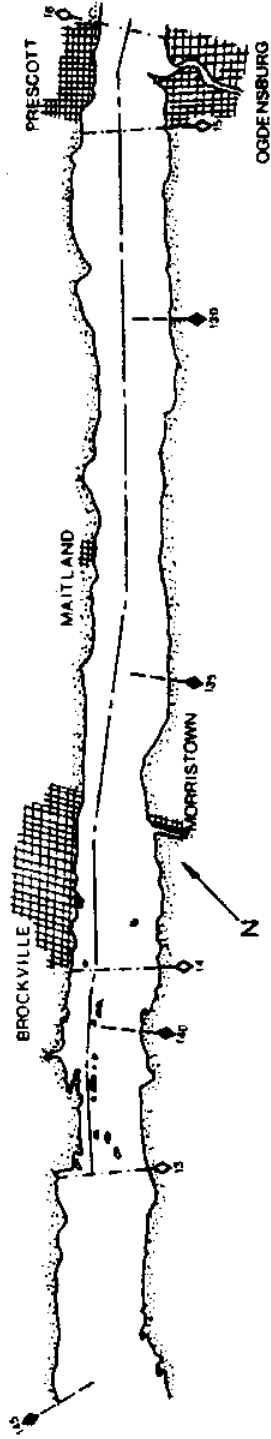
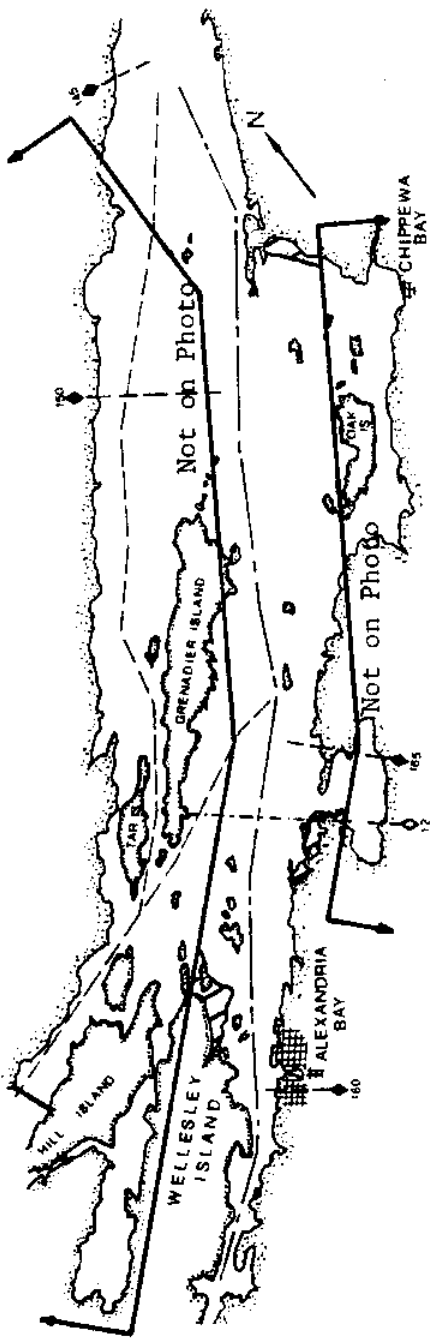
ICE CHARTS

Ice charts of the St. Lawrence River for winters between 1971 and 1981 are presented chronologically in this chapter.

Winter of 1971-72

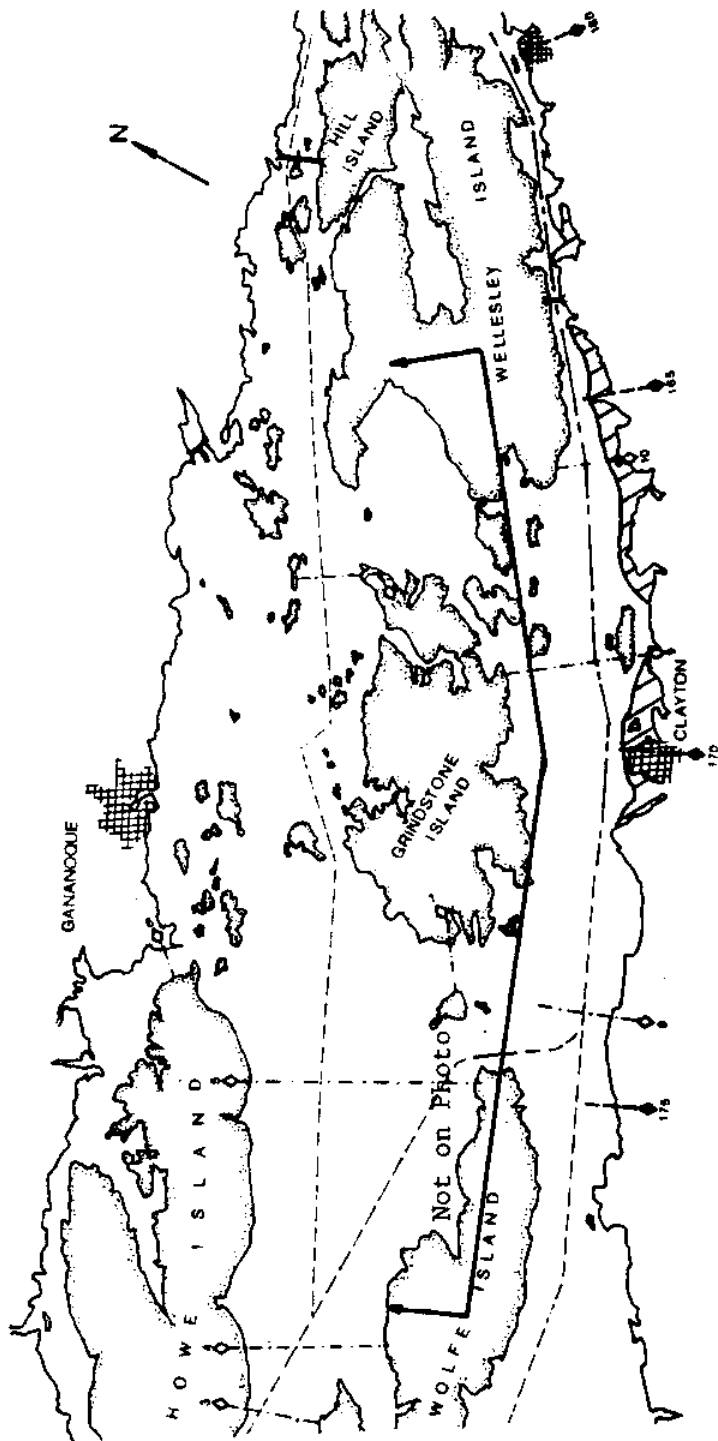


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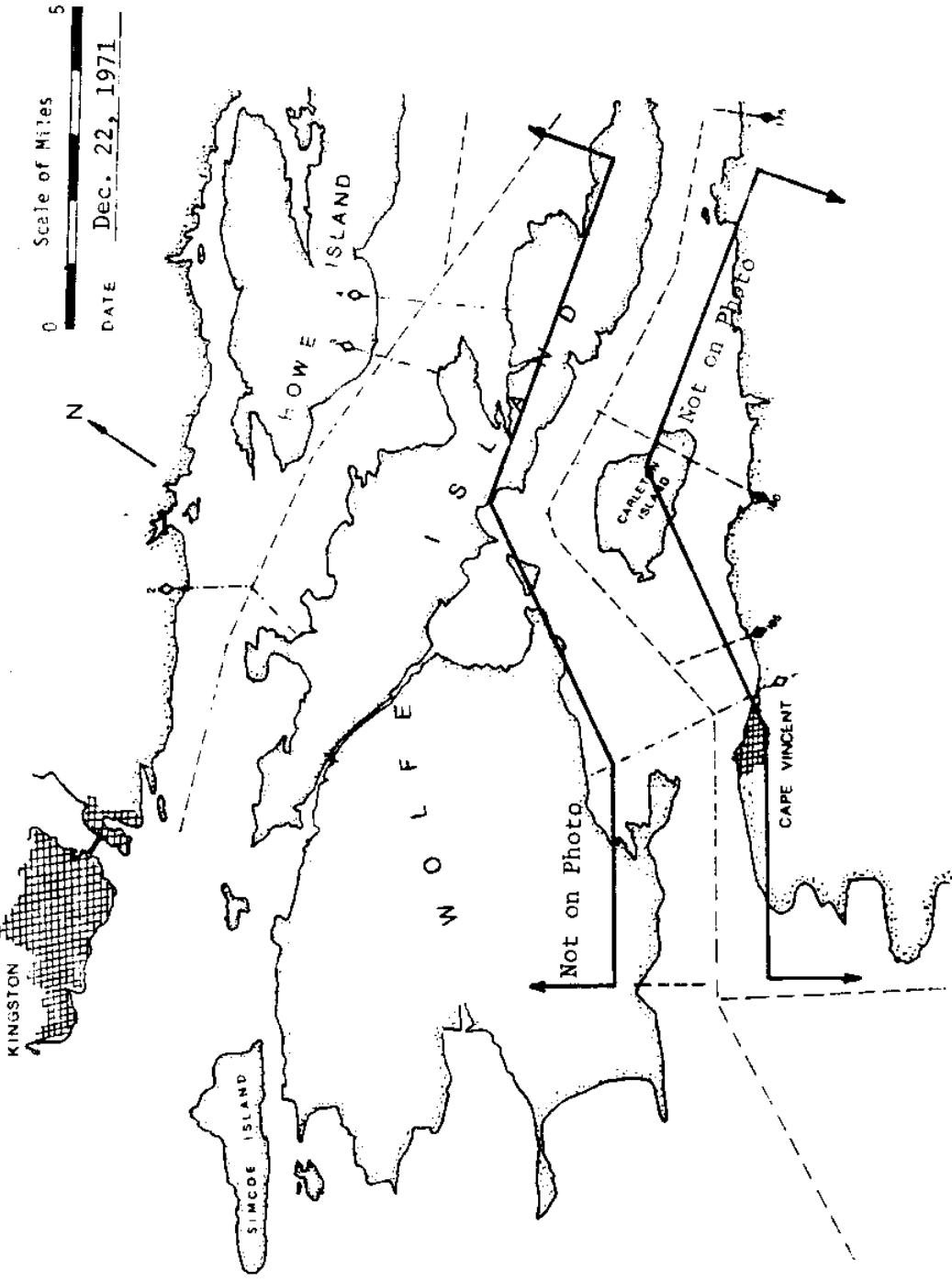
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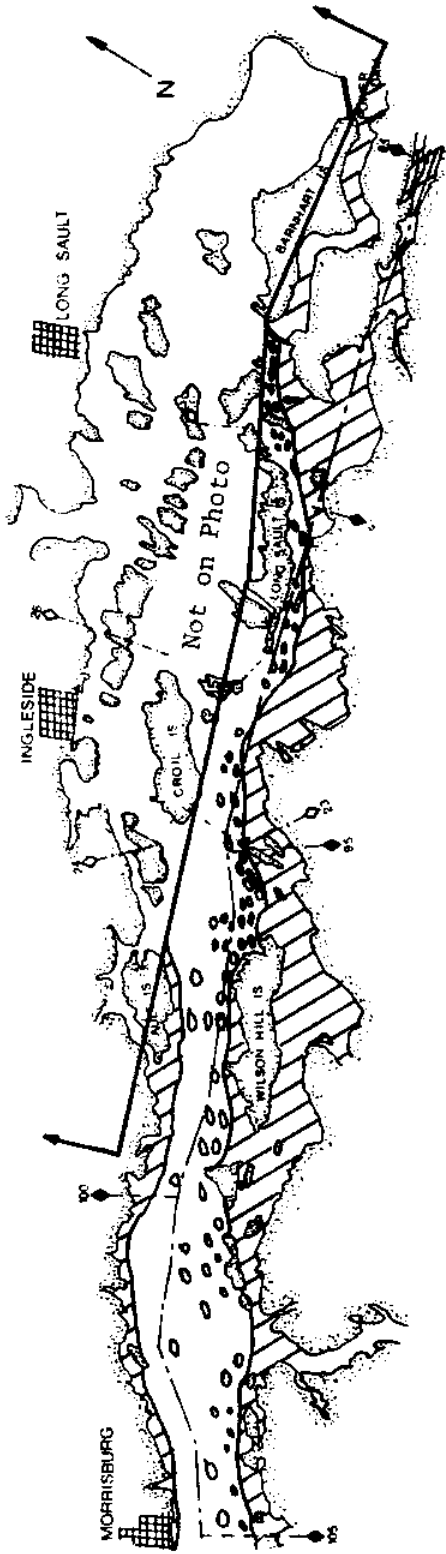
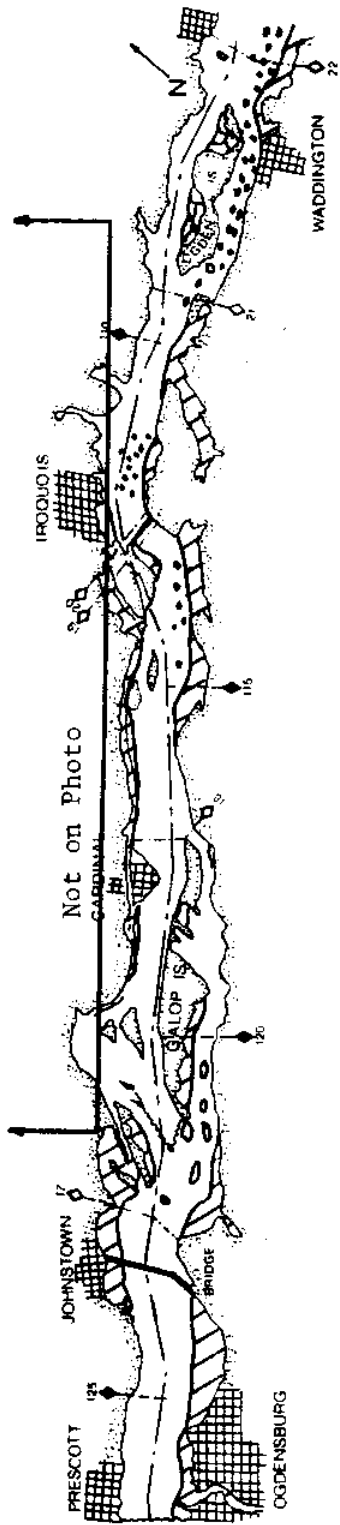
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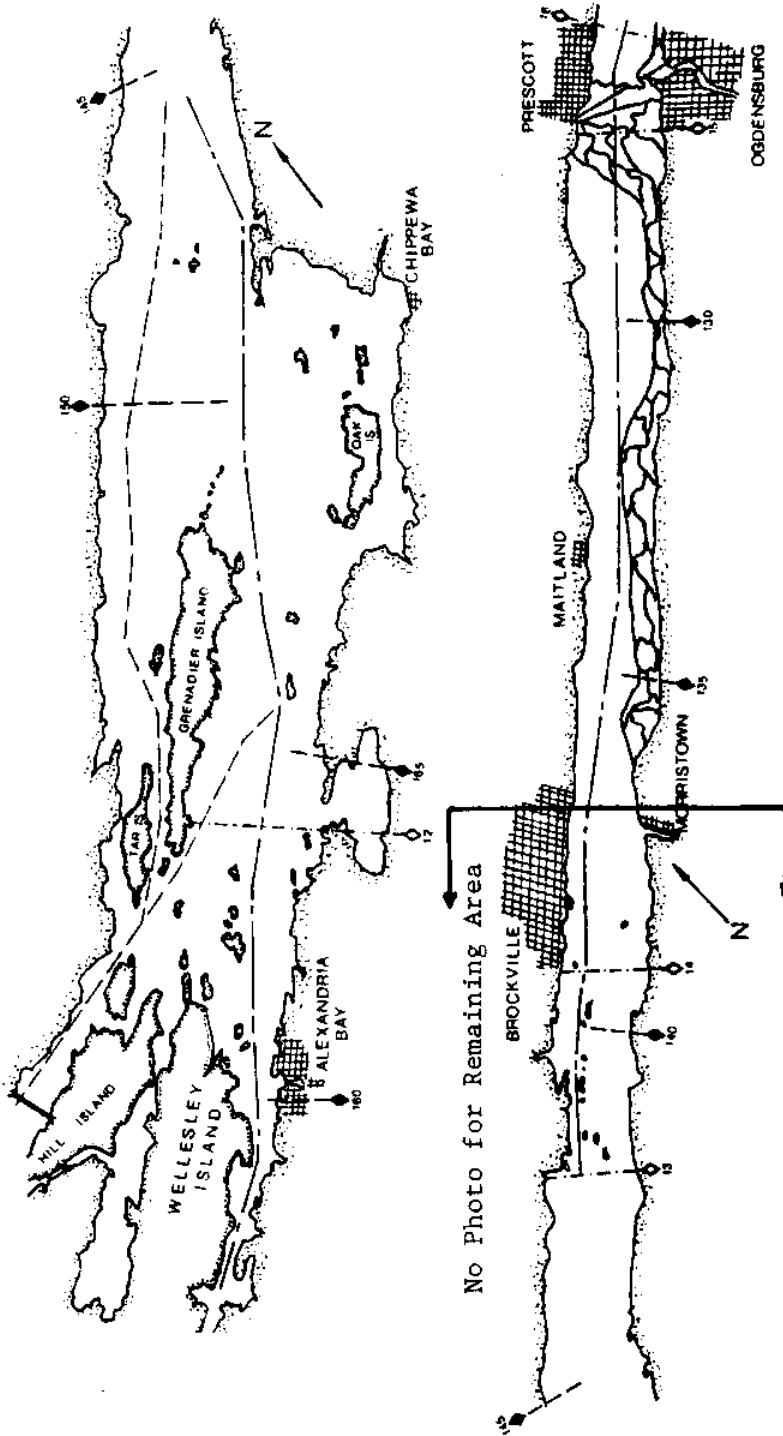


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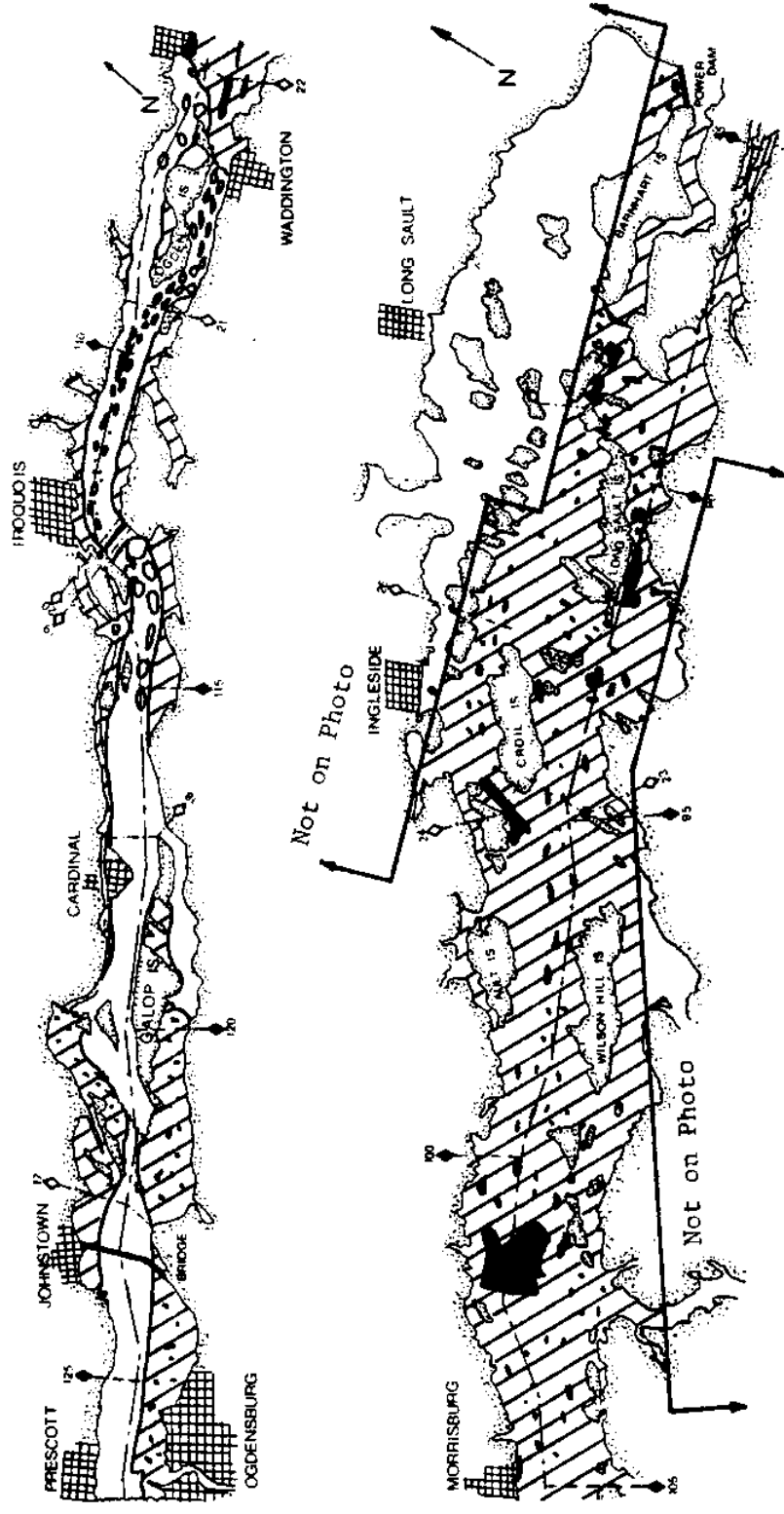






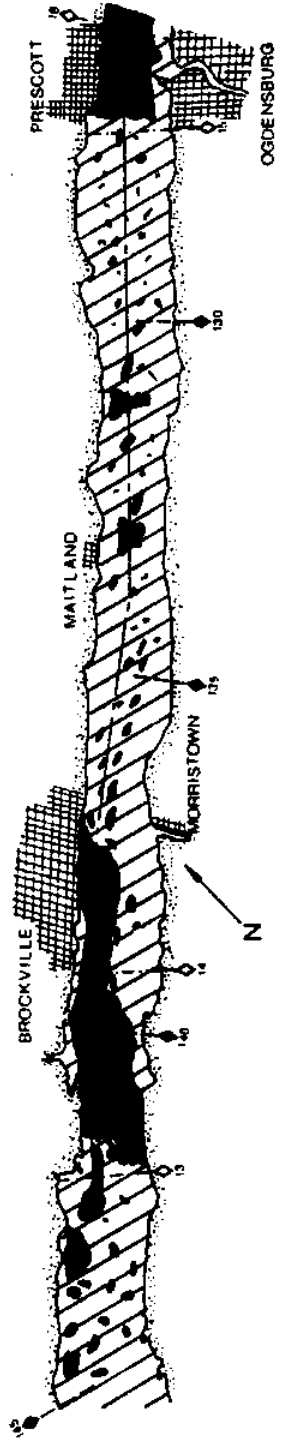
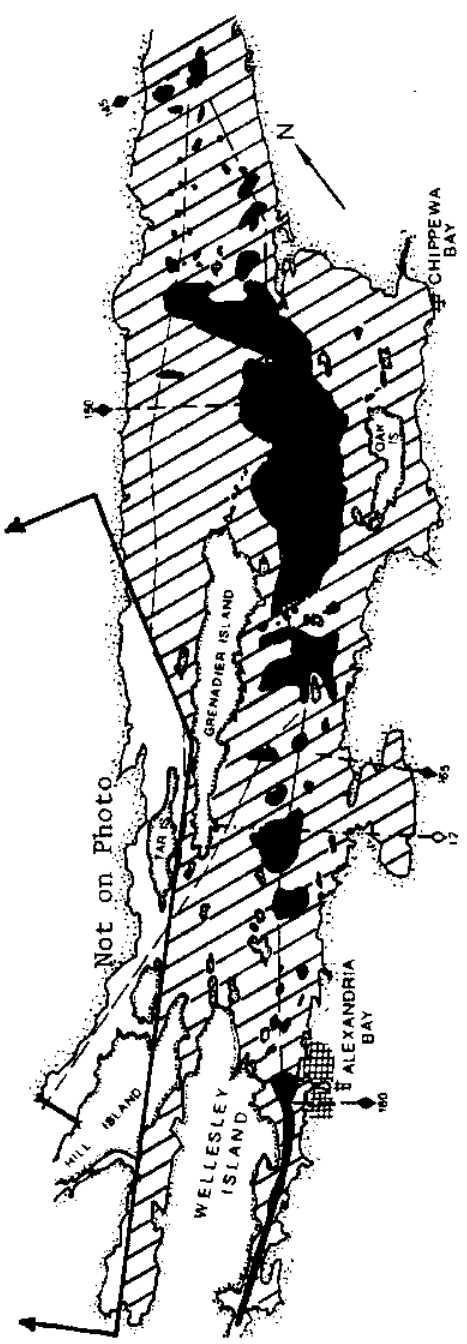
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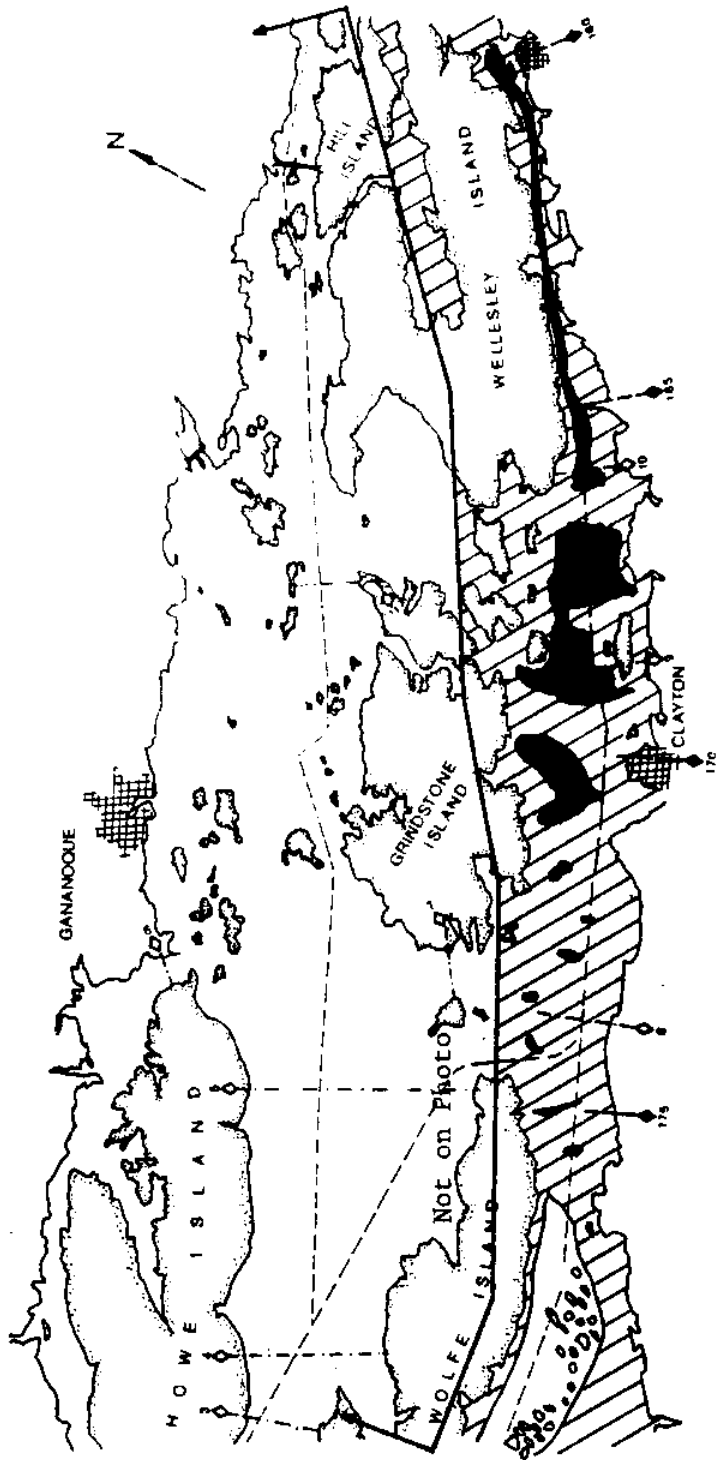


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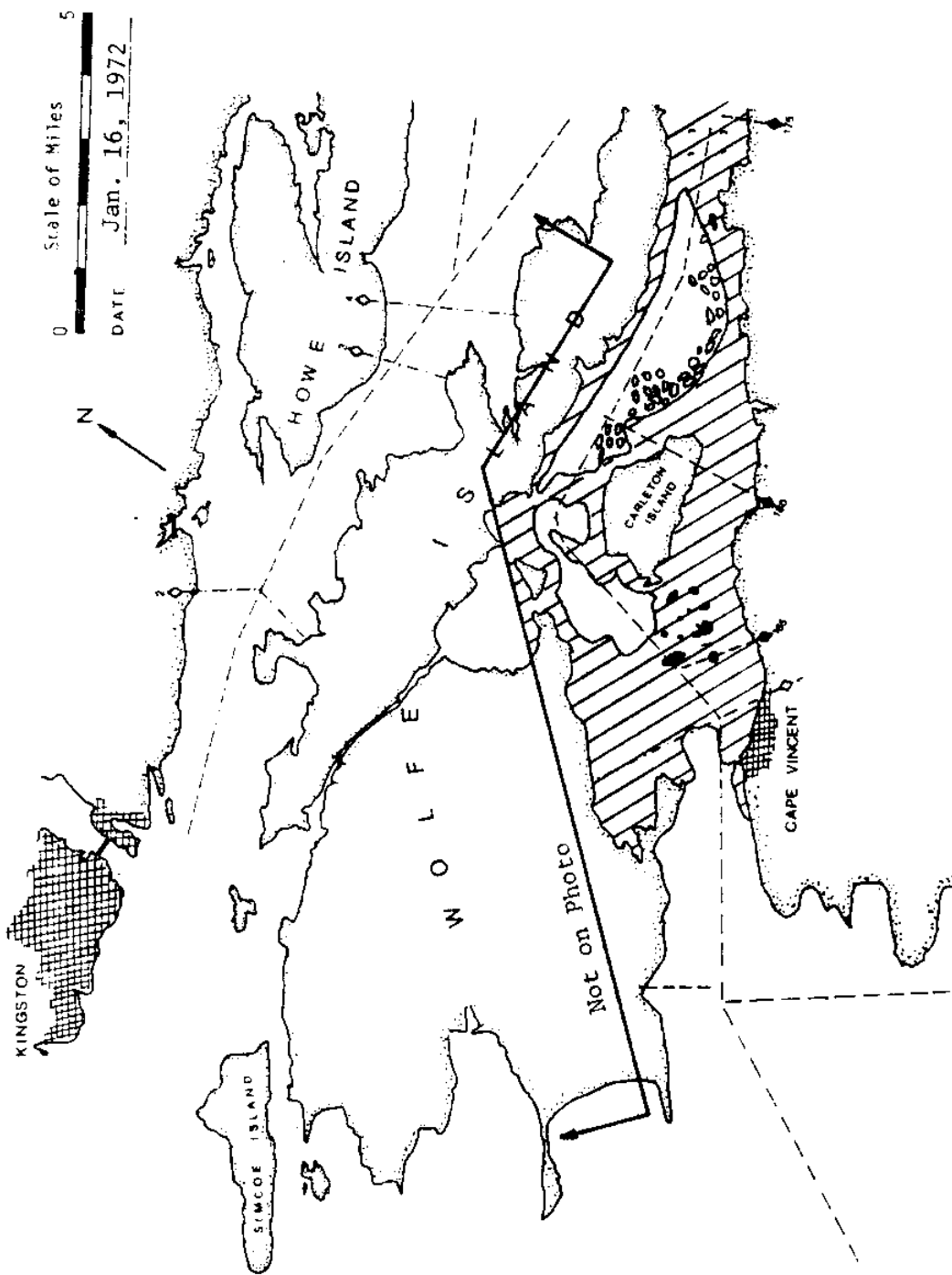


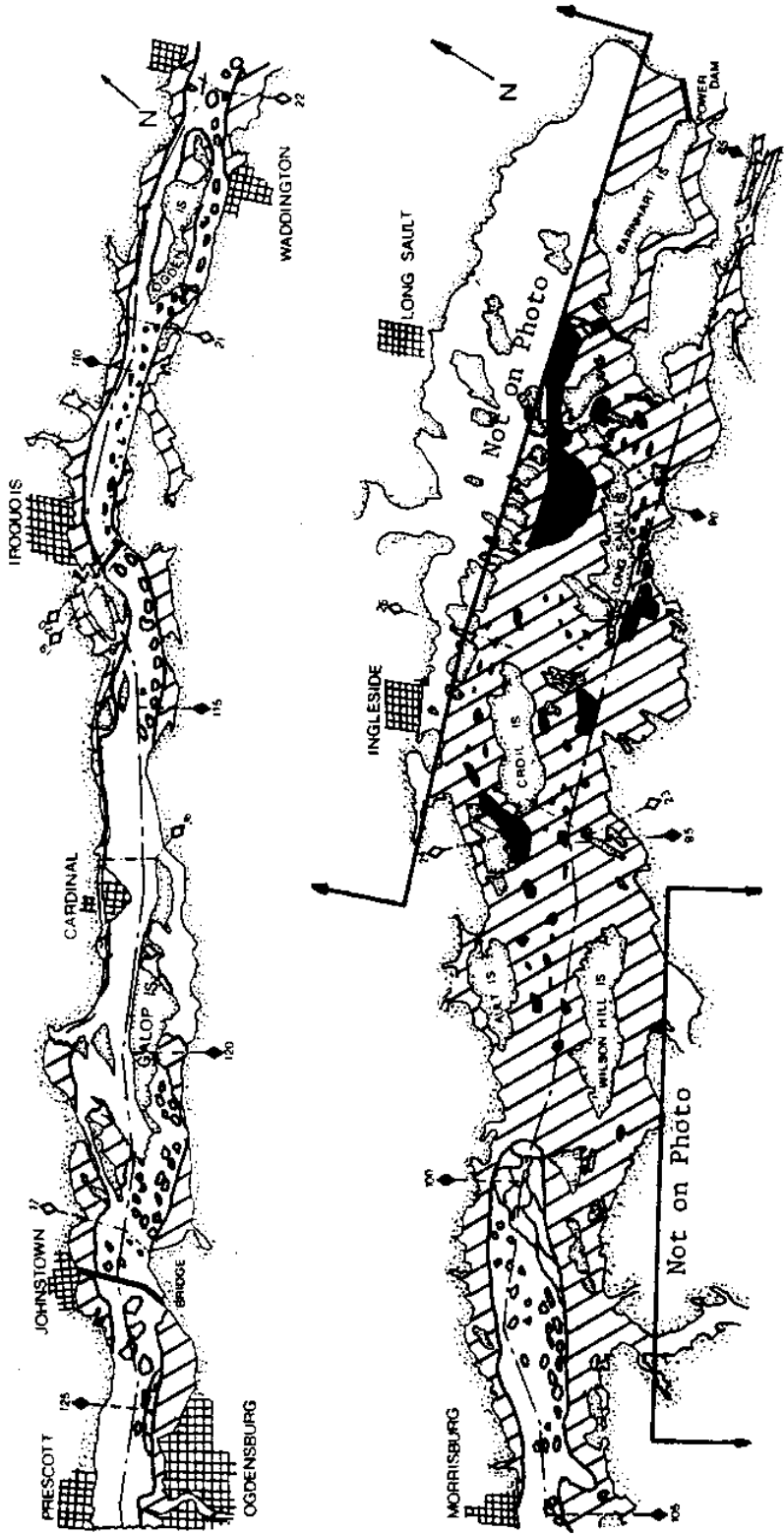
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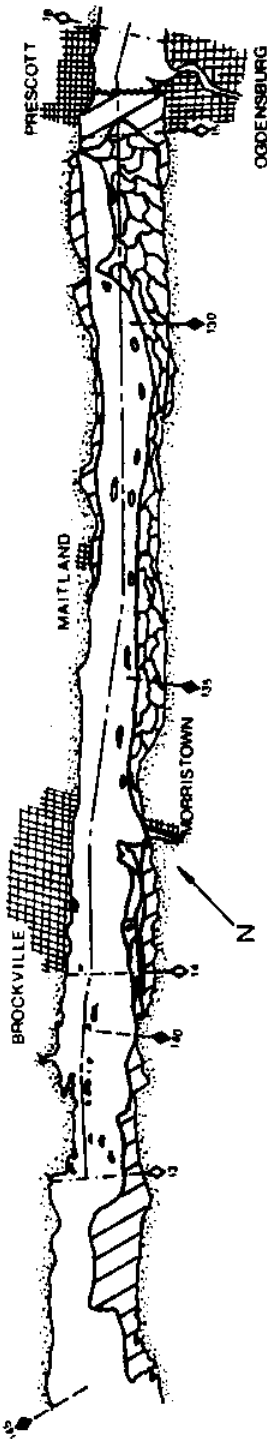
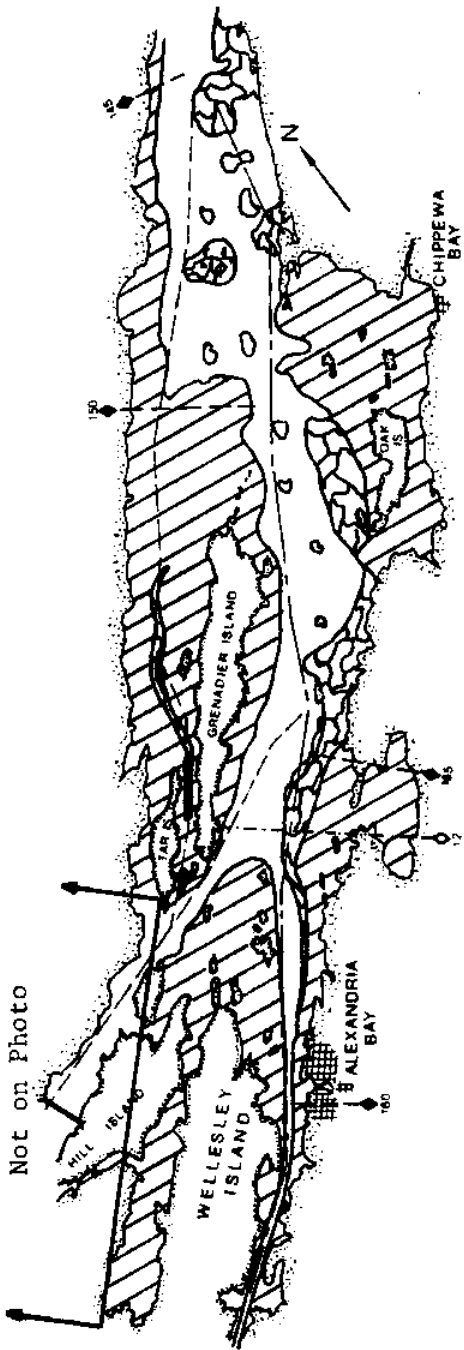




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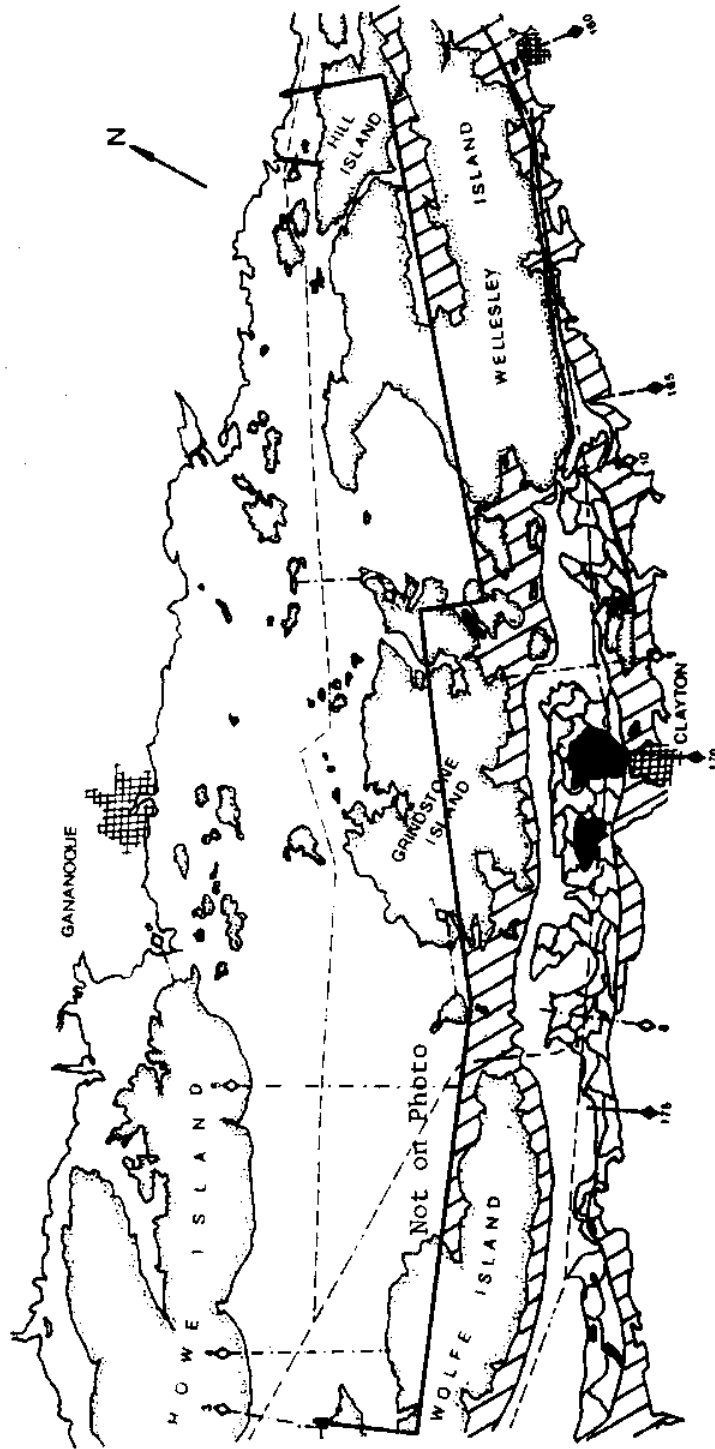
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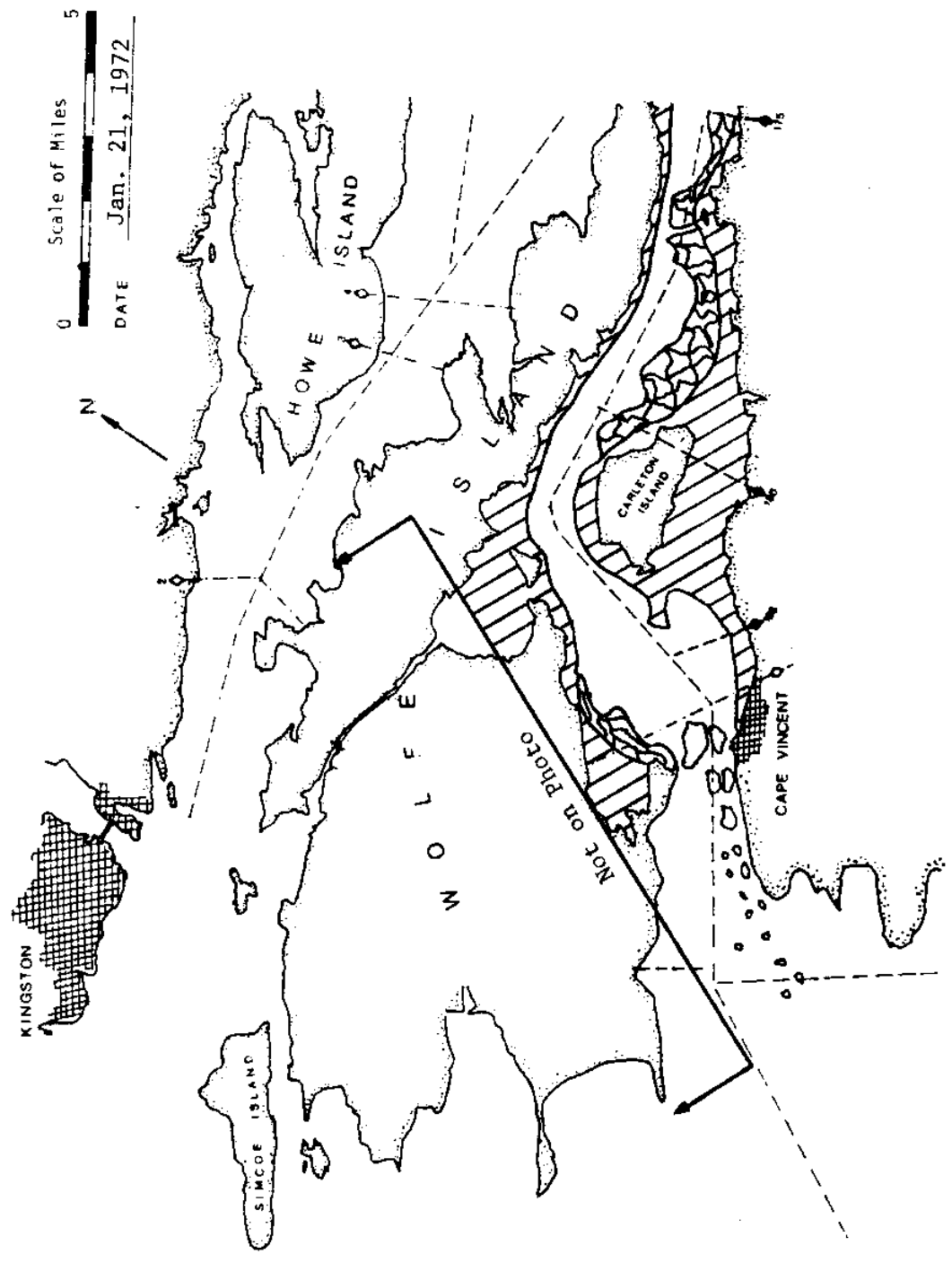


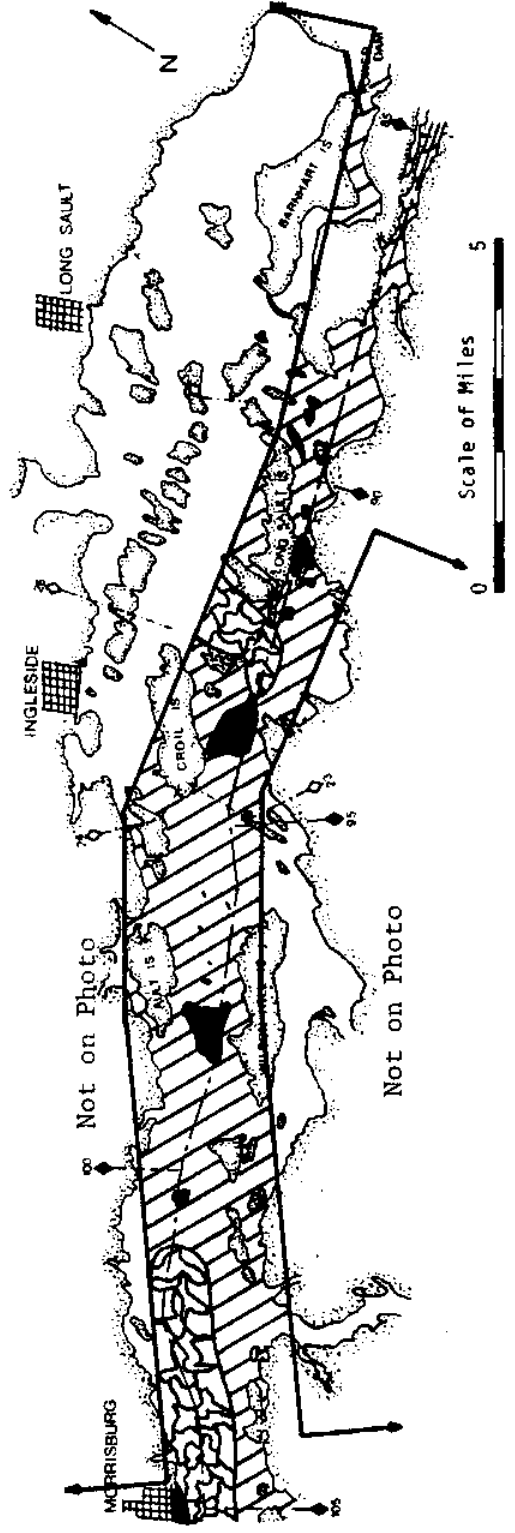
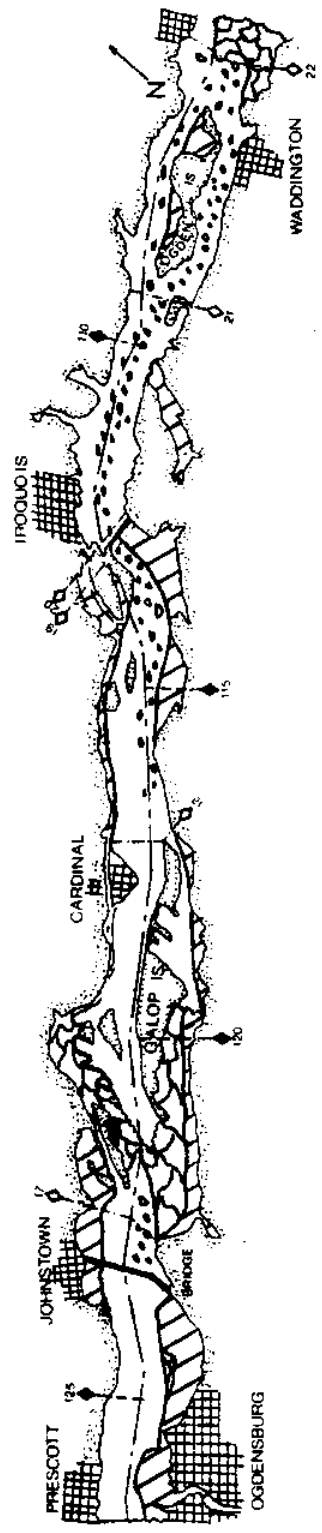
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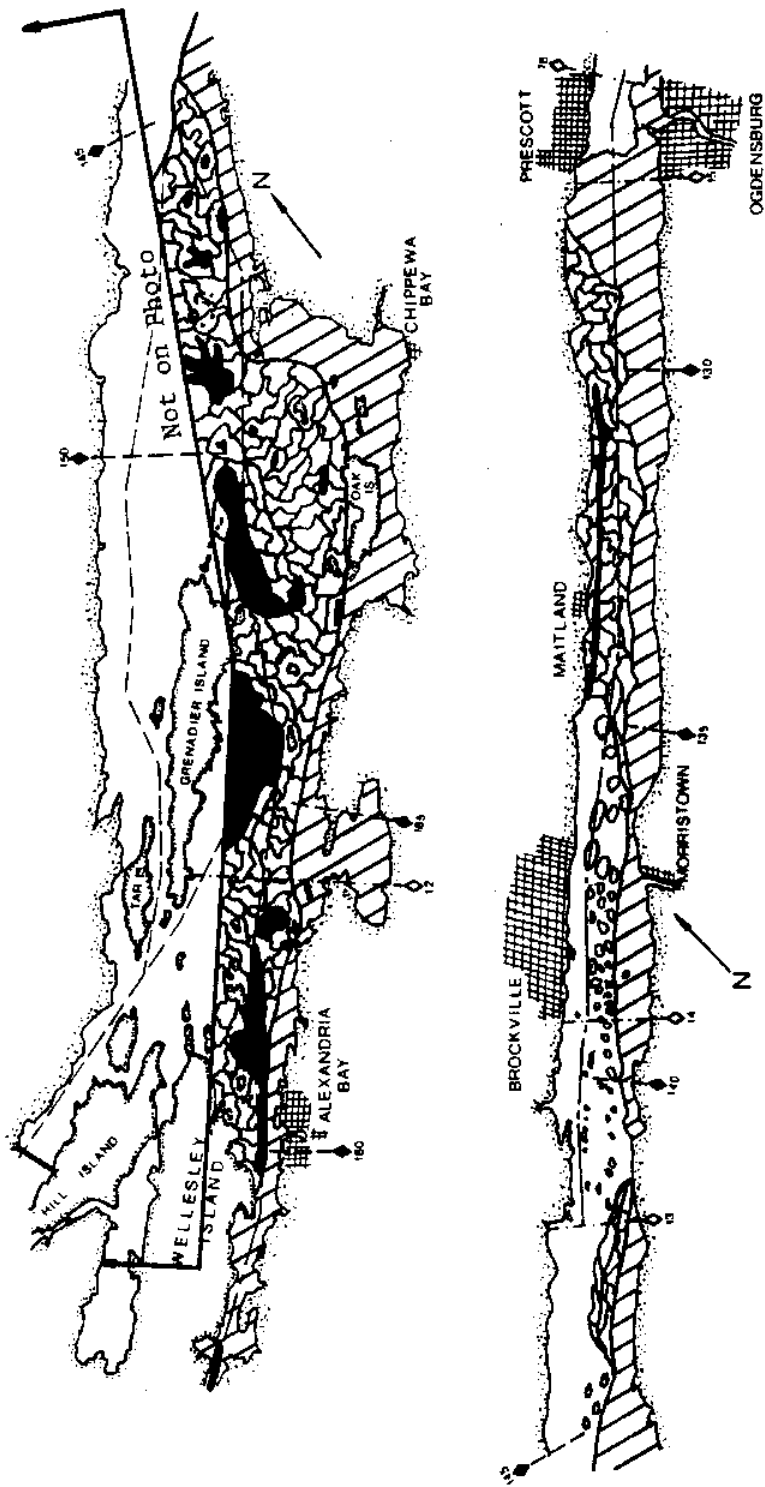
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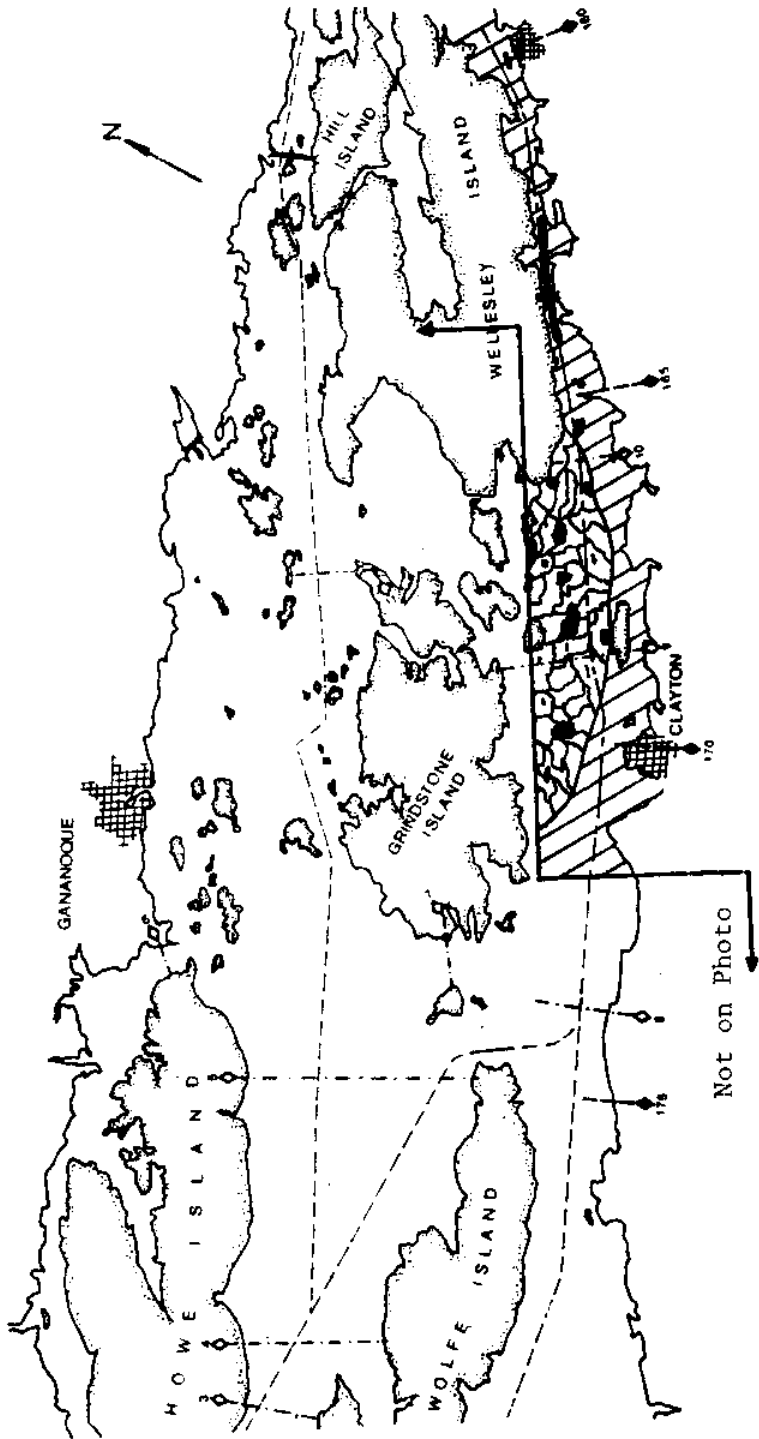




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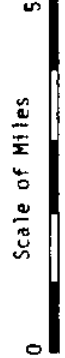
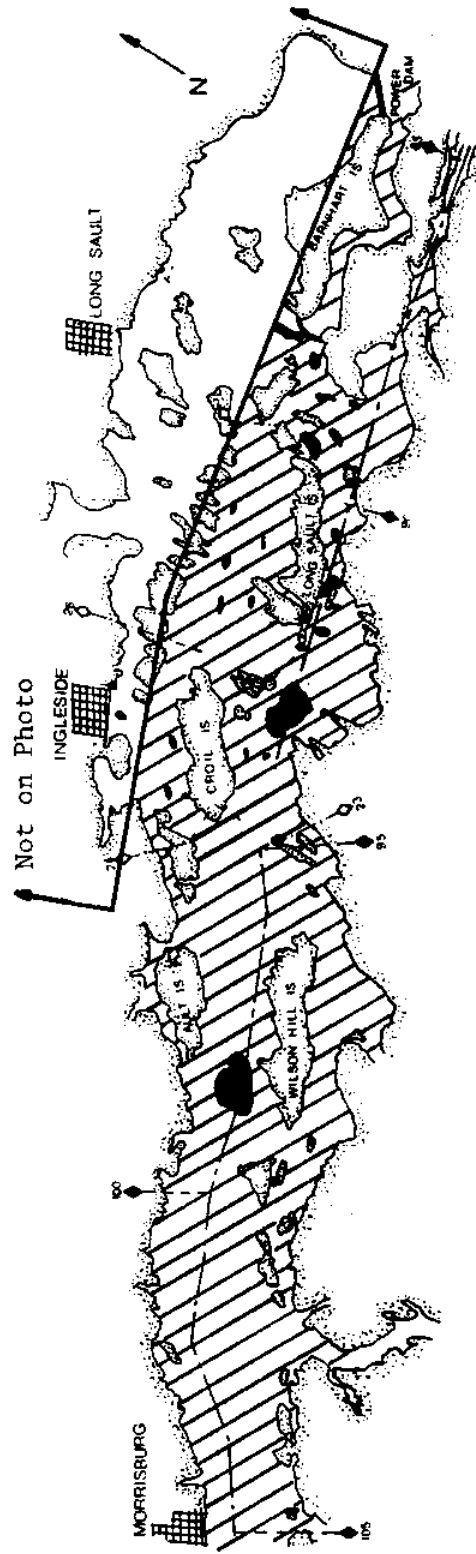
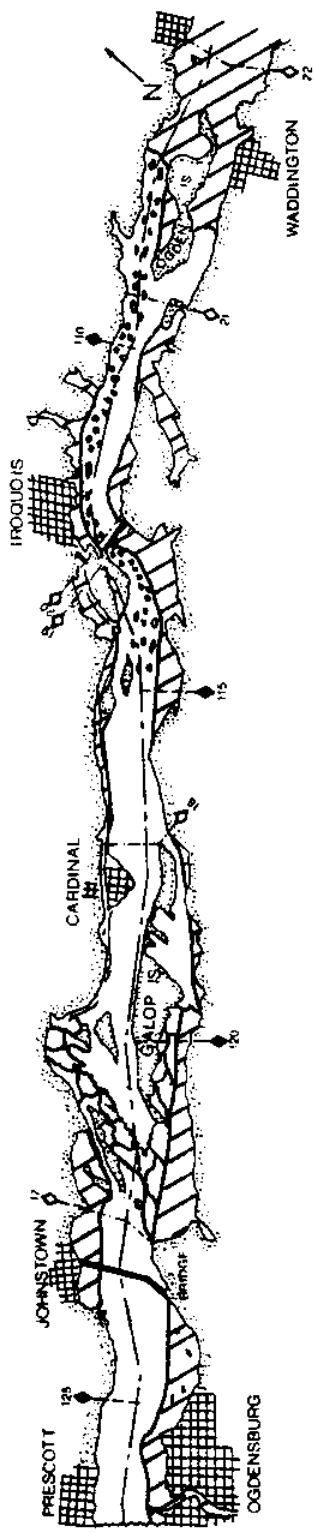


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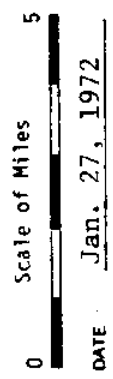
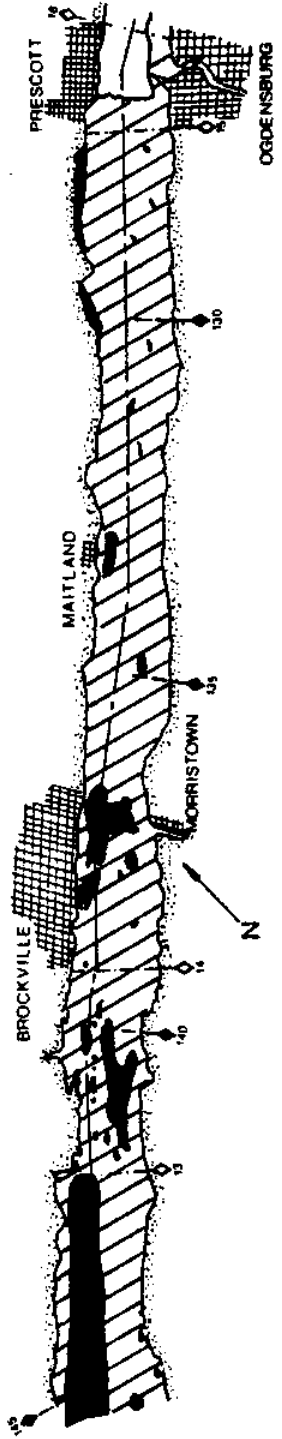
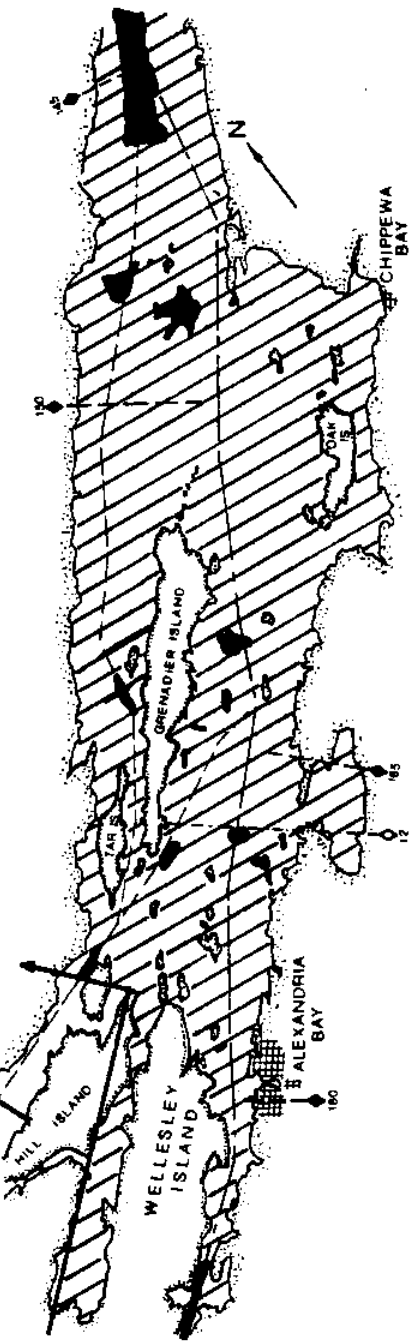
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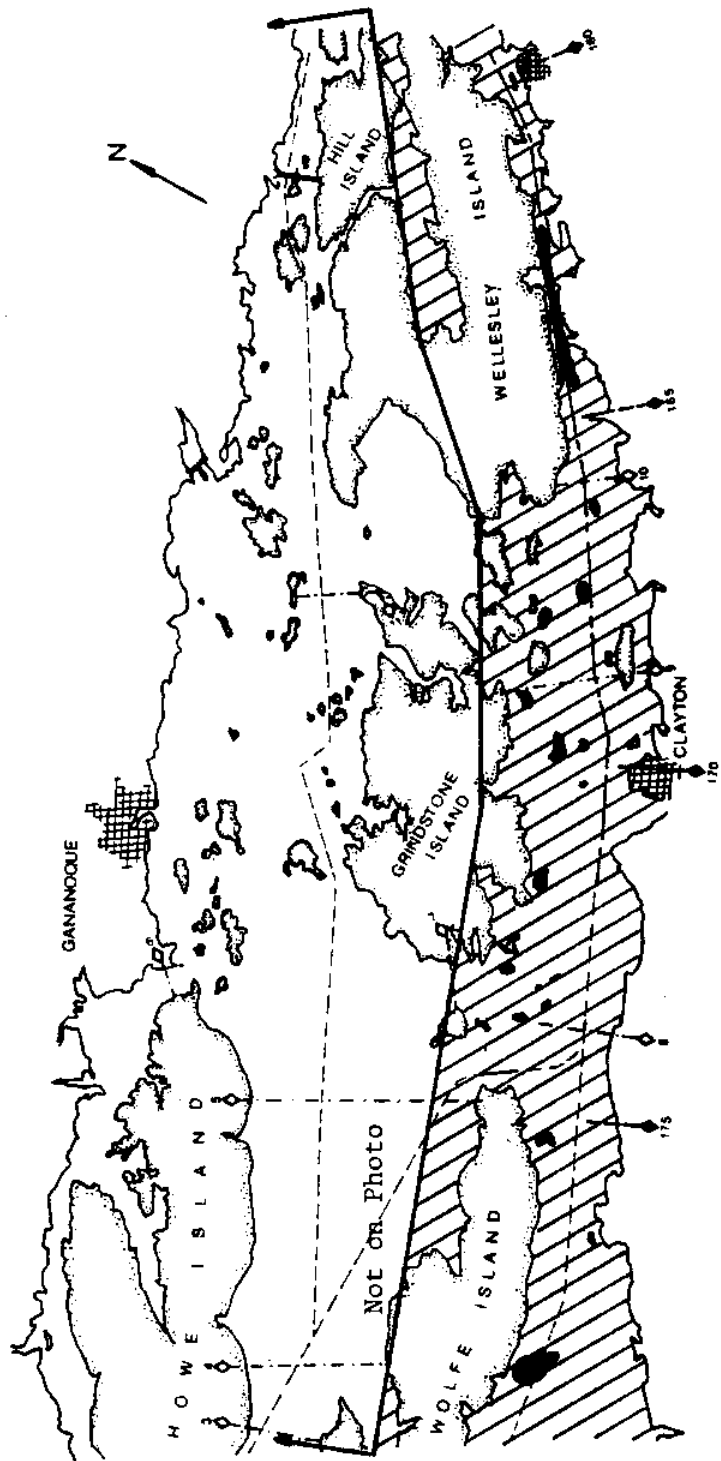
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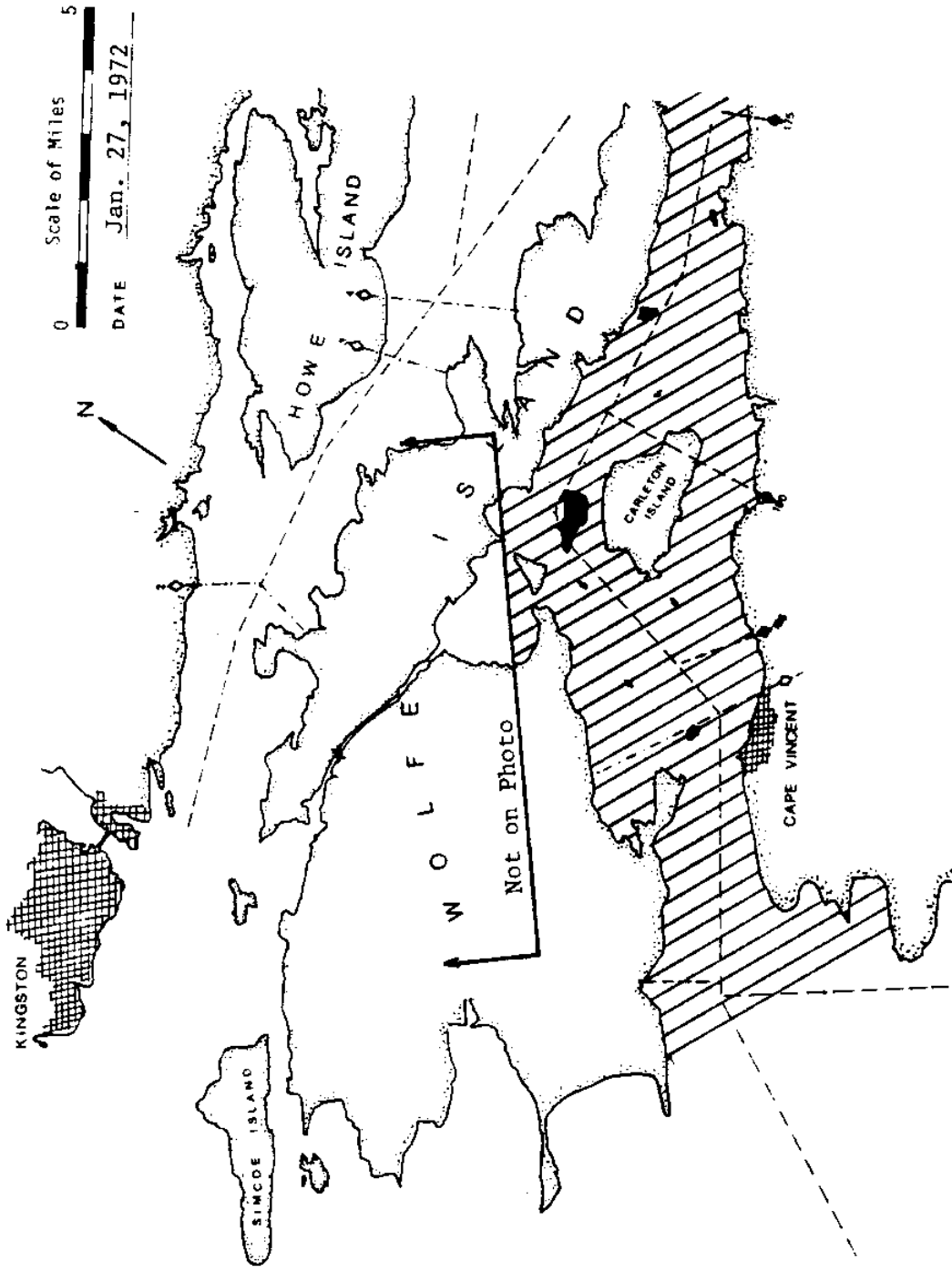
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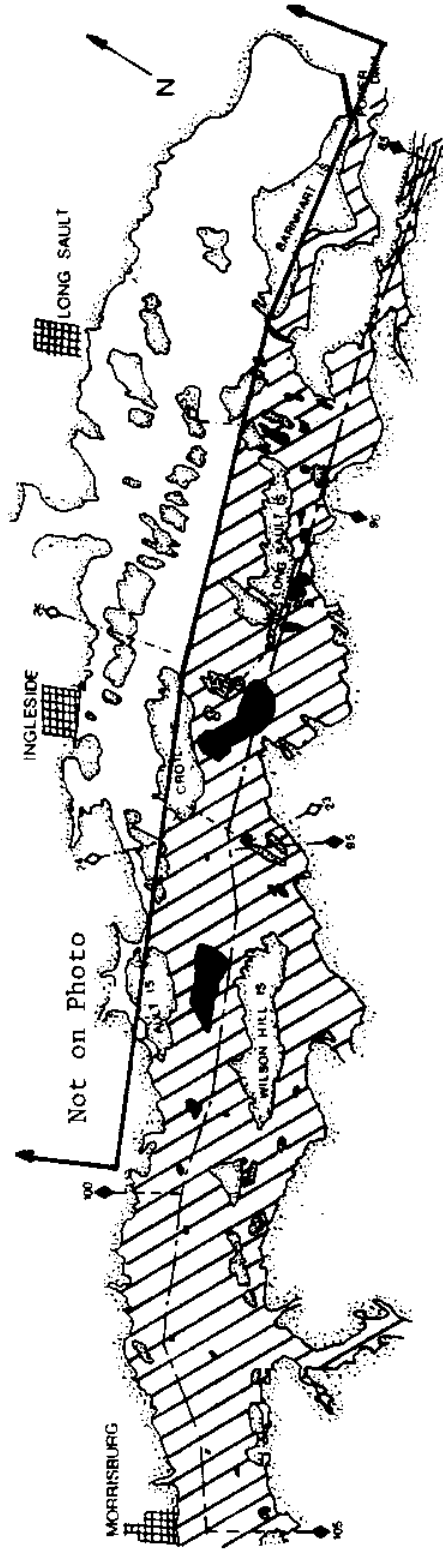
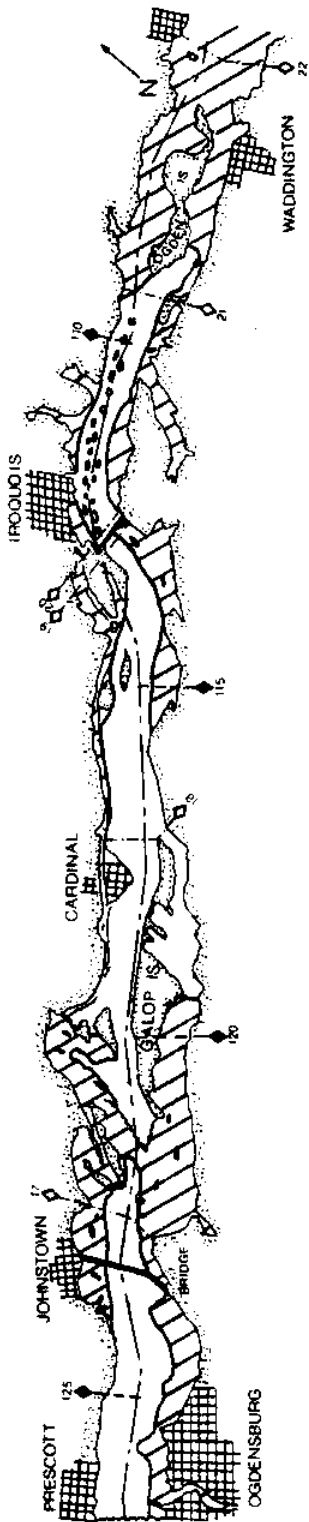




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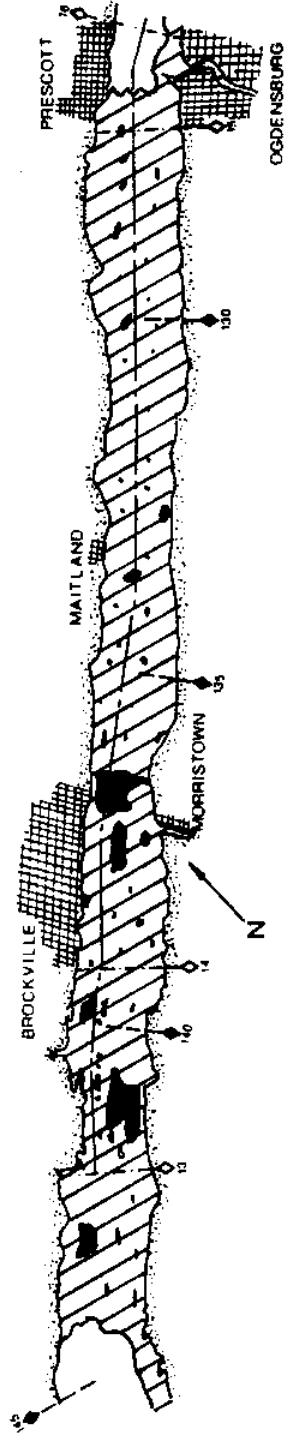
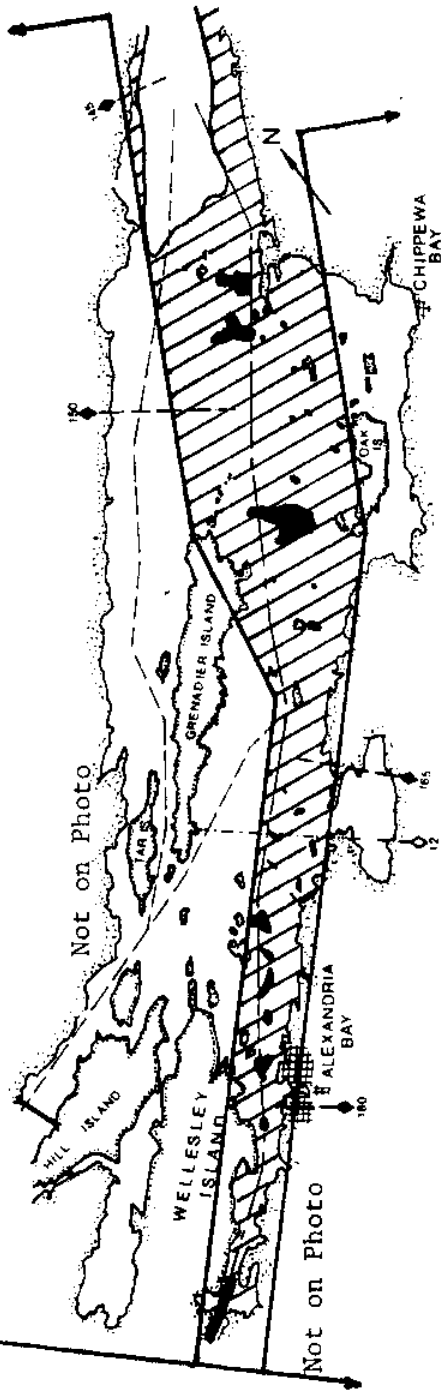




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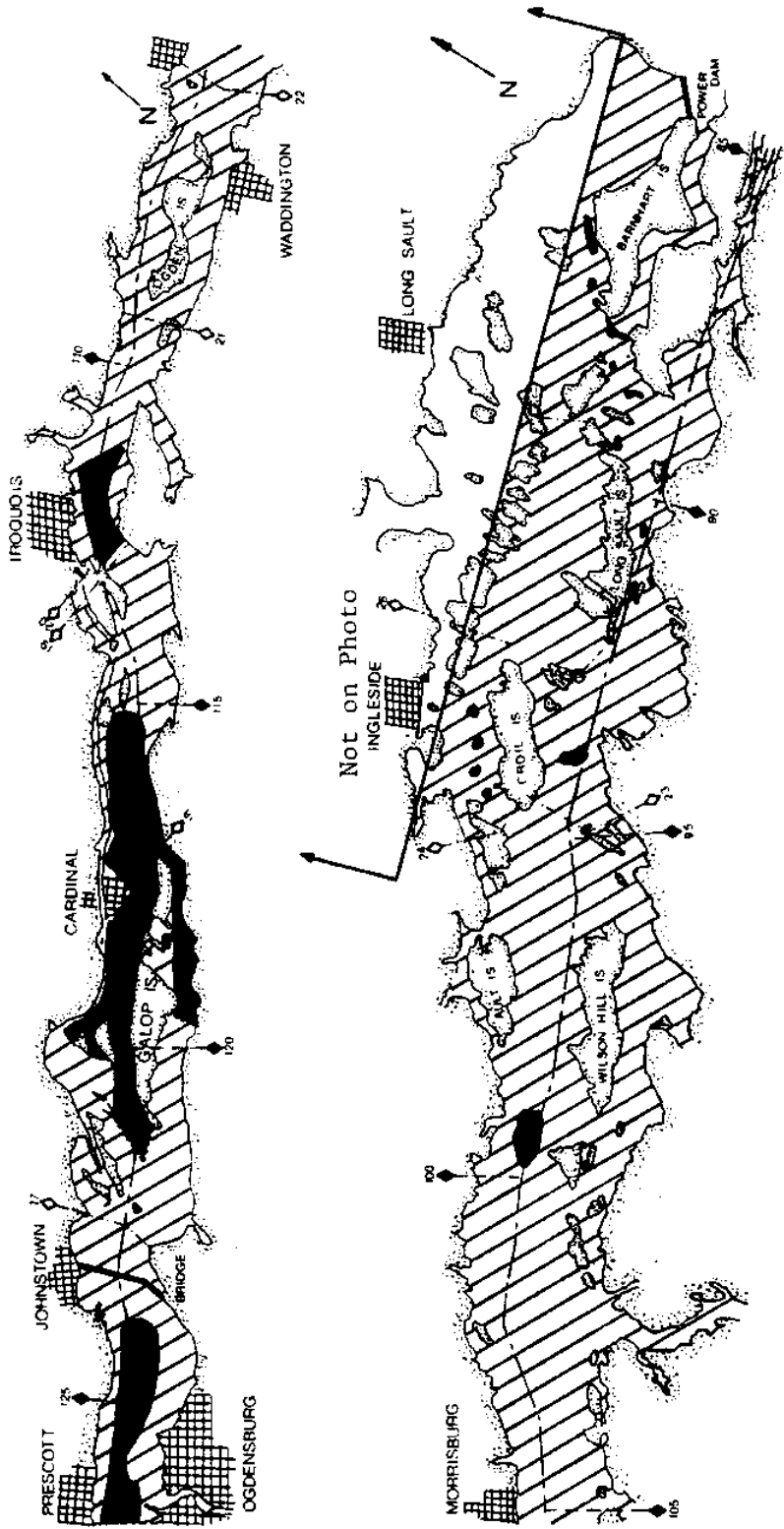
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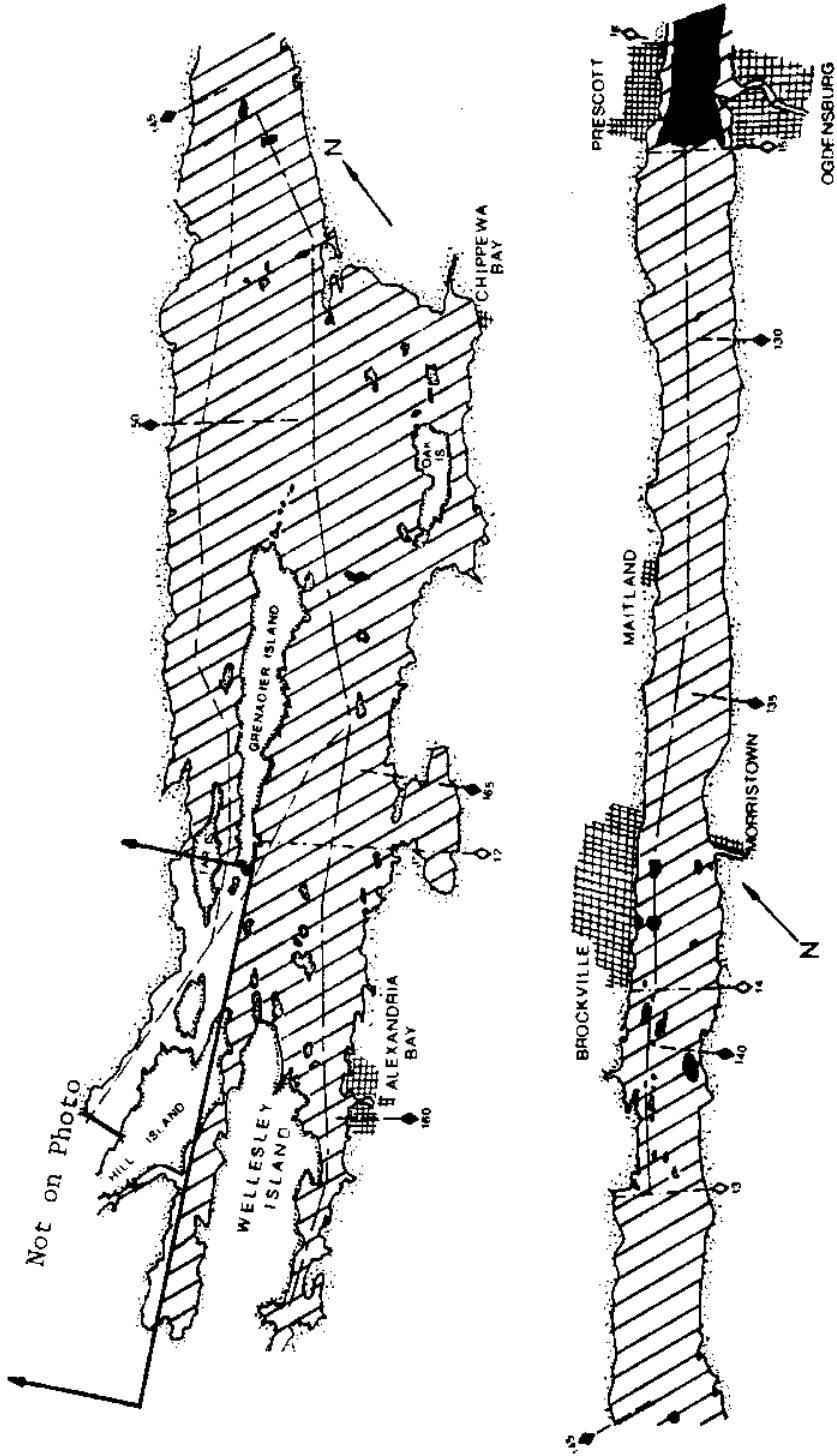
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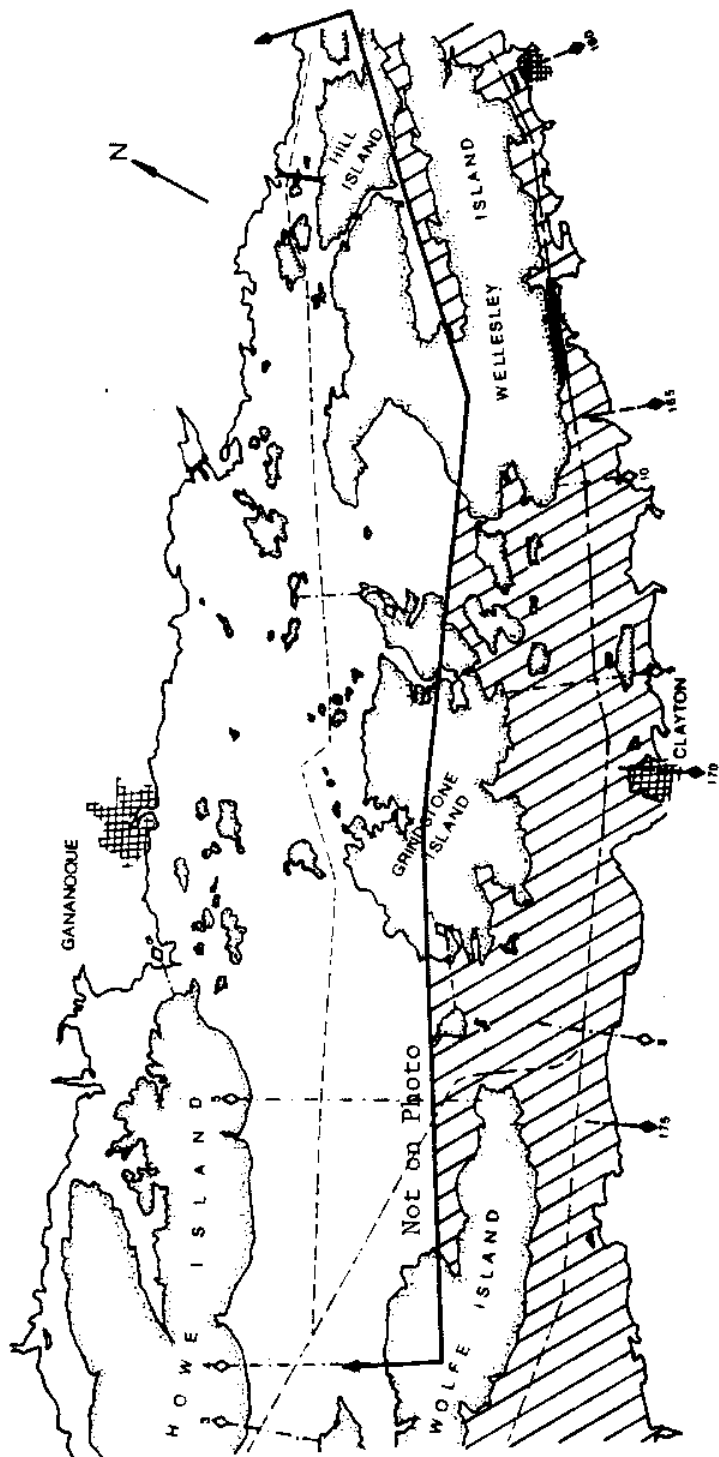
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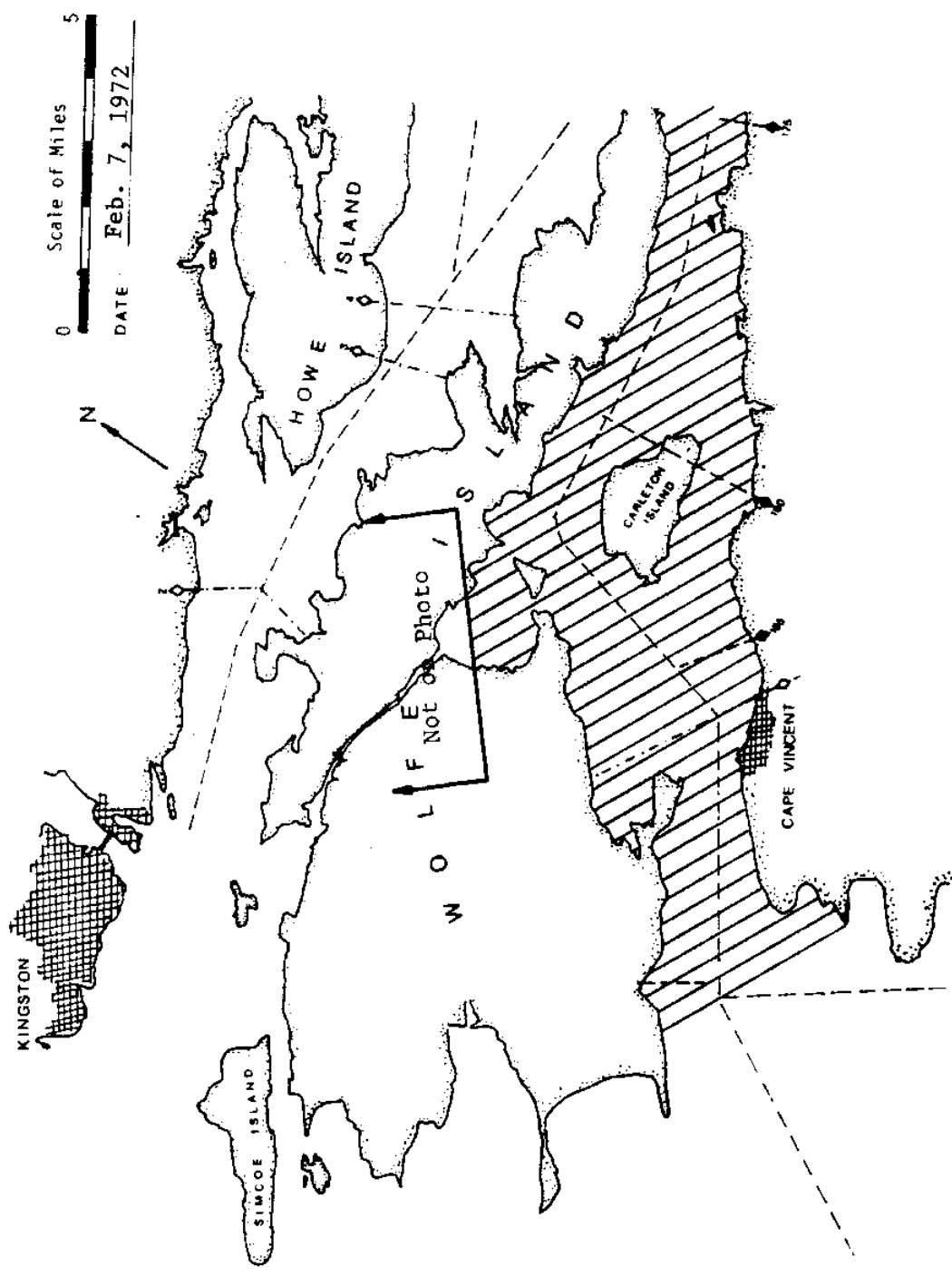
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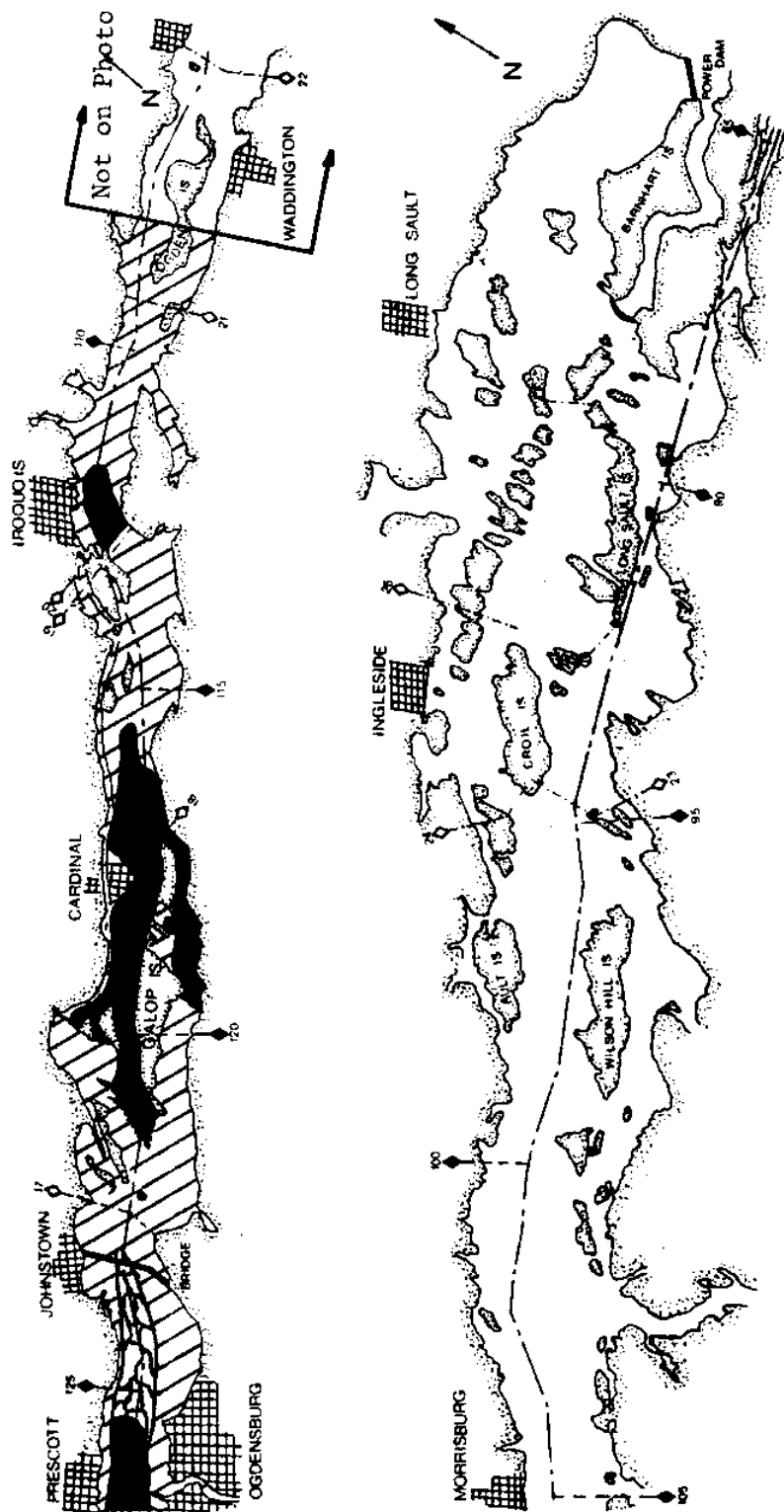


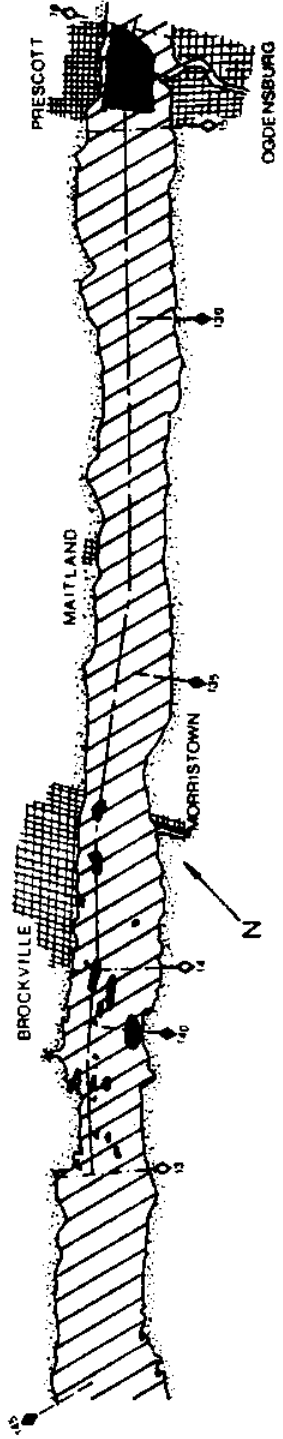
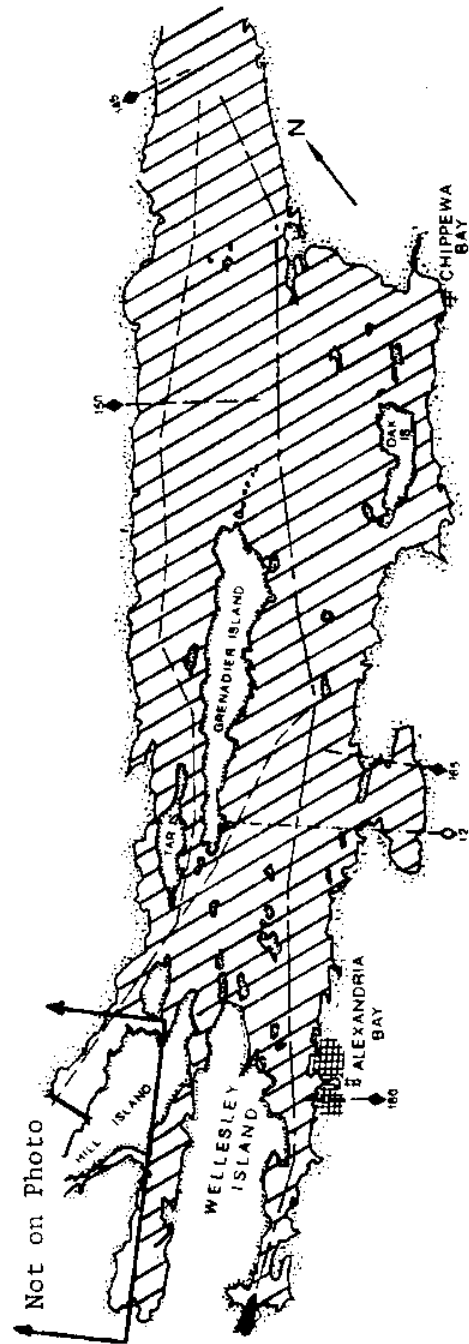


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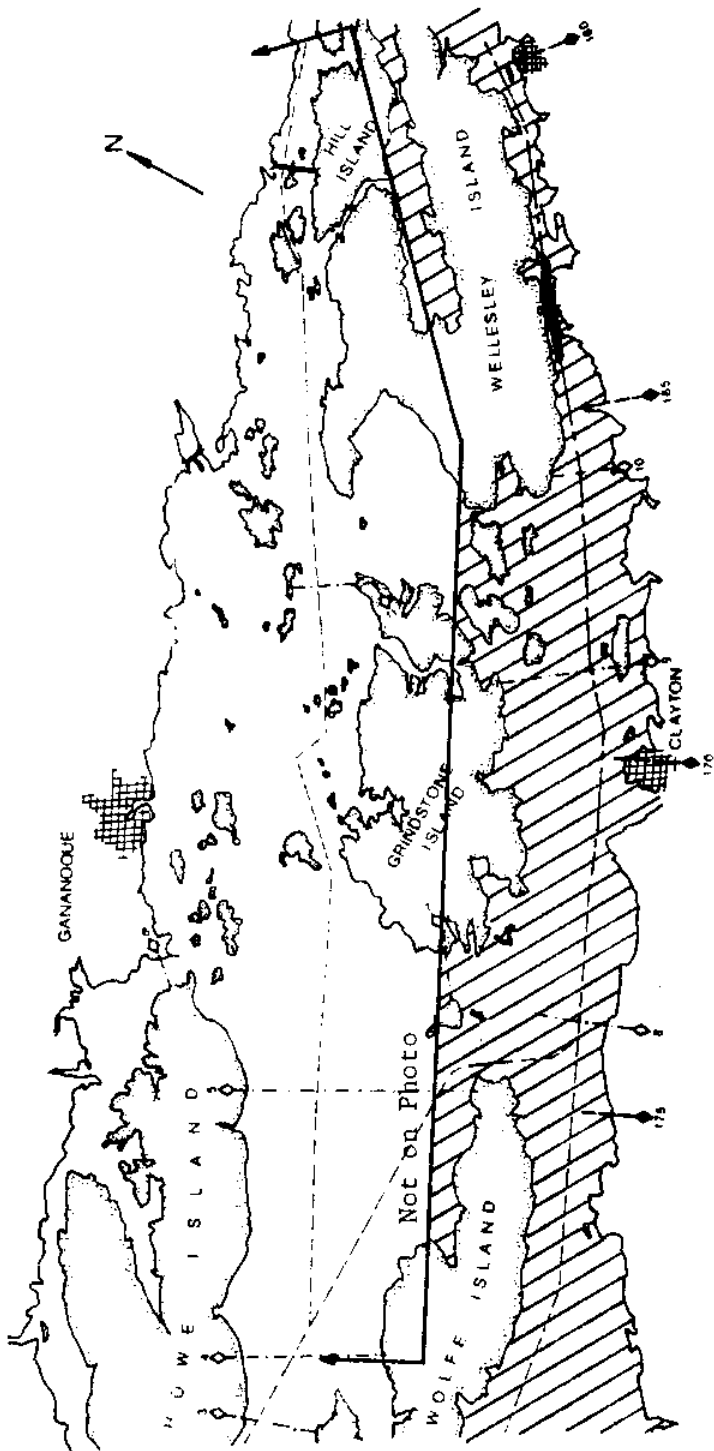






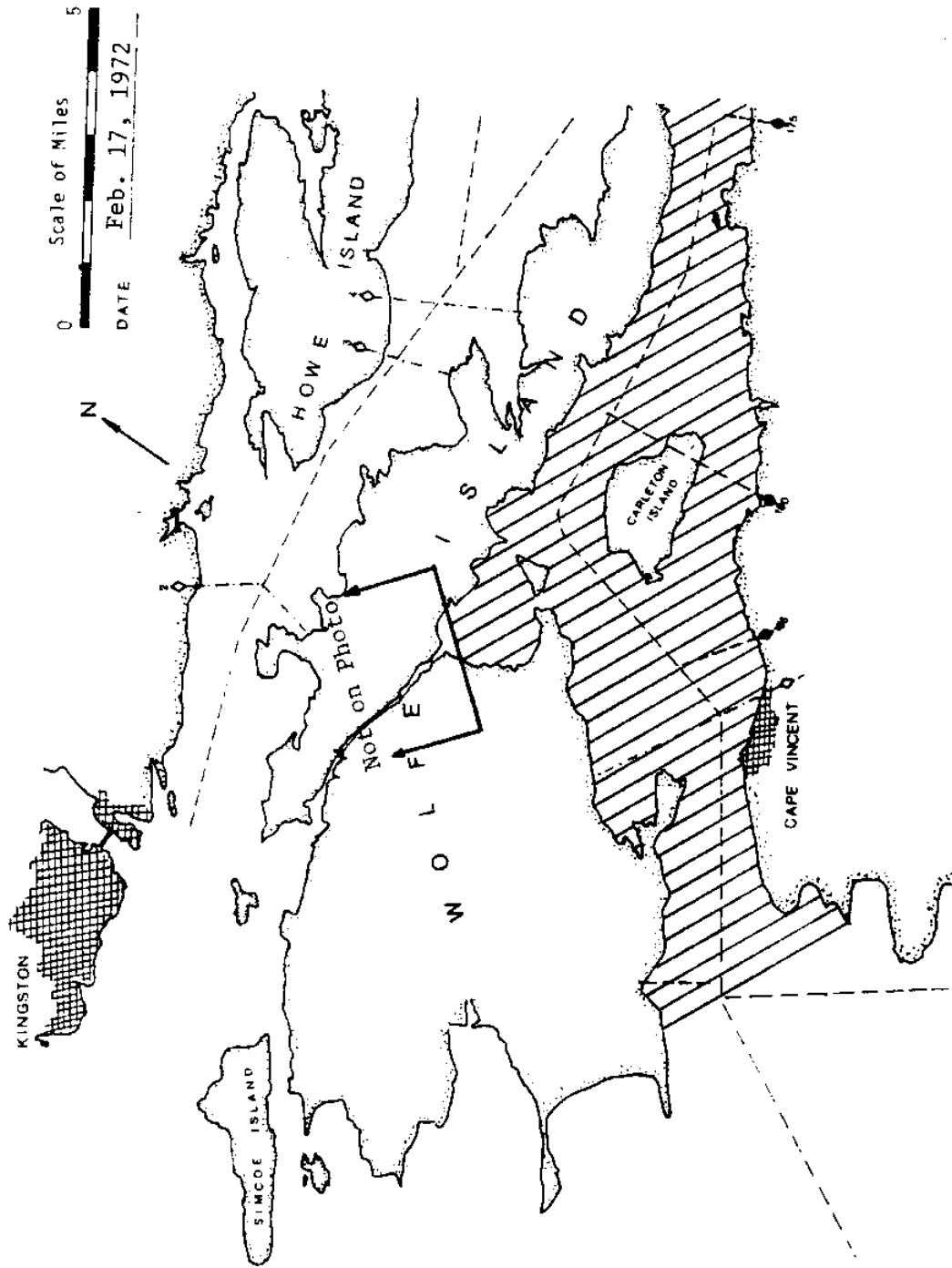
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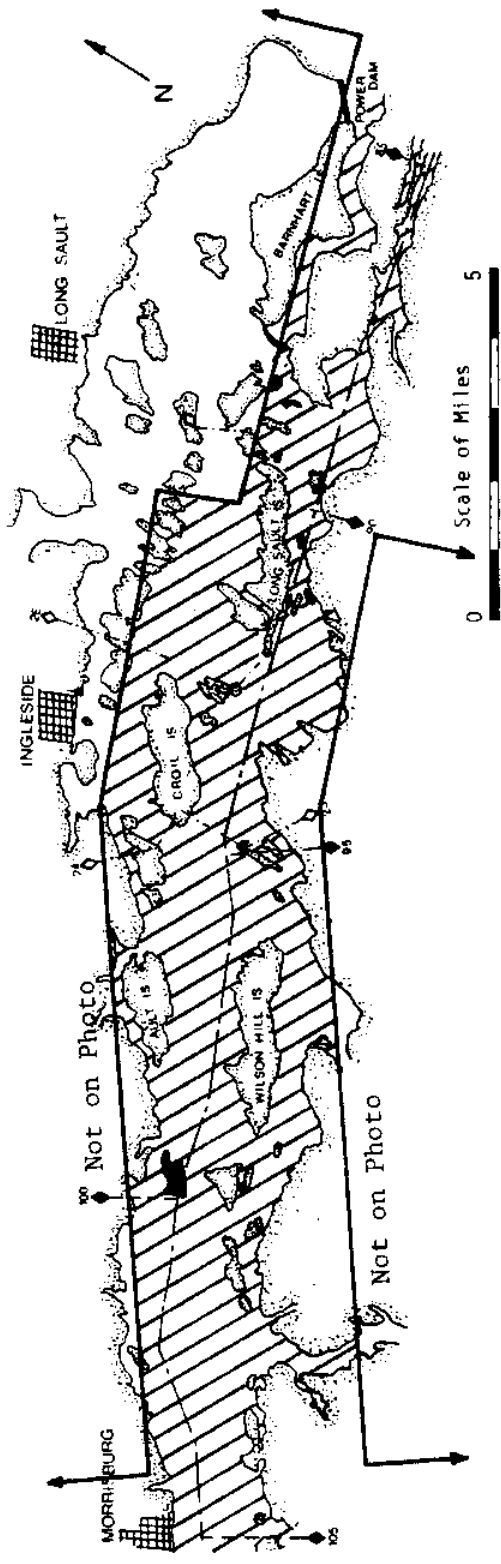
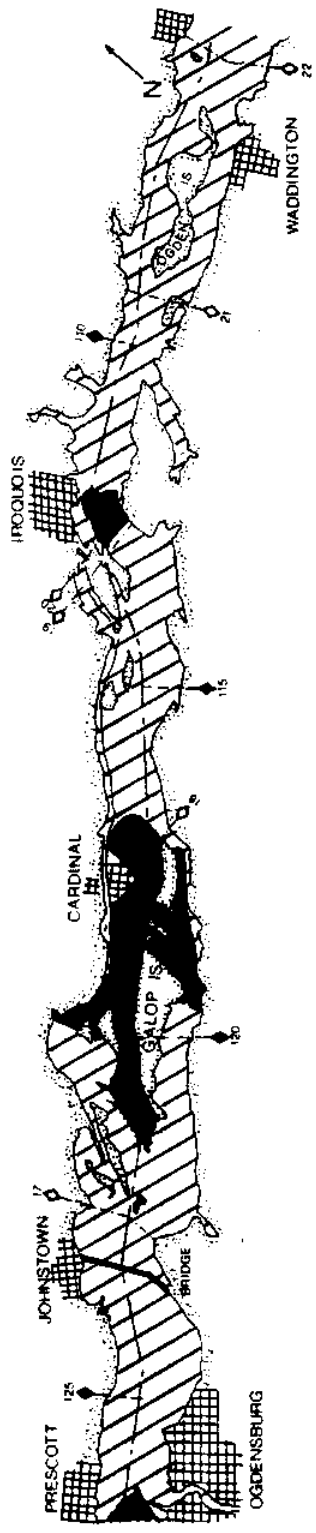
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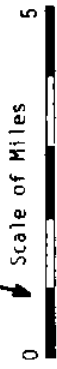
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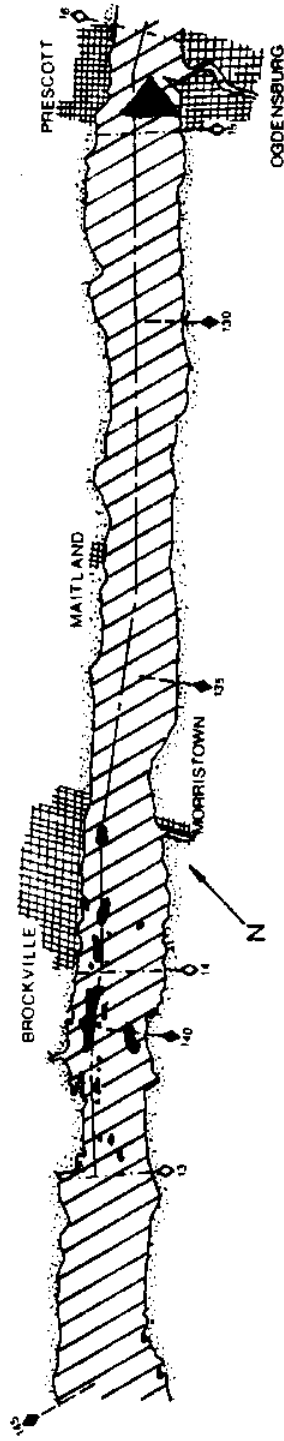
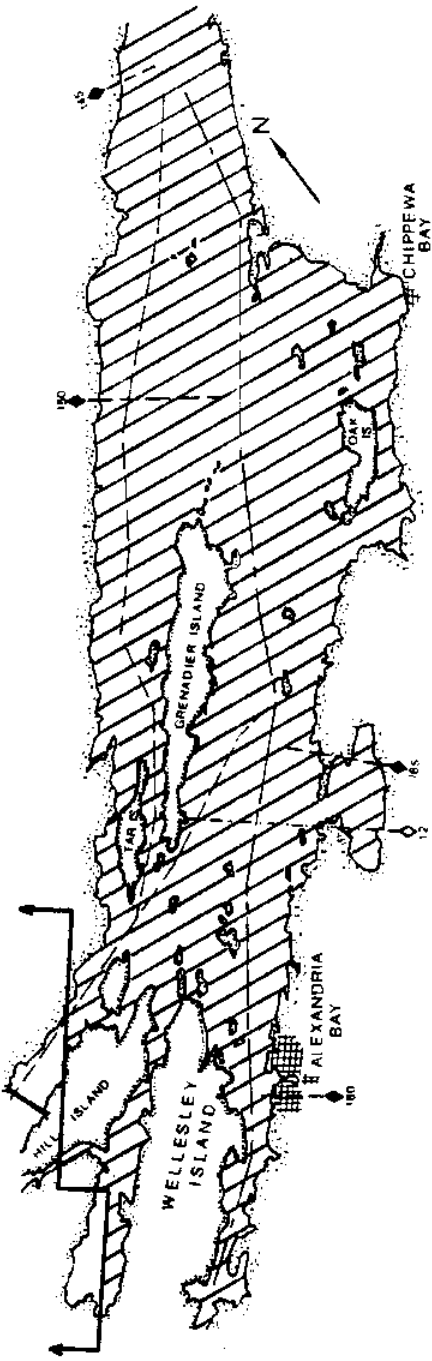
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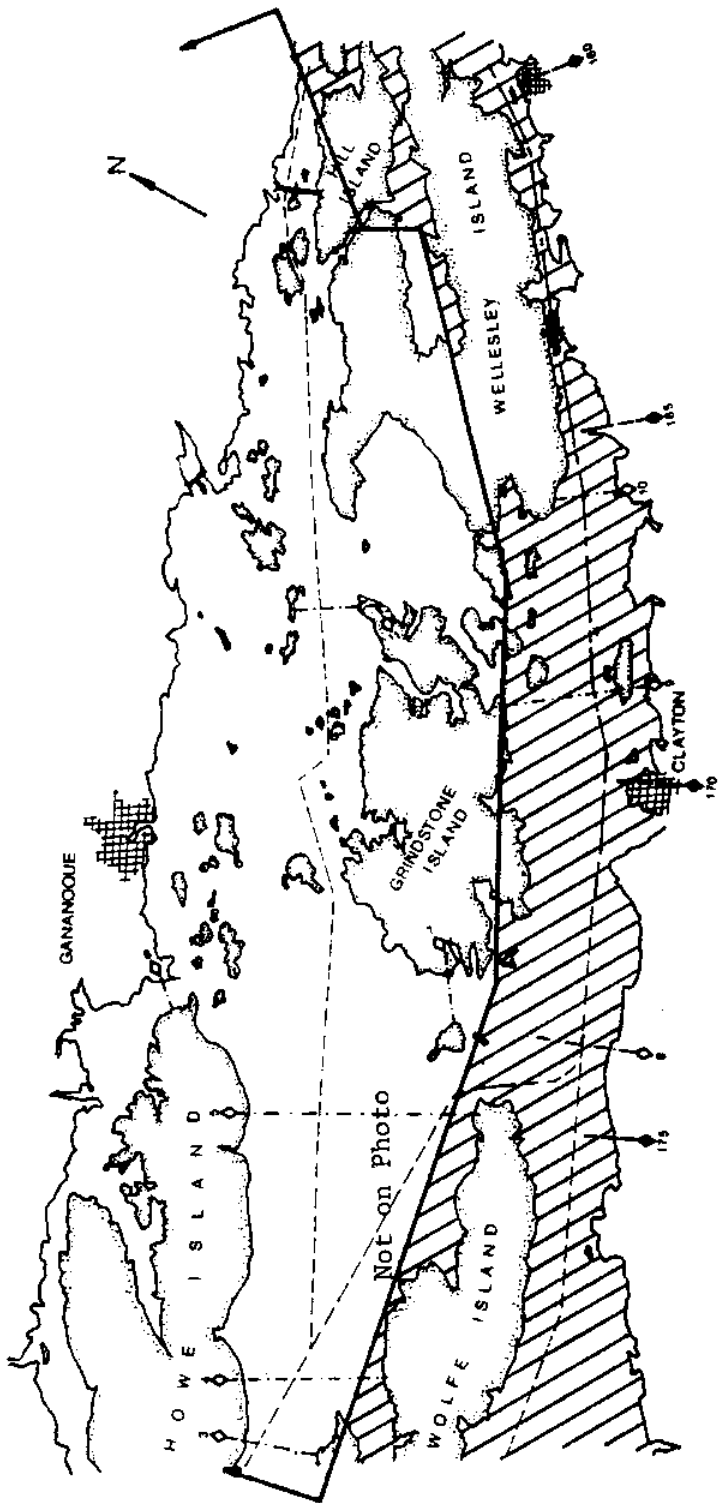
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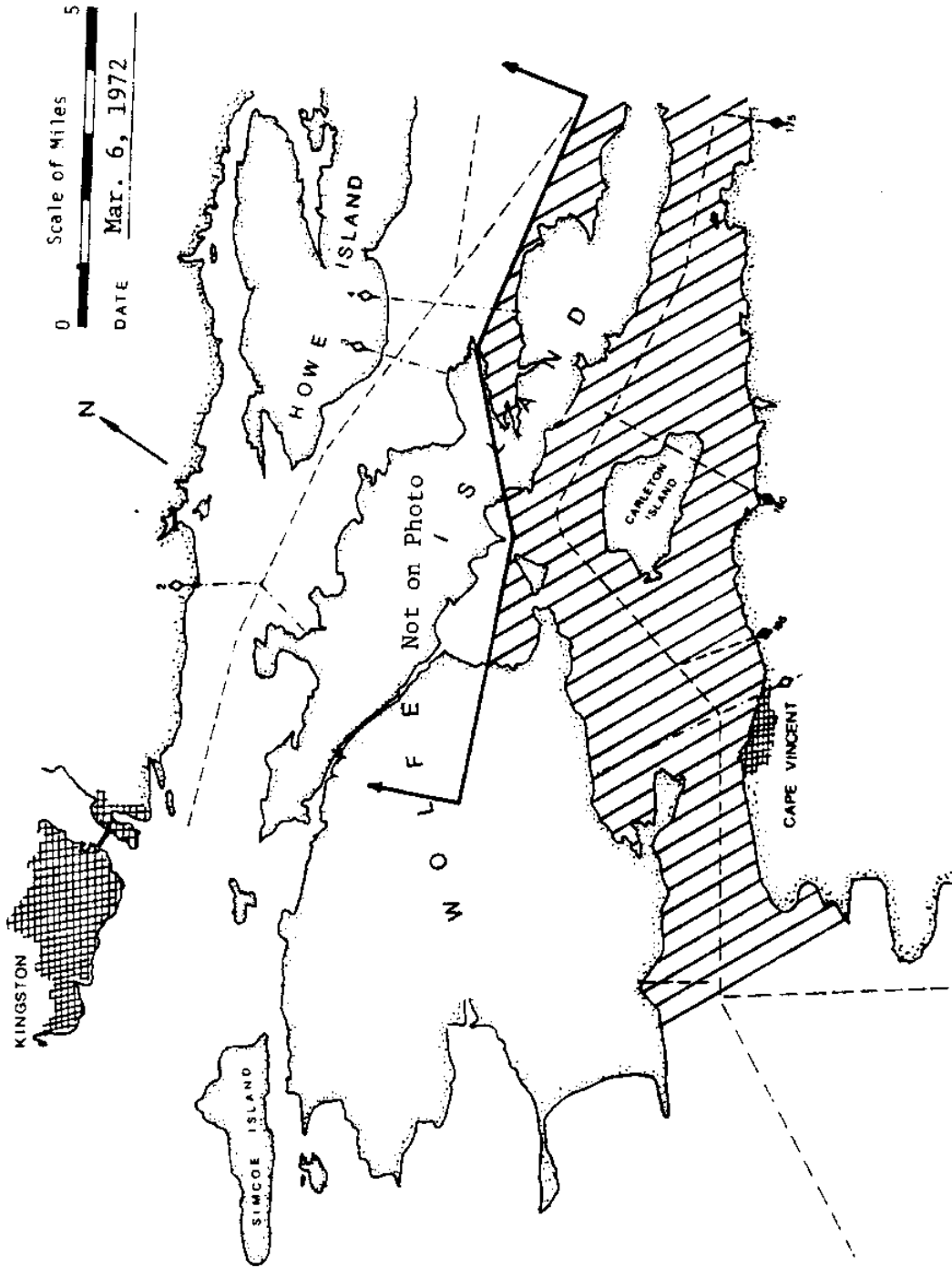
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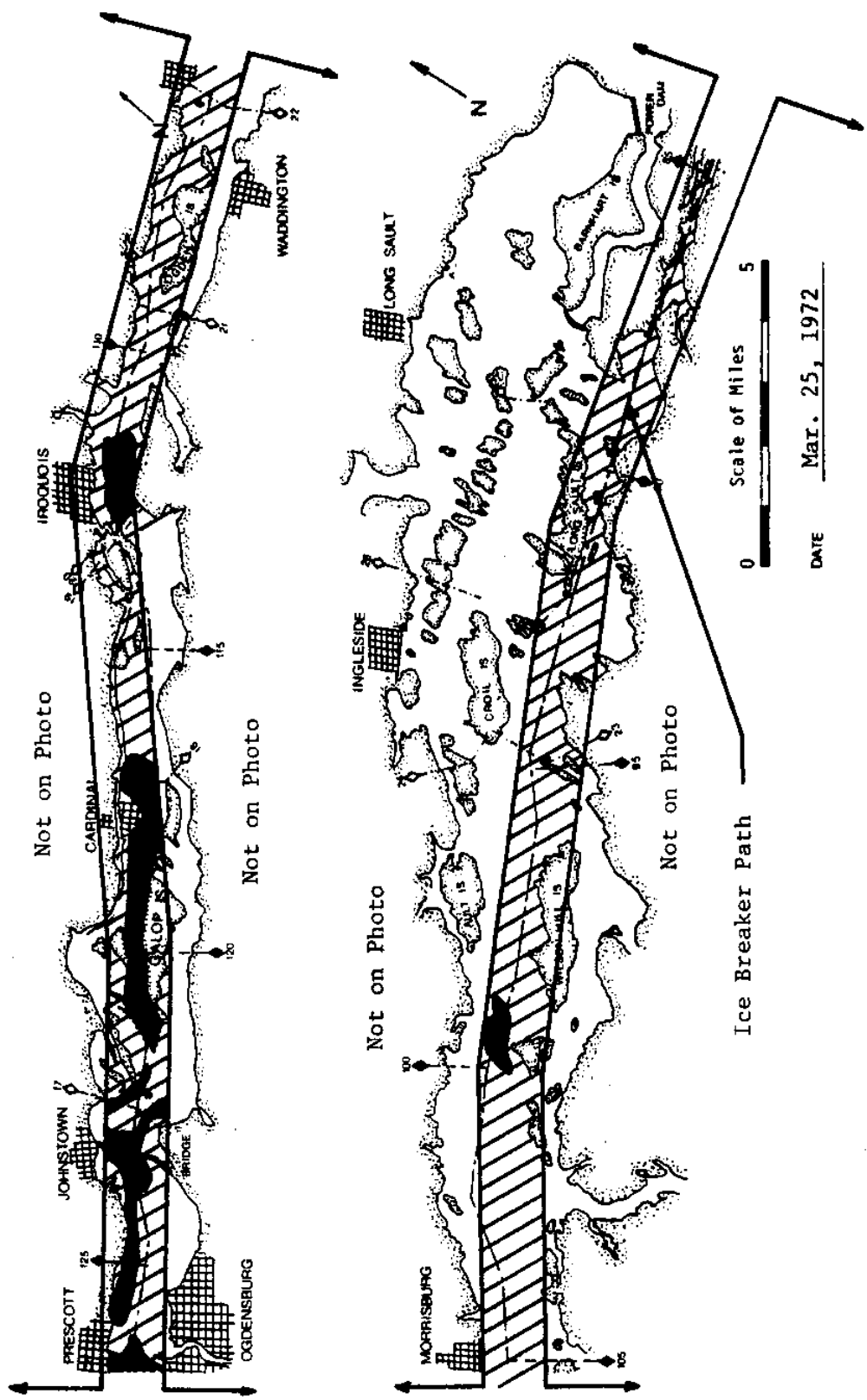
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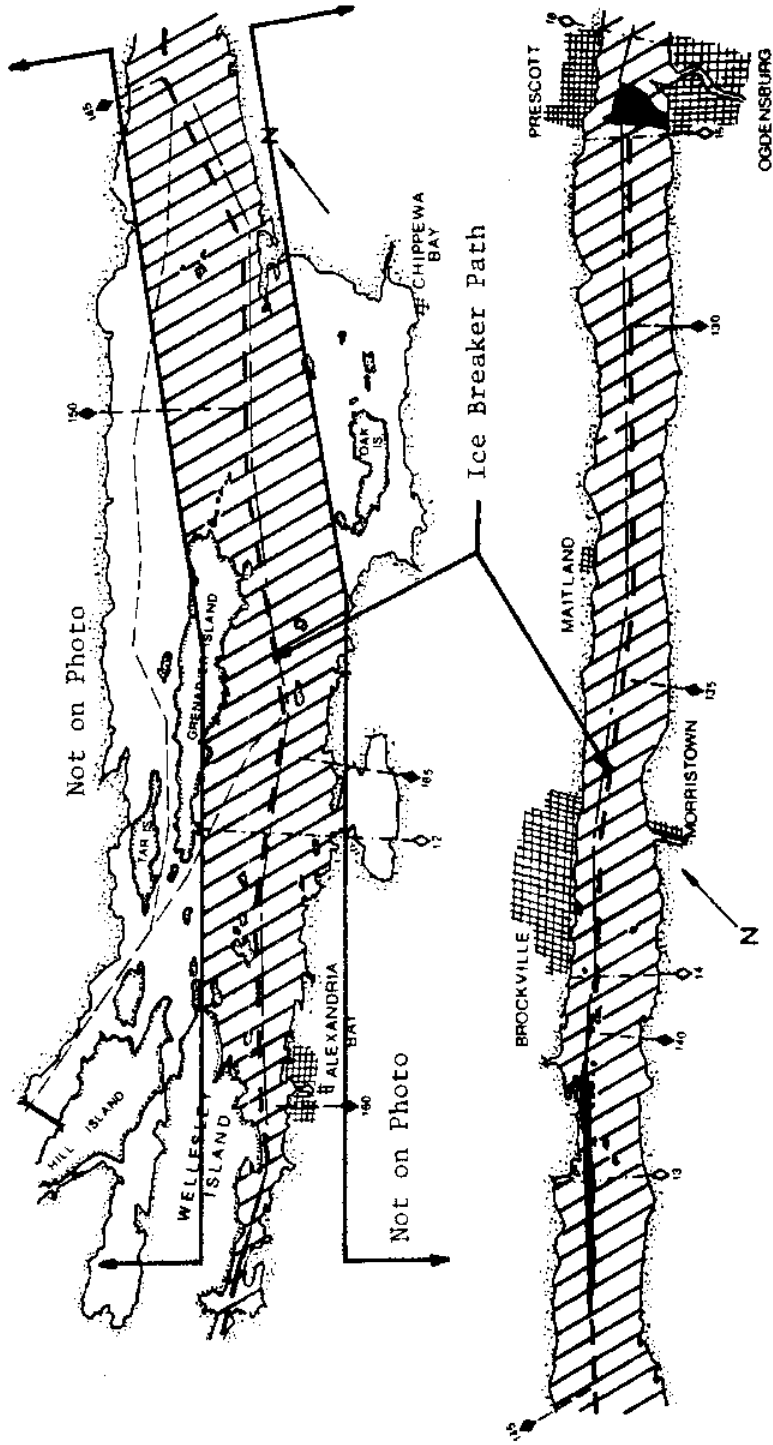
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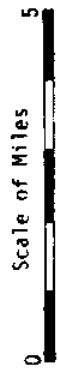
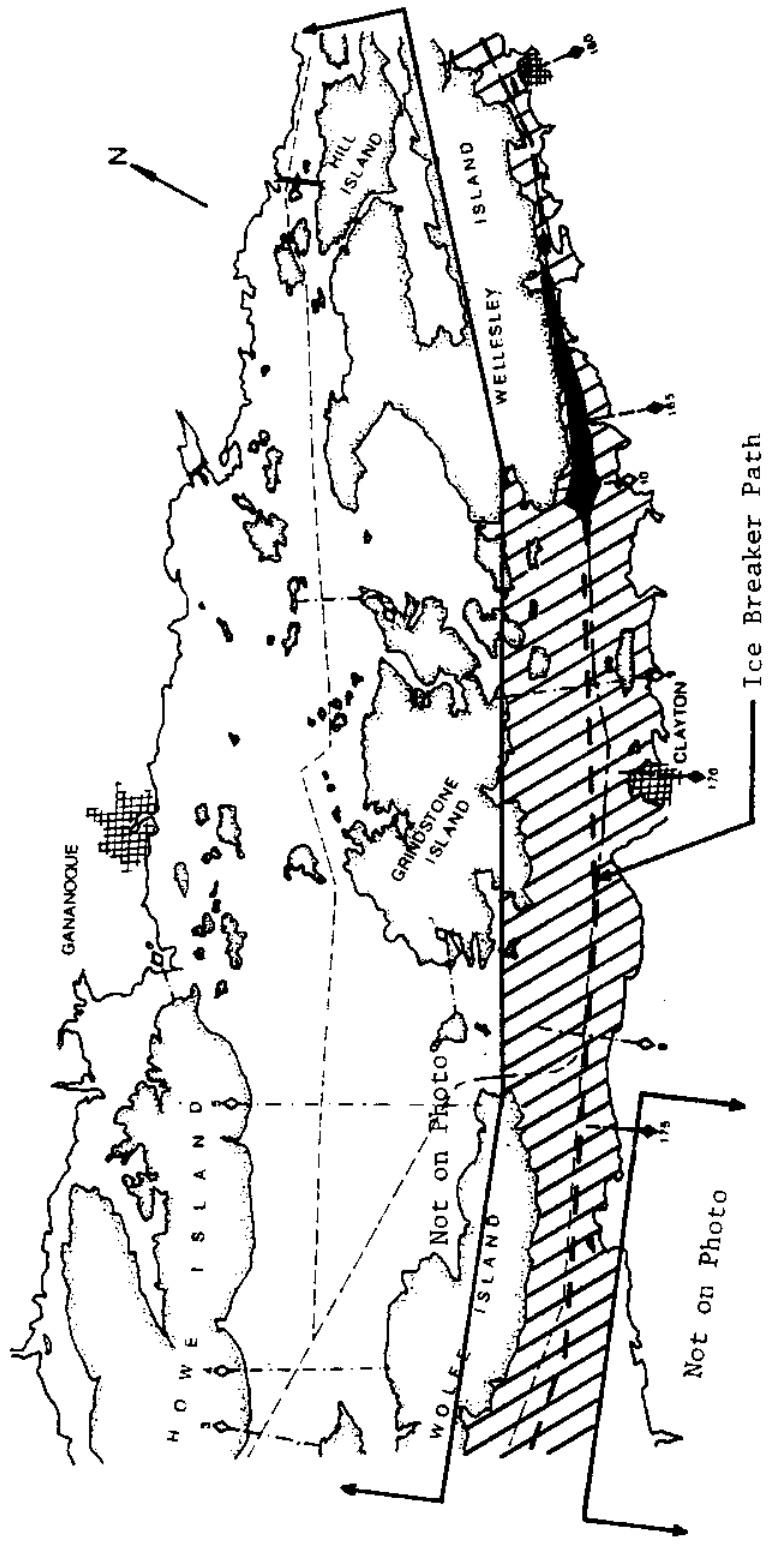
Ice Breaker Path

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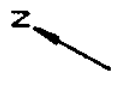
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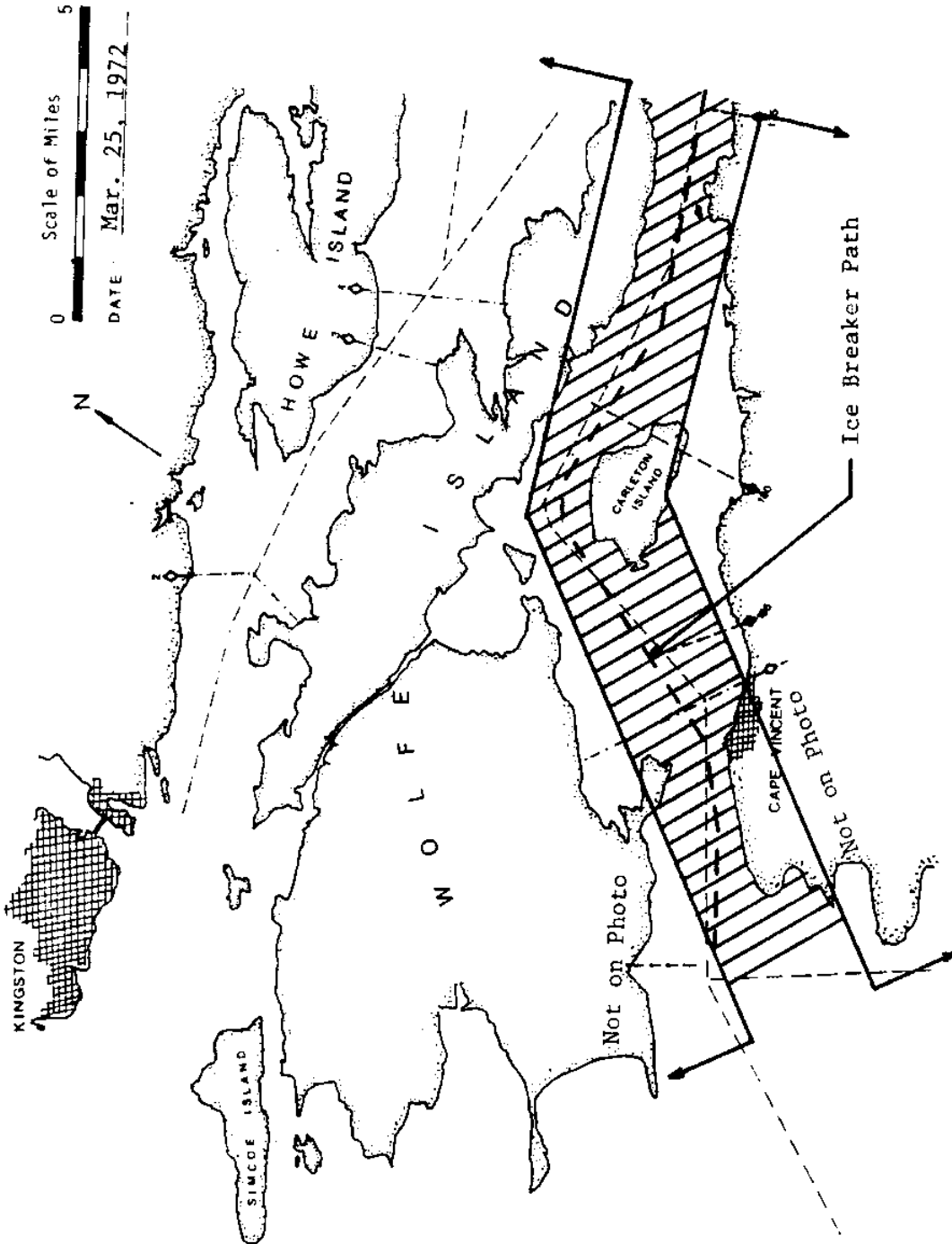


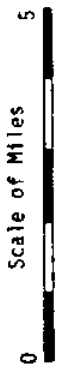
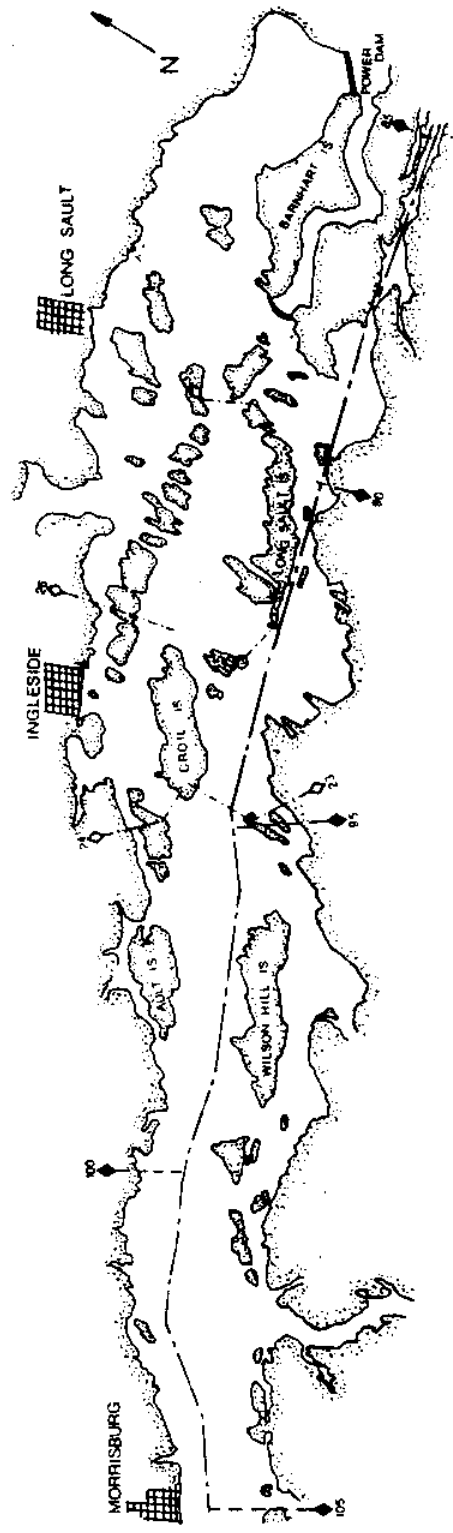
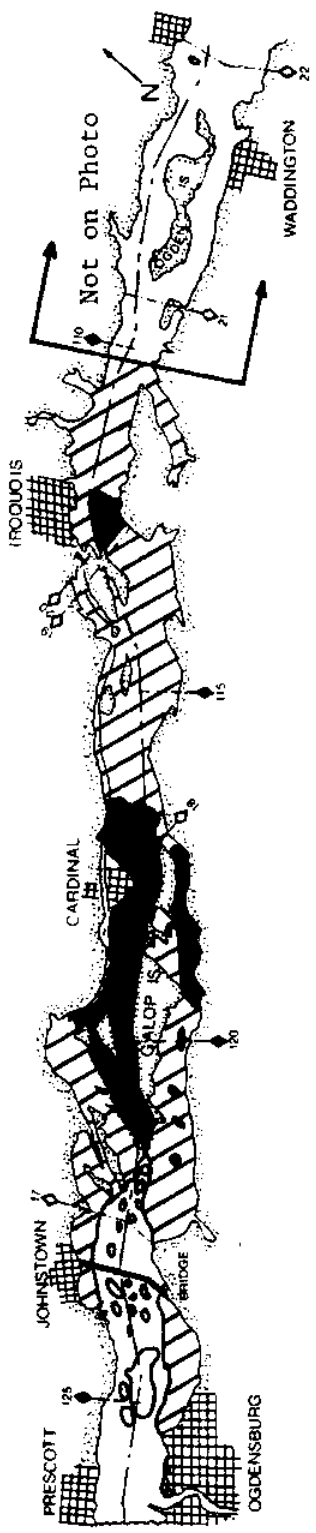
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Ice Breaker Path

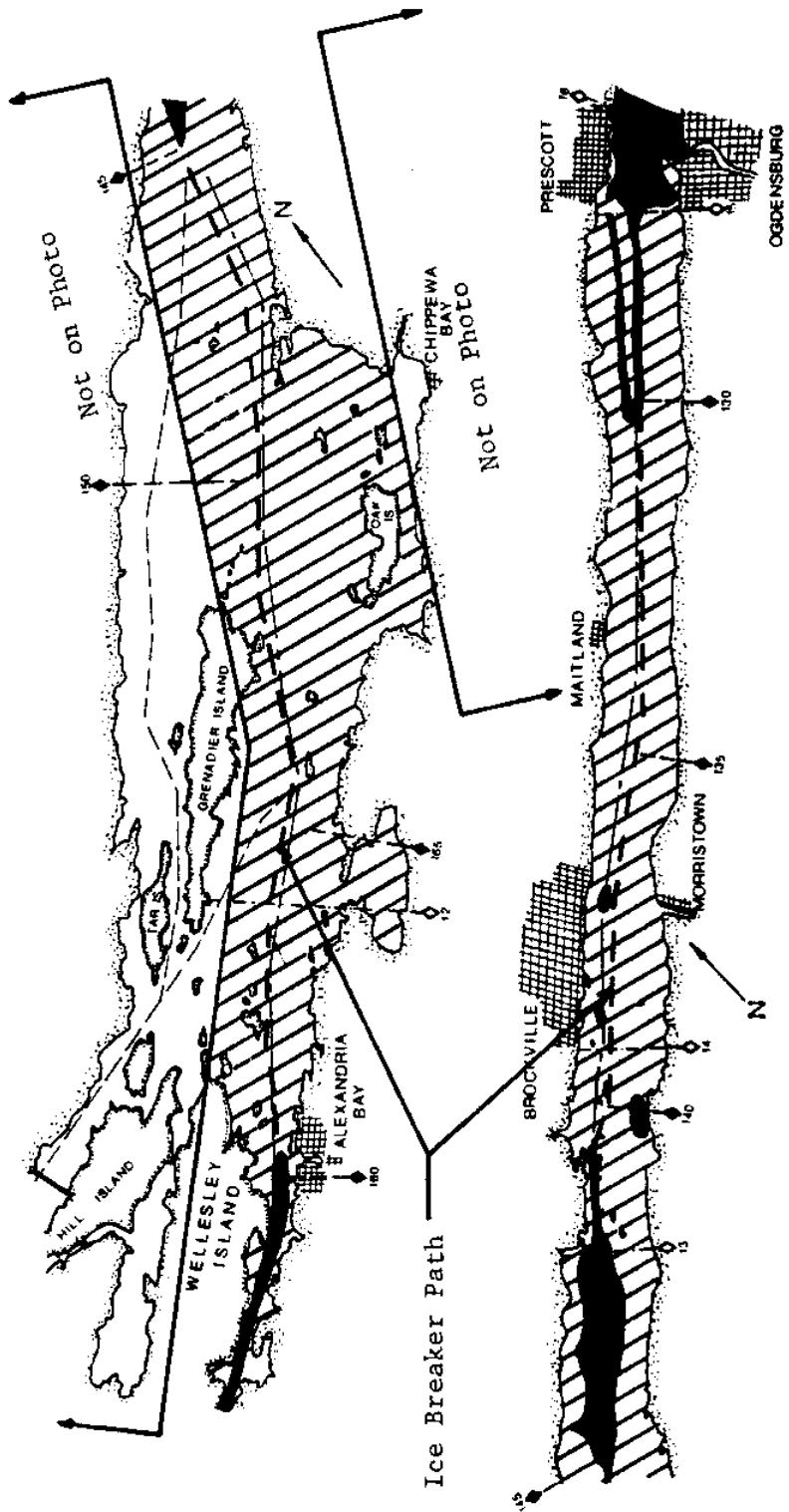
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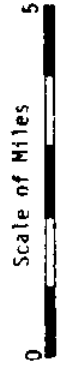
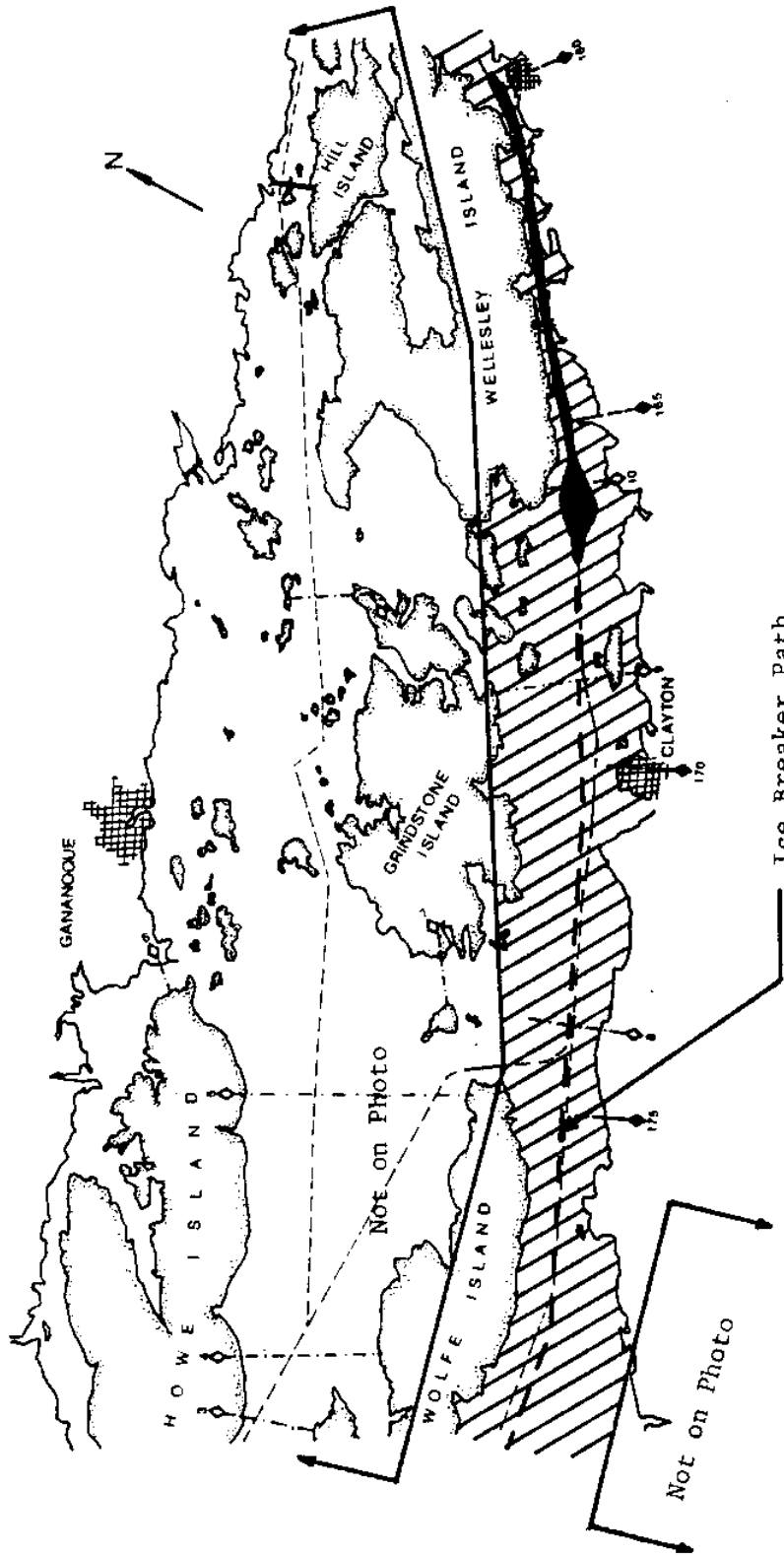




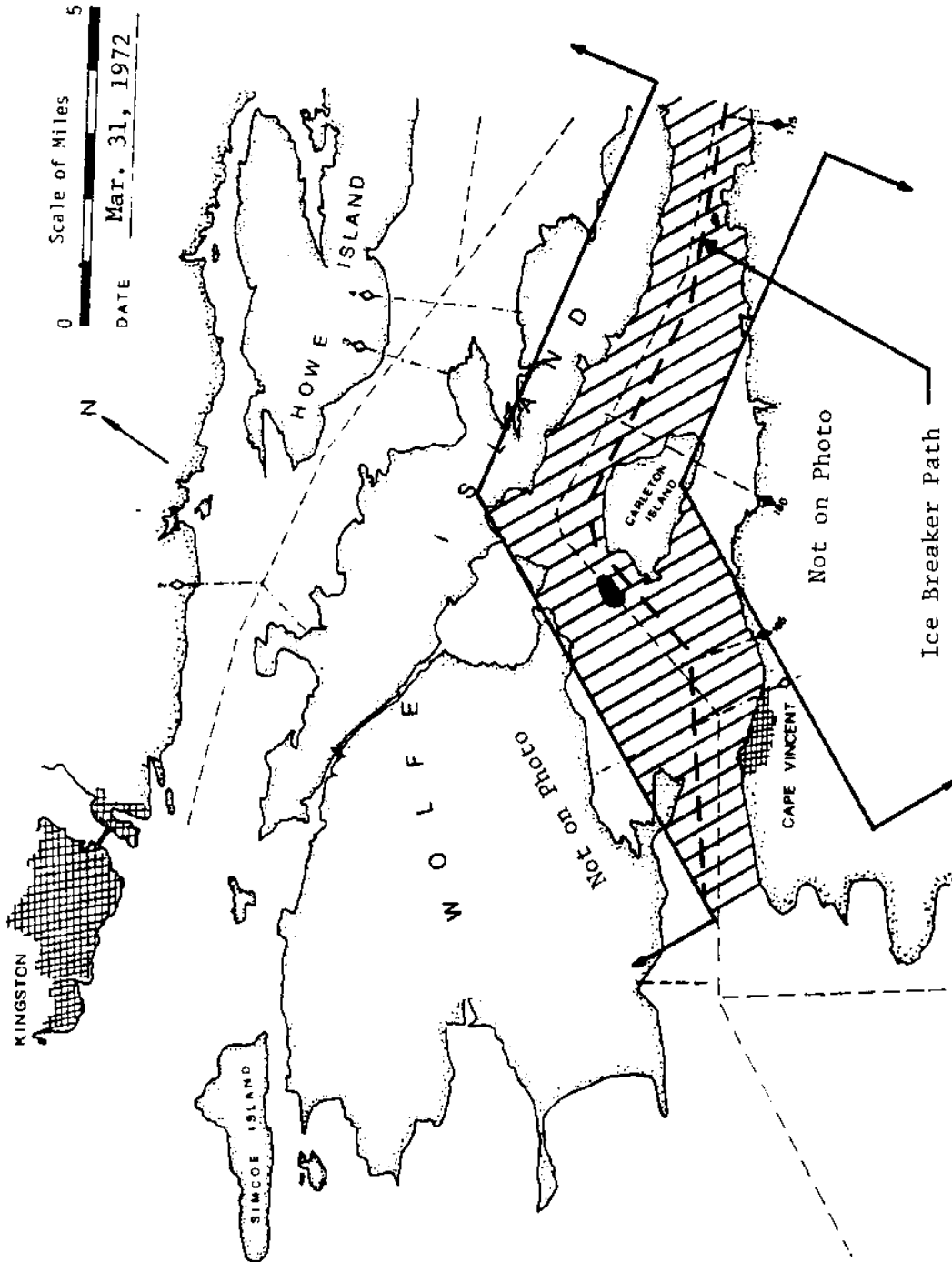
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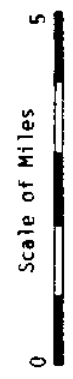
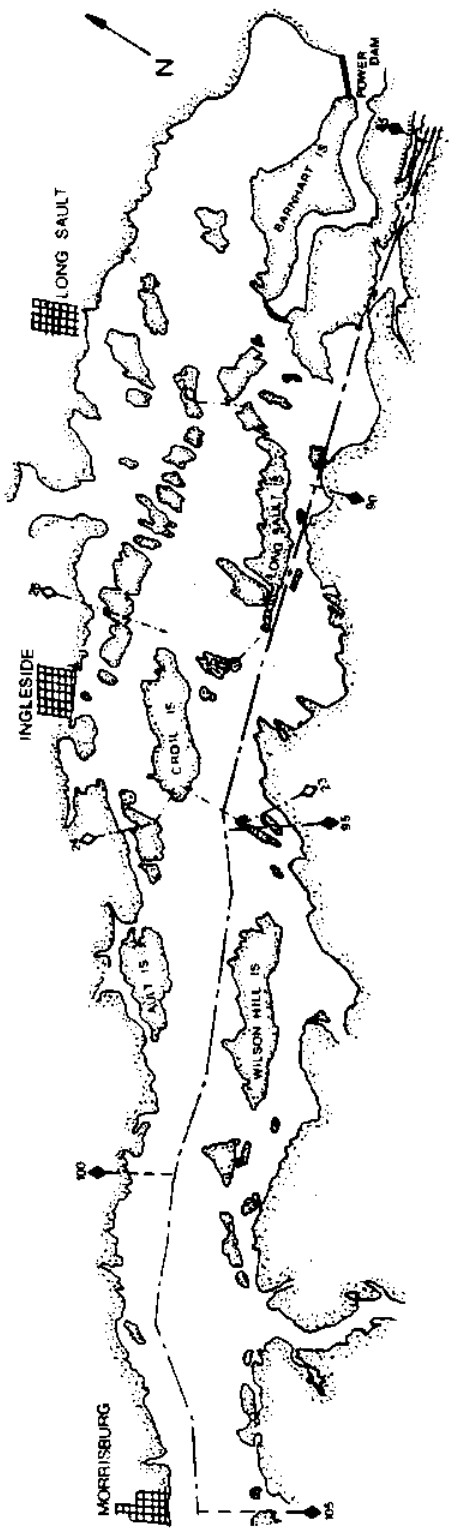
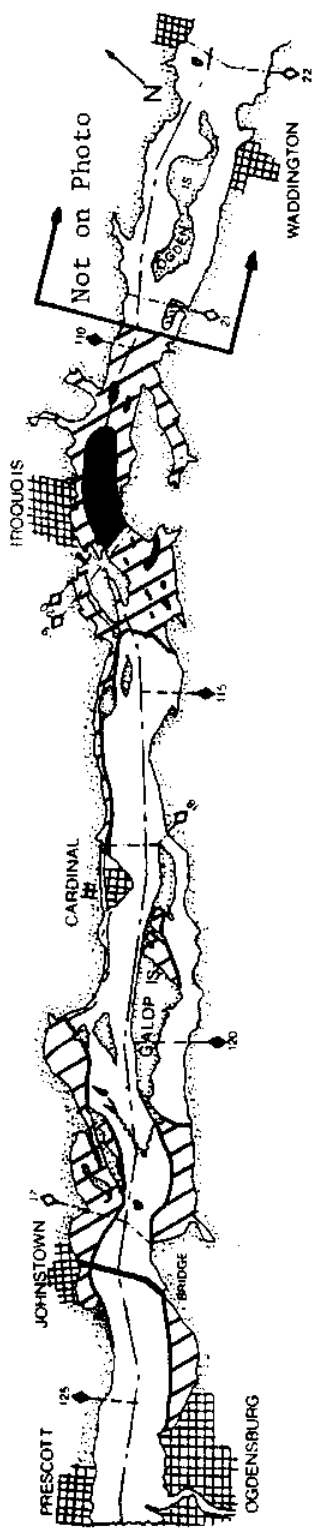


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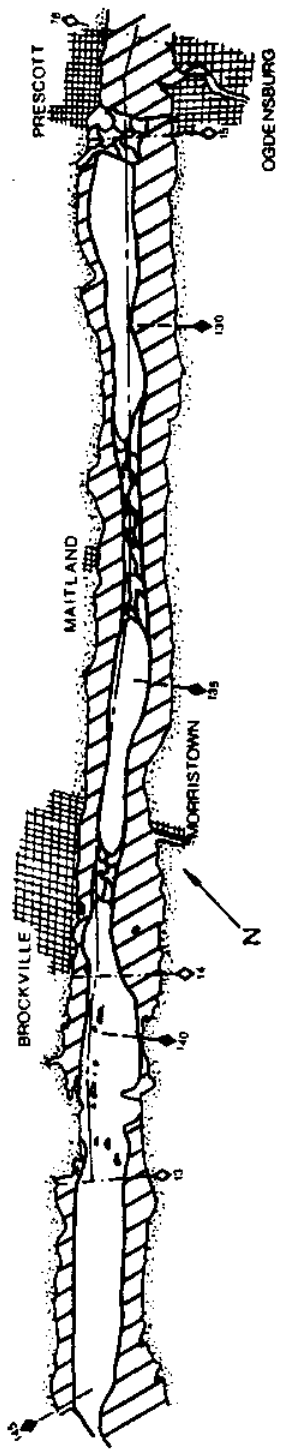
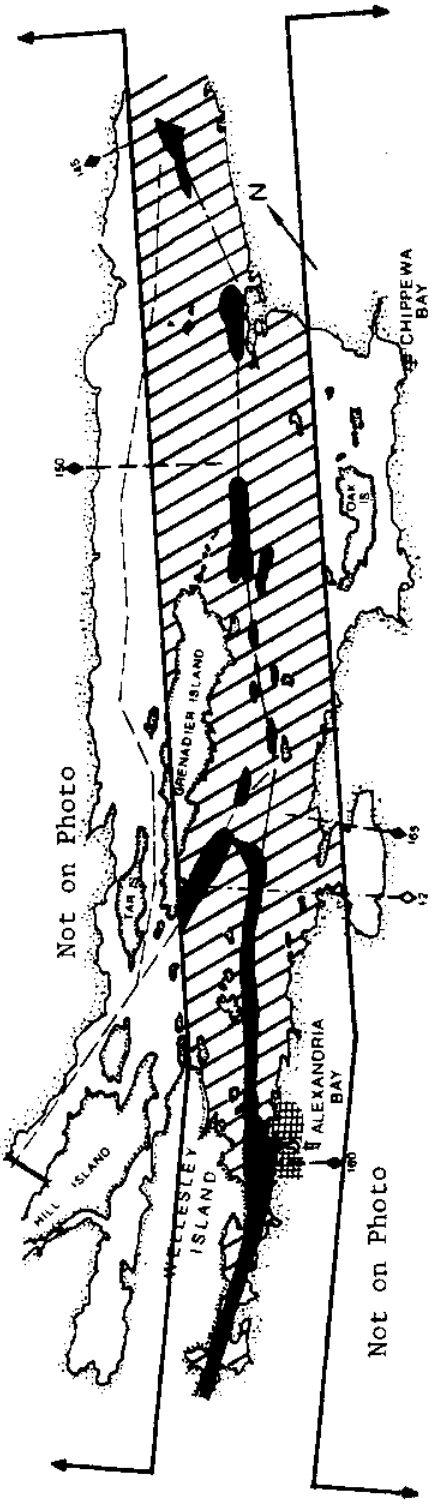


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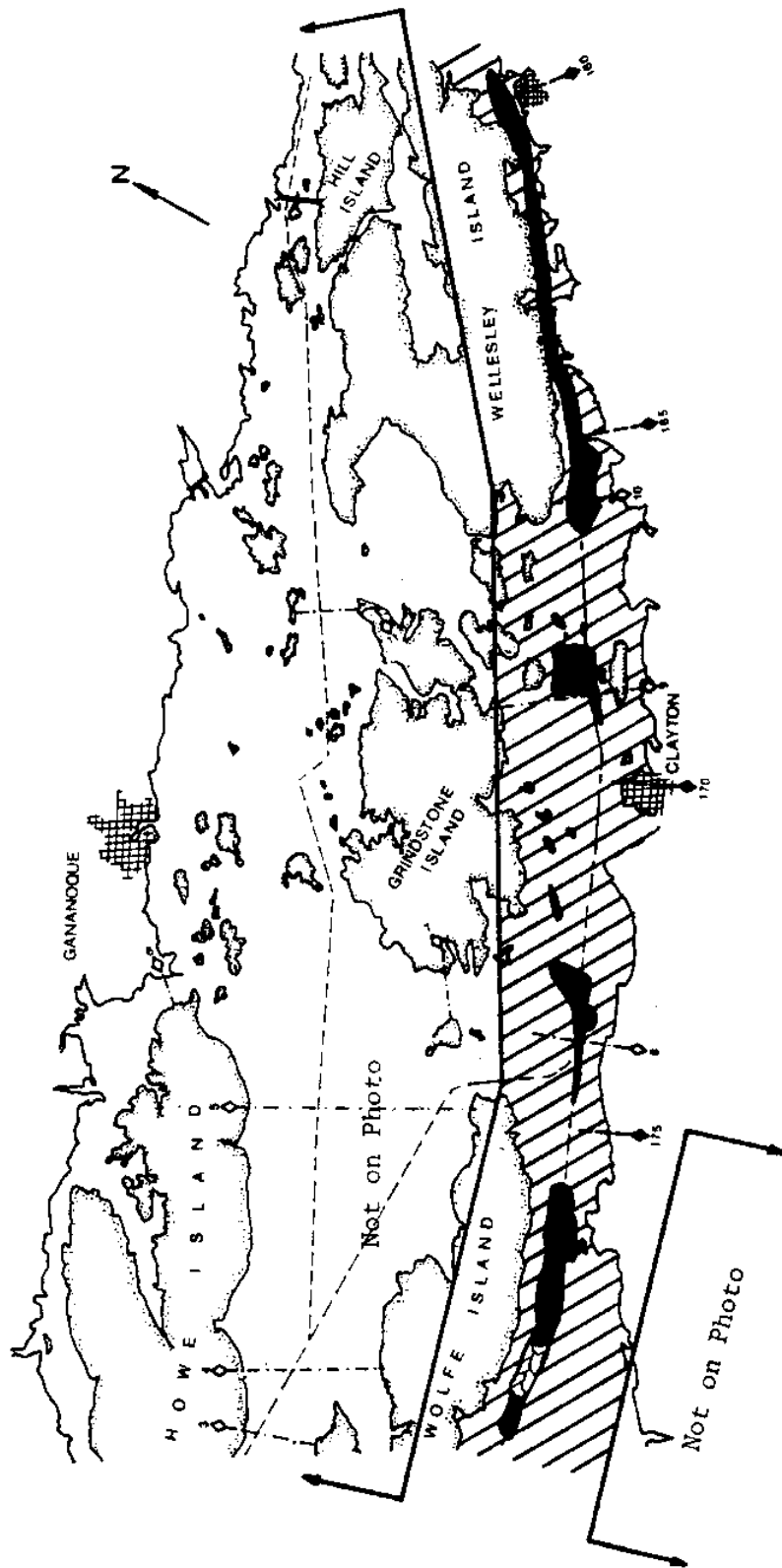




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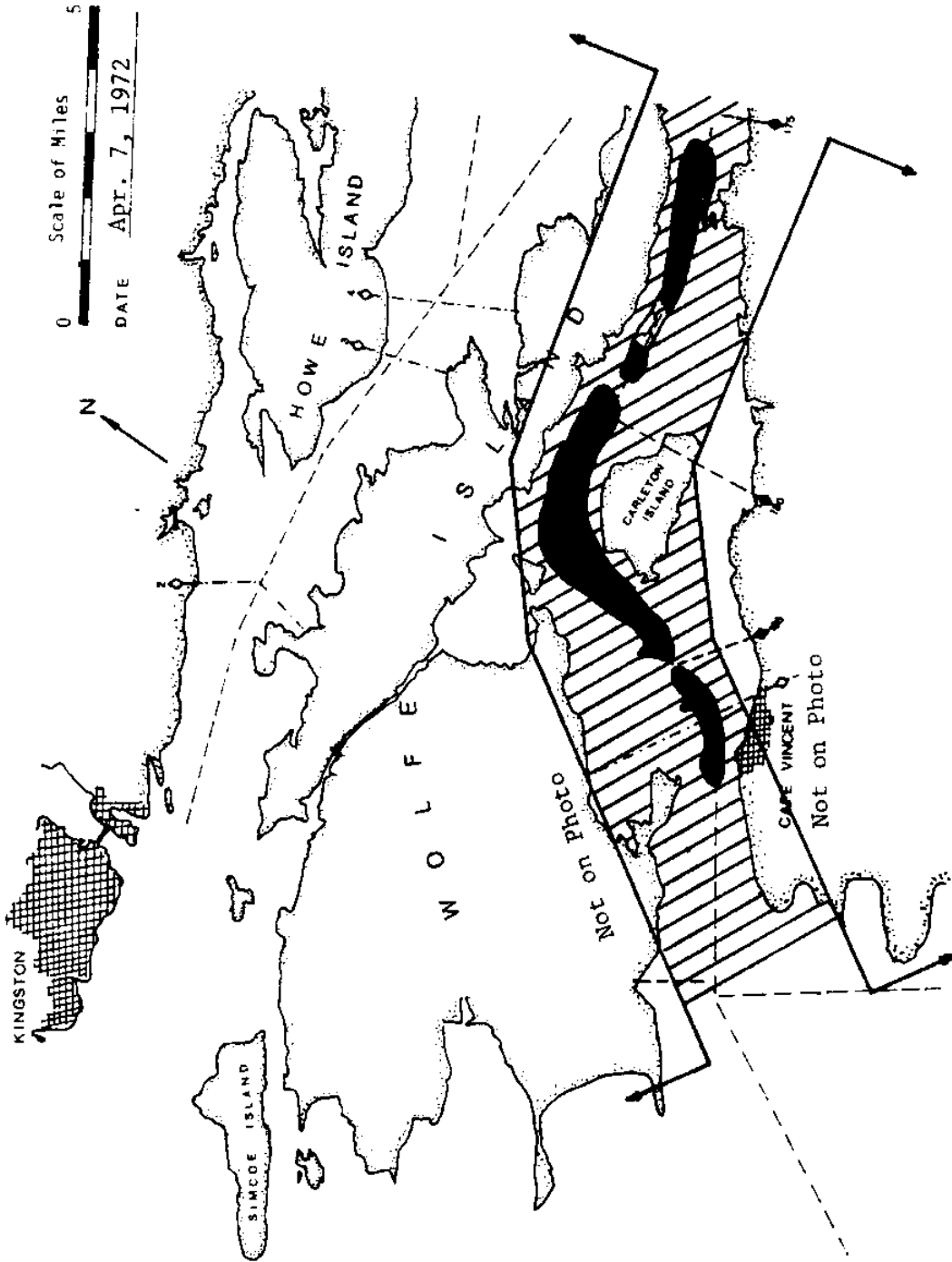


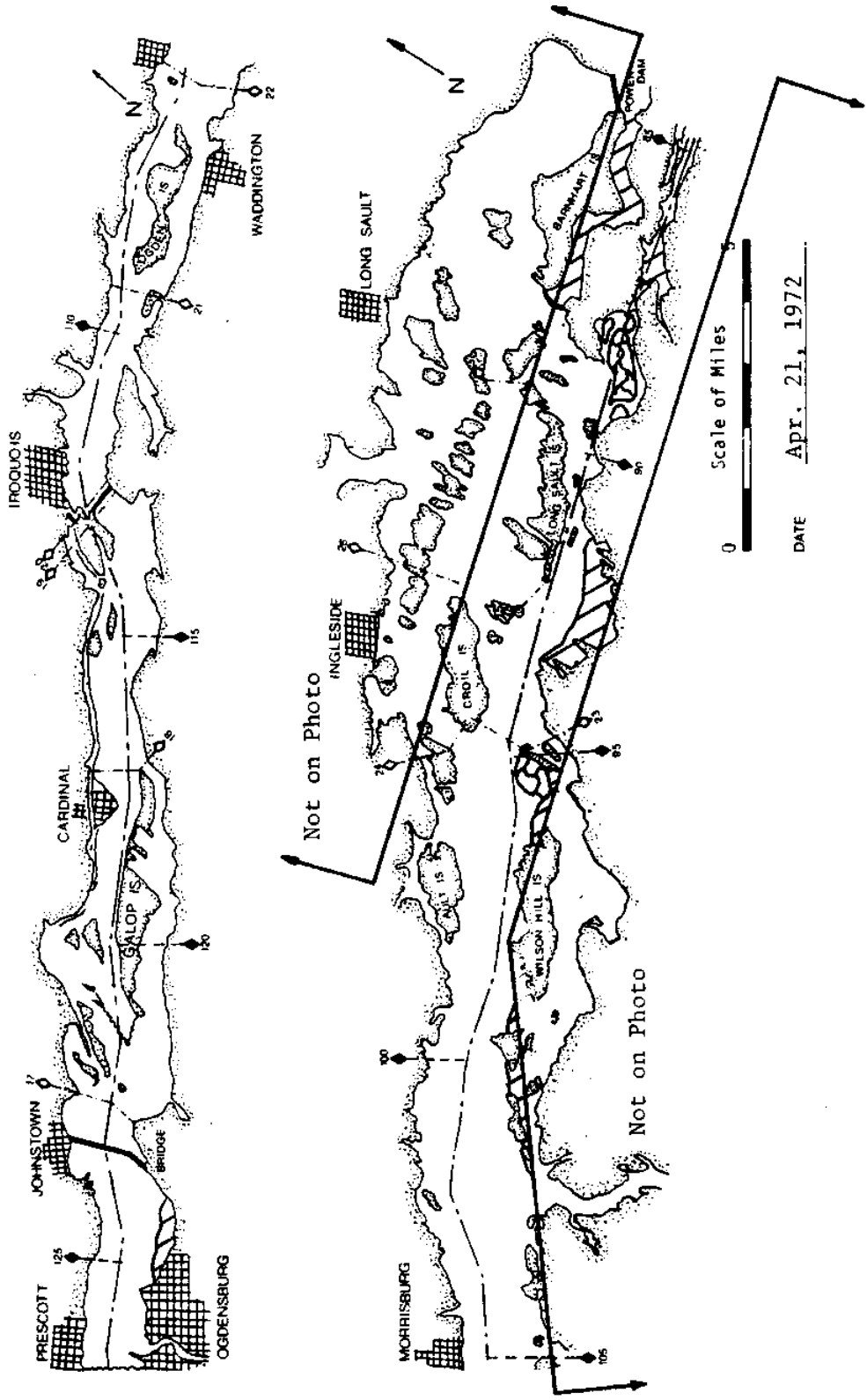
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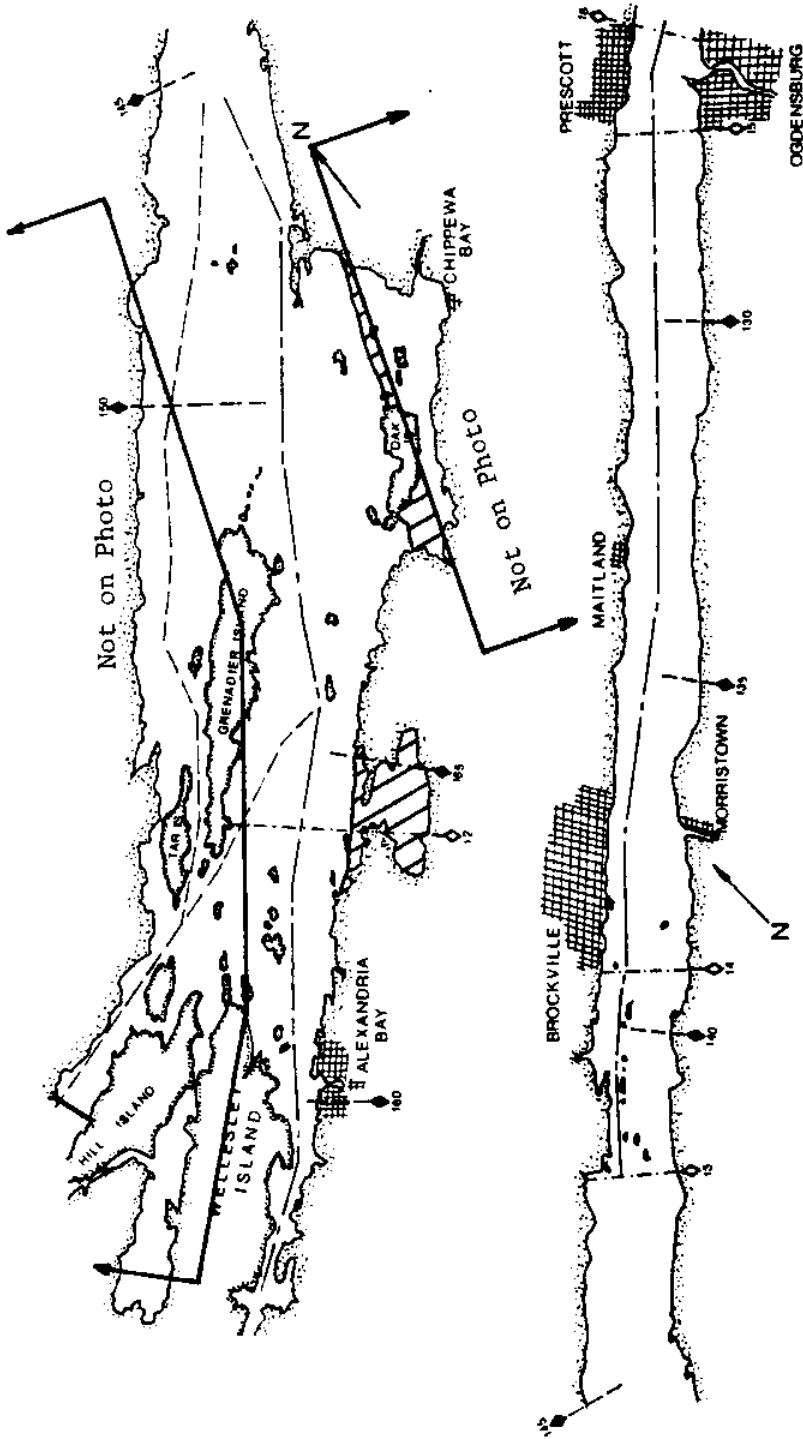


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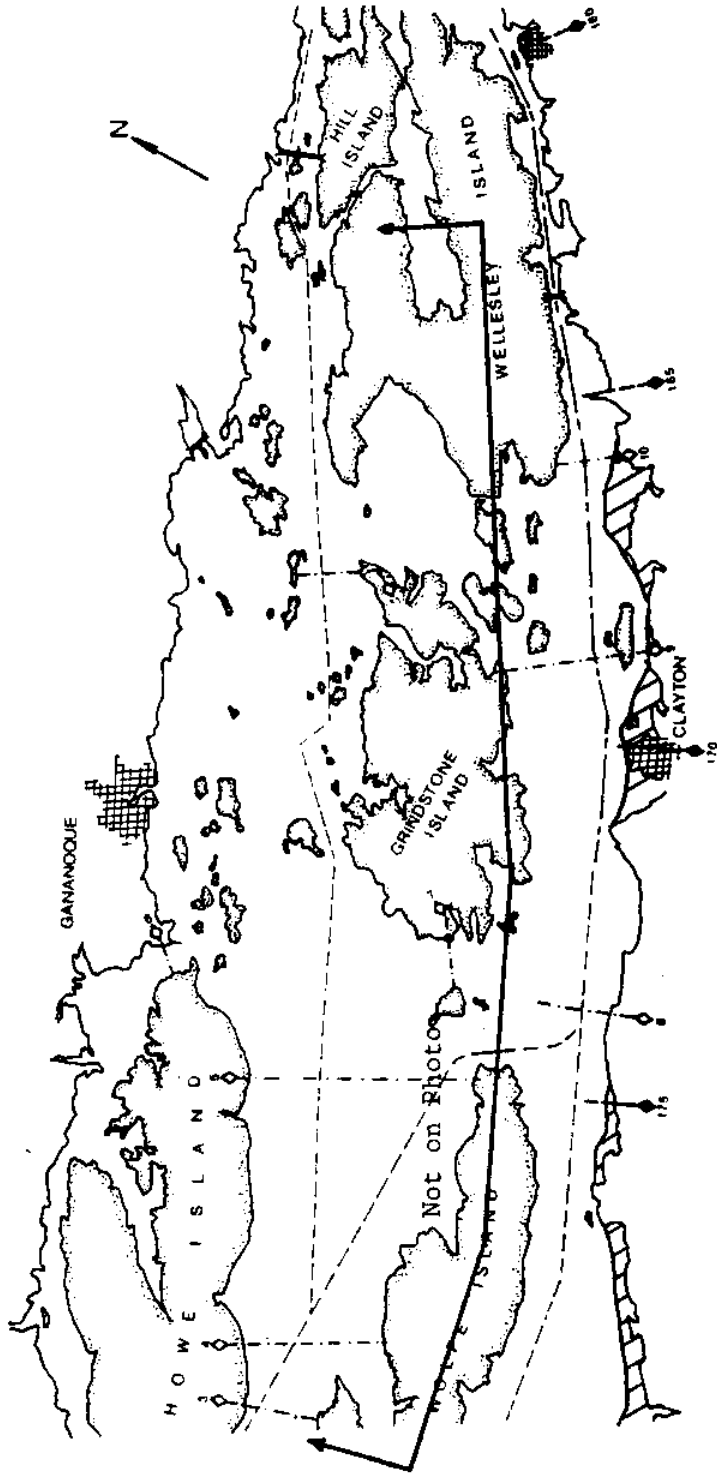
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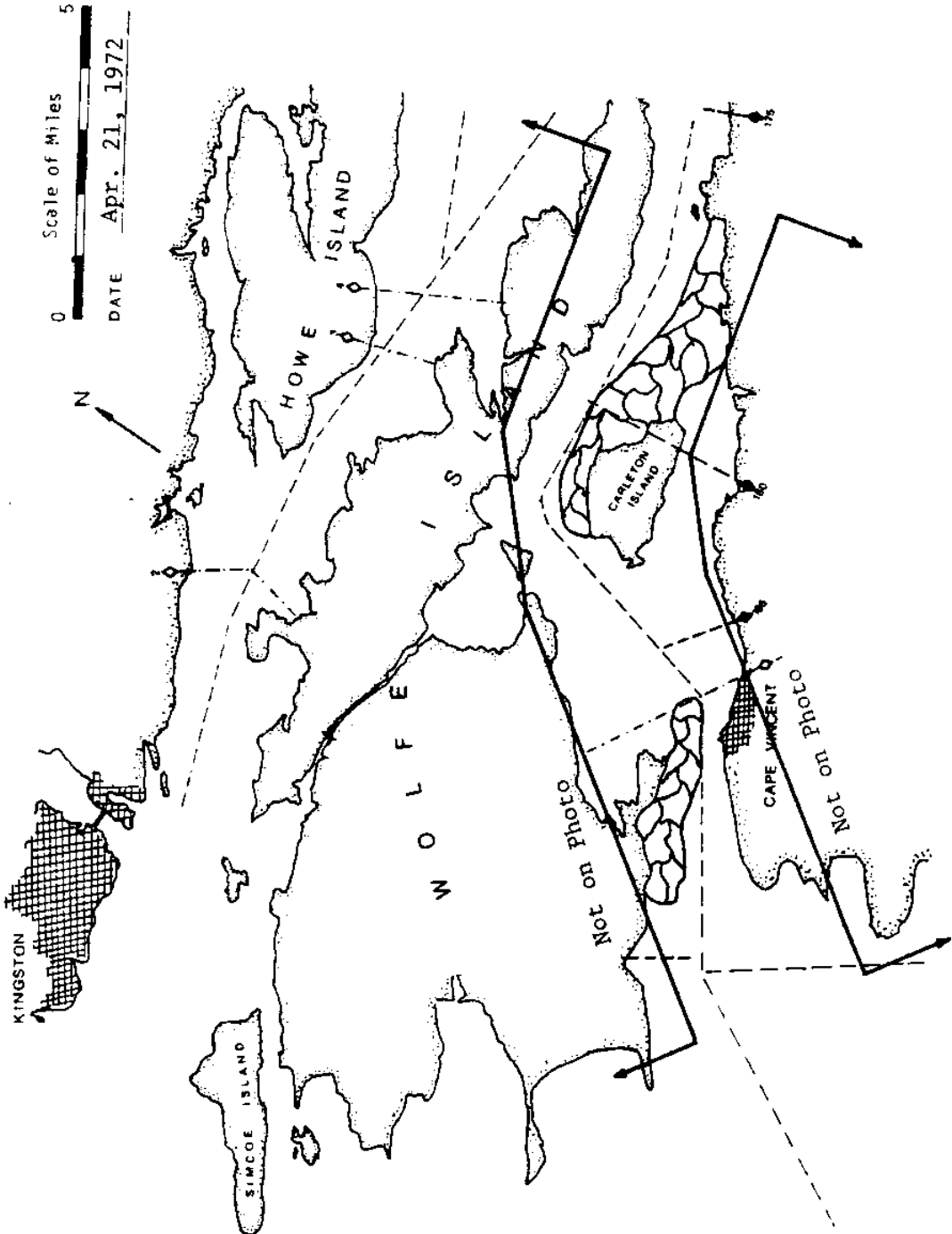


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 DATE Apr. 21, 1972

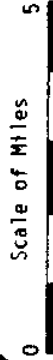
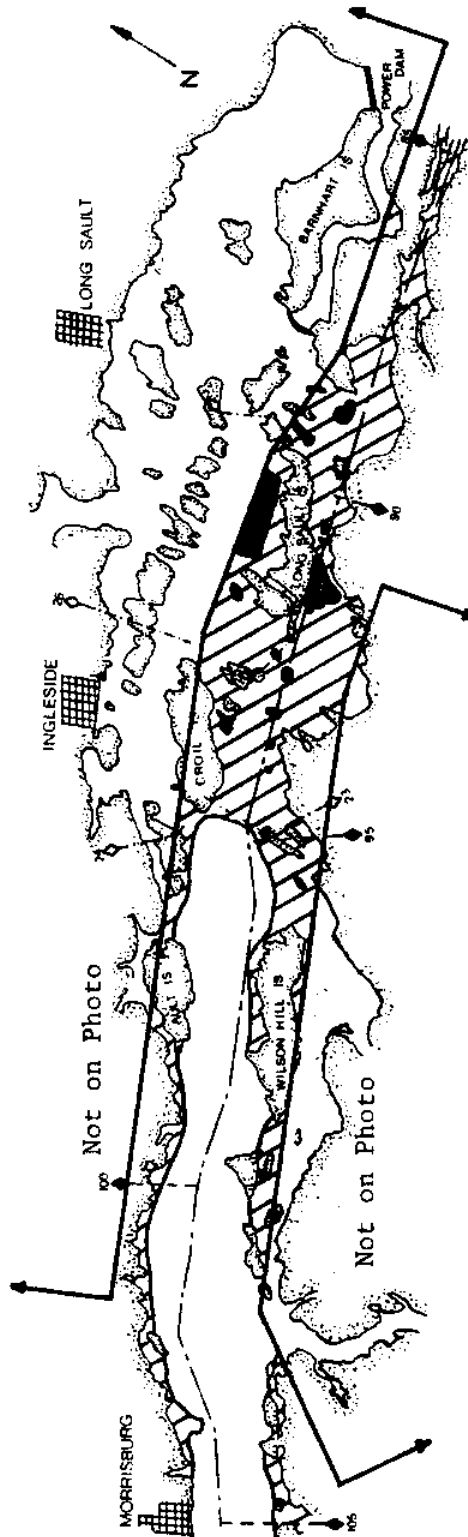
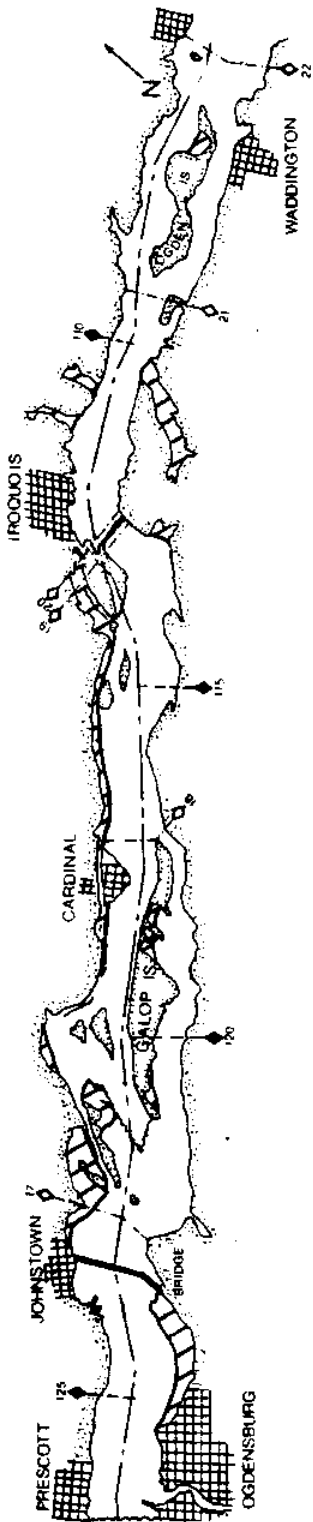


0 Scale of Miles 5

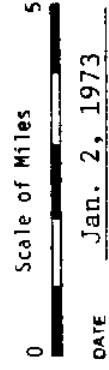
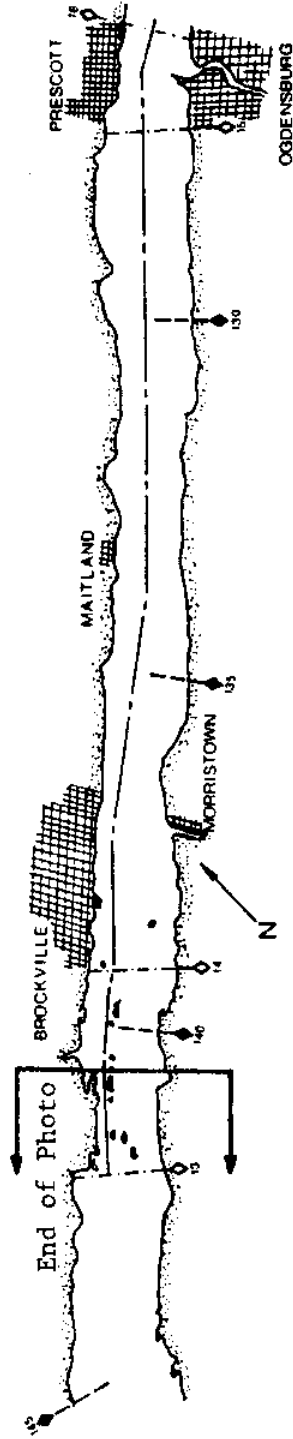
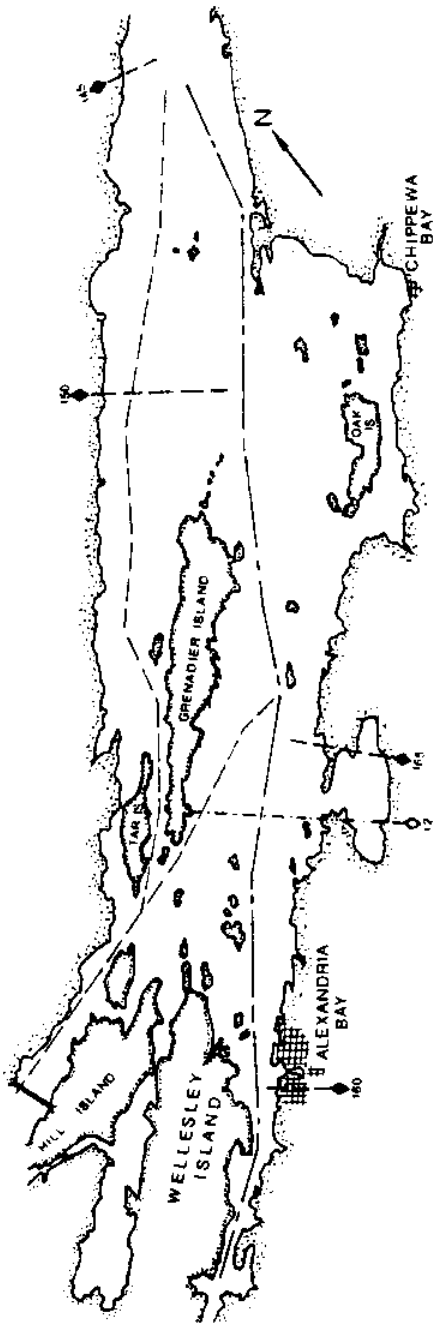
DATE APR. 21, 1972

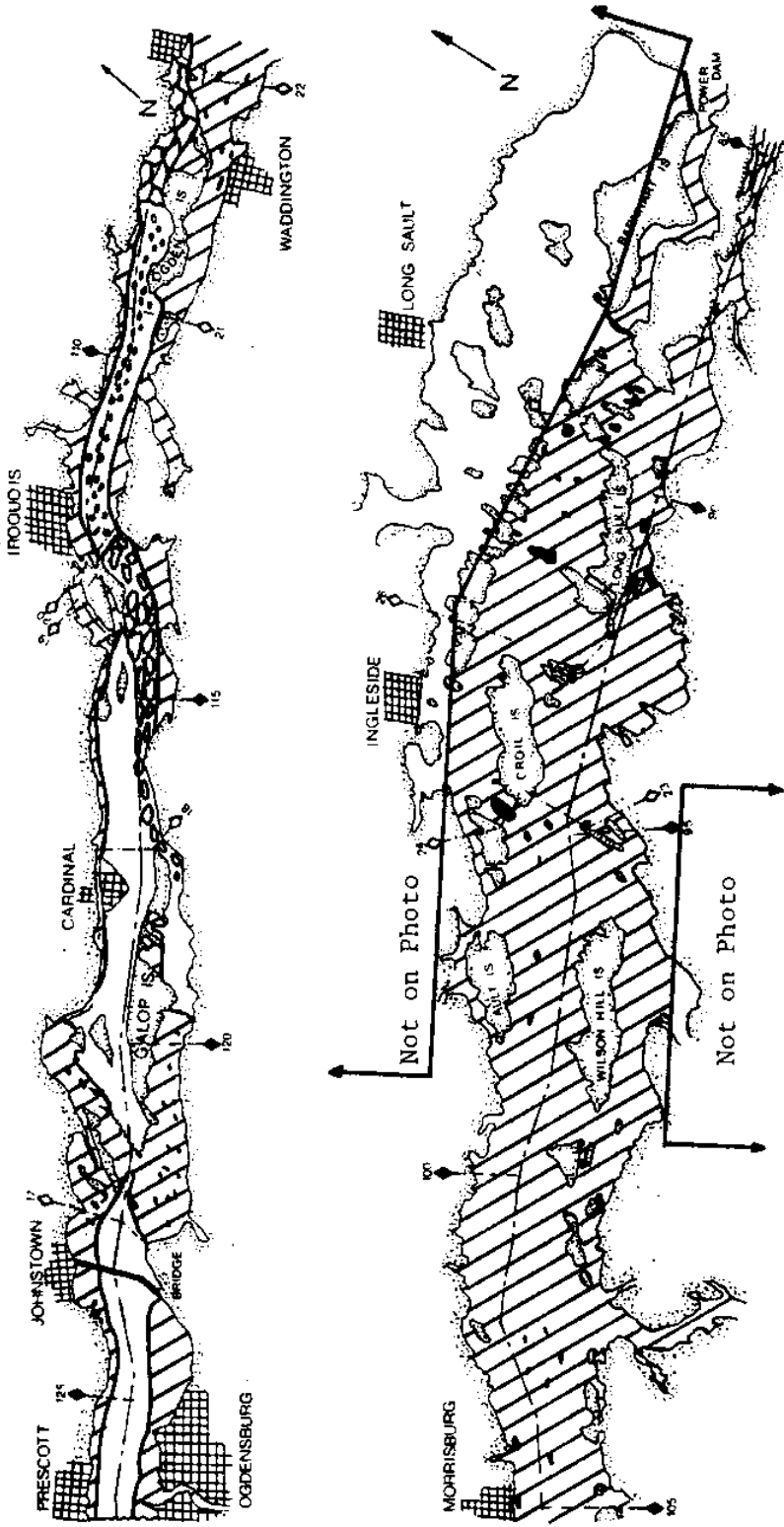


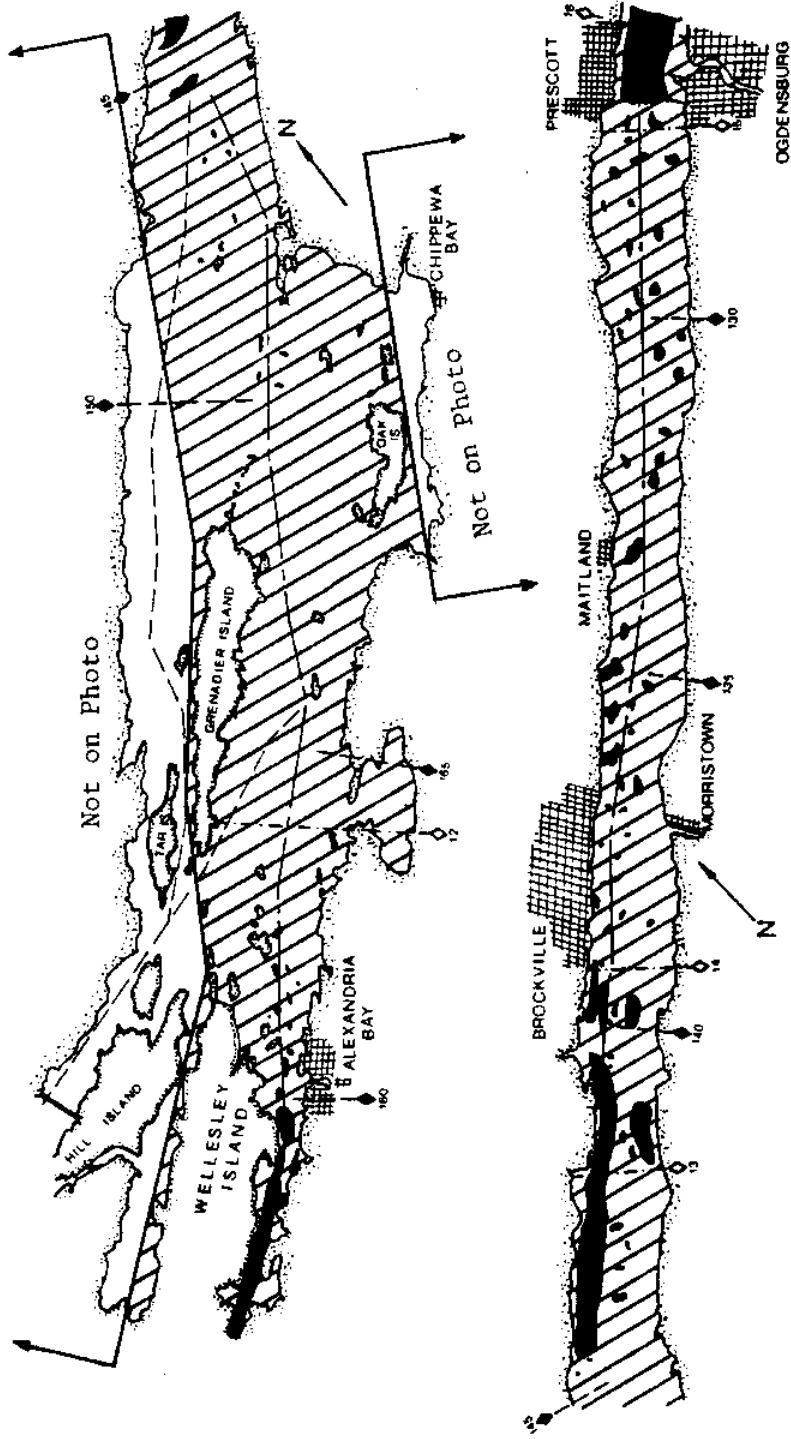
Winter of 1972-73



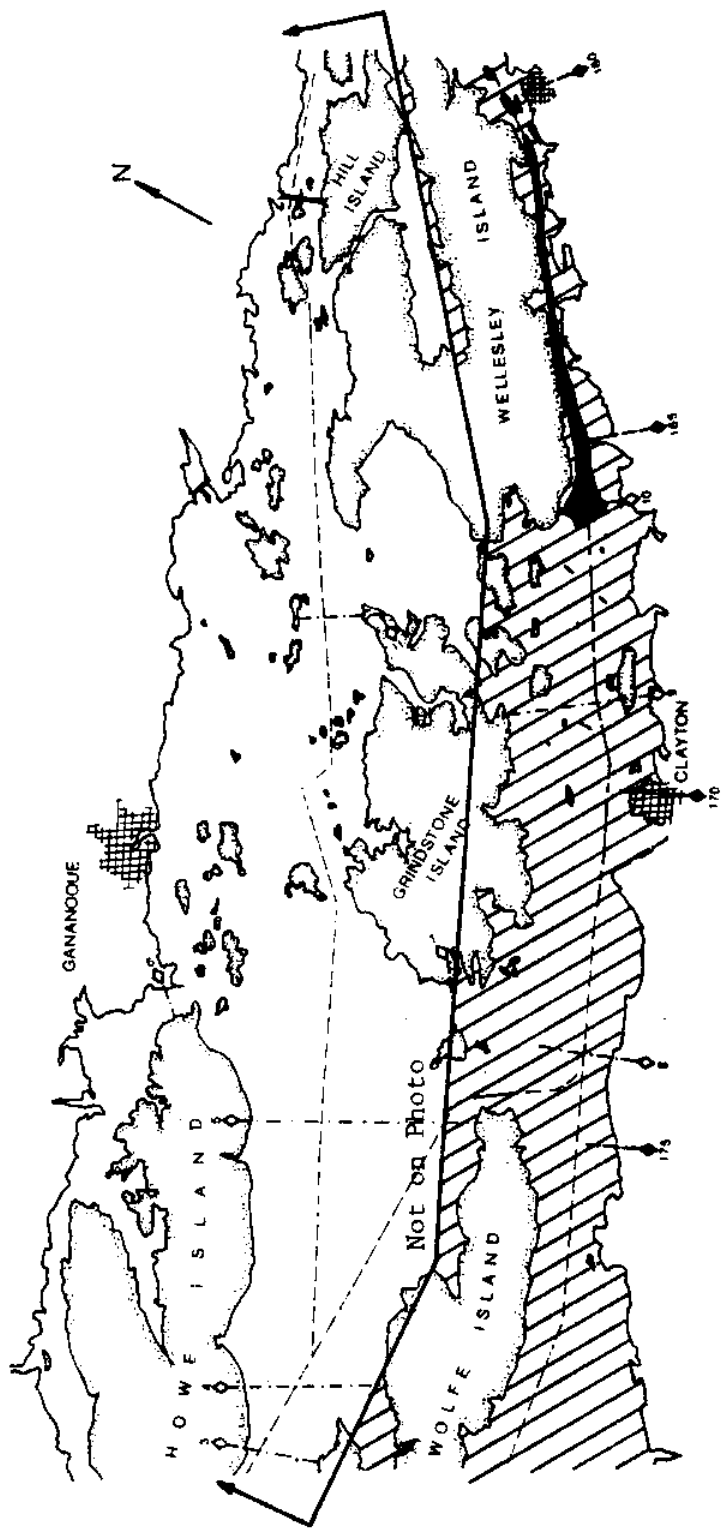
DATE Jan. 2, 1973





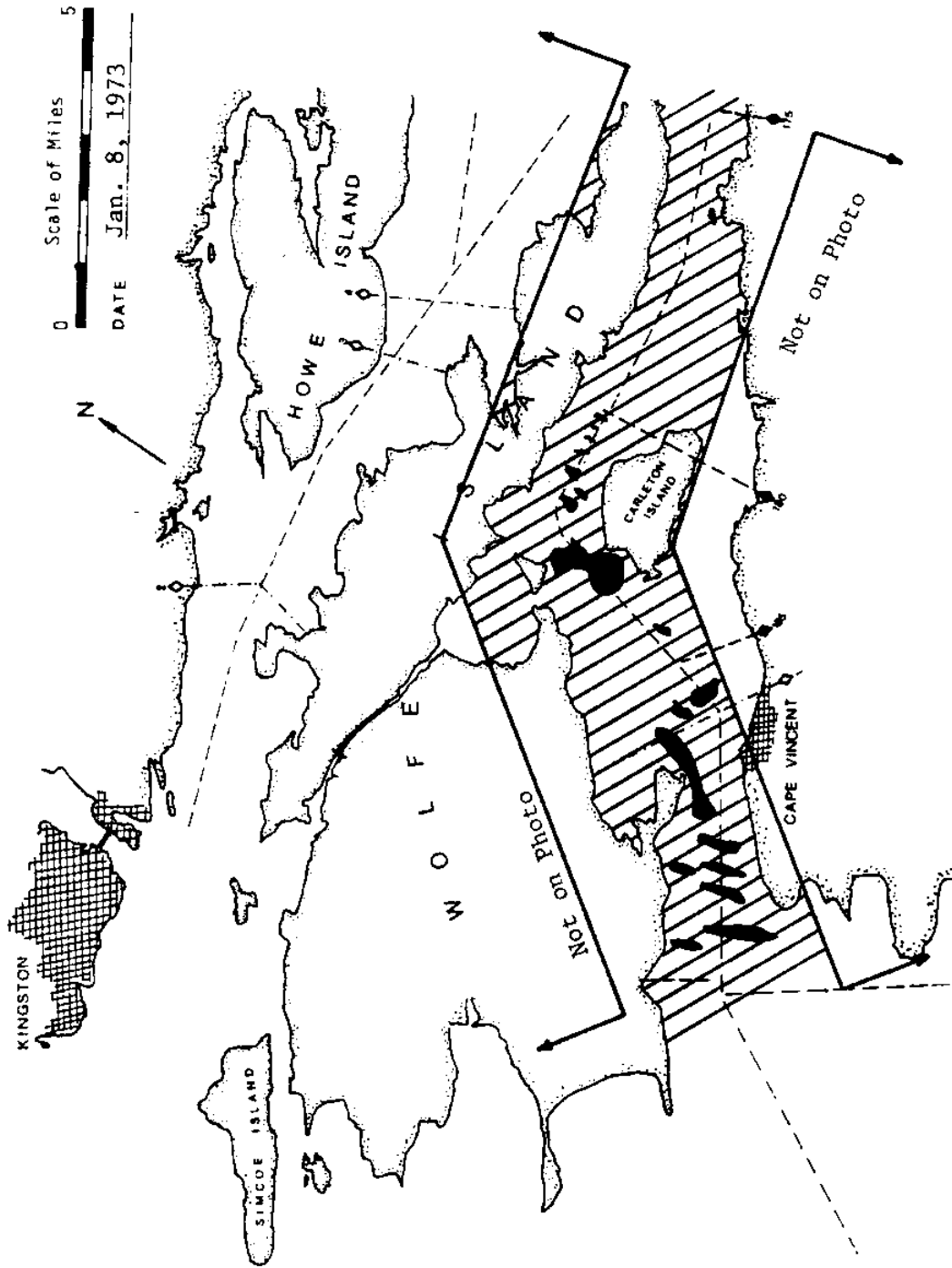


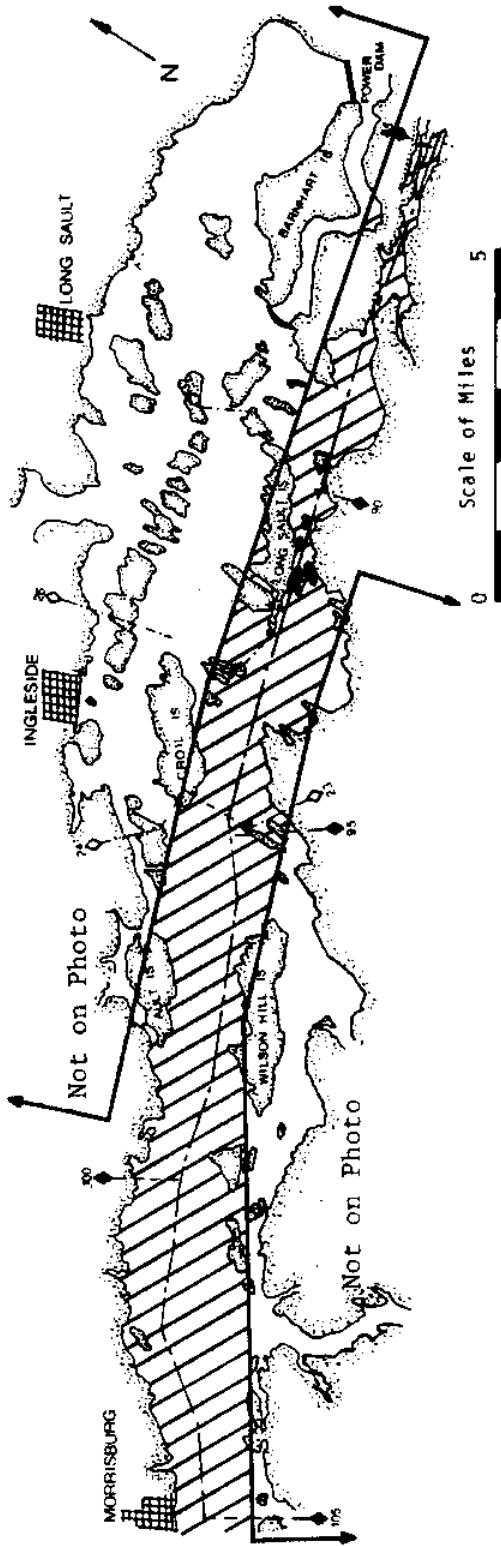
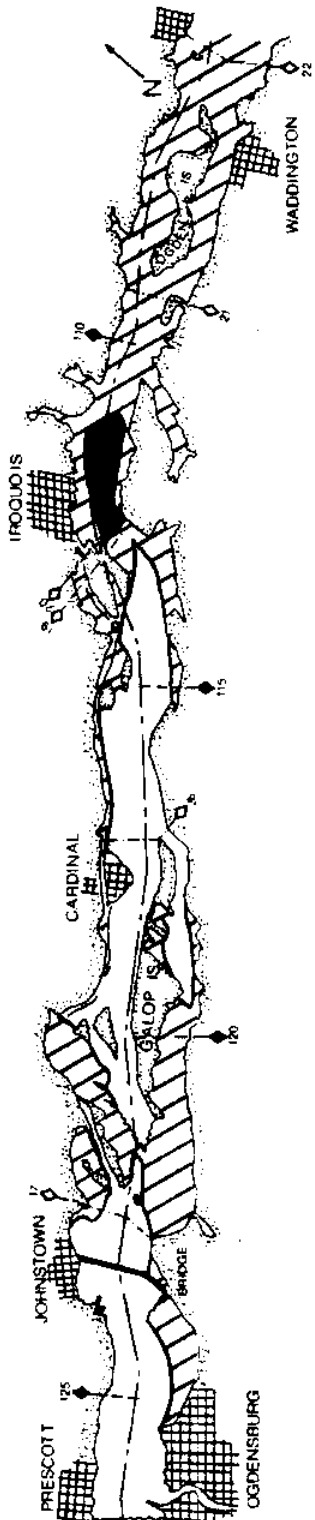
0 Scale of Miles 5
 DATE Jan. 8, 1973

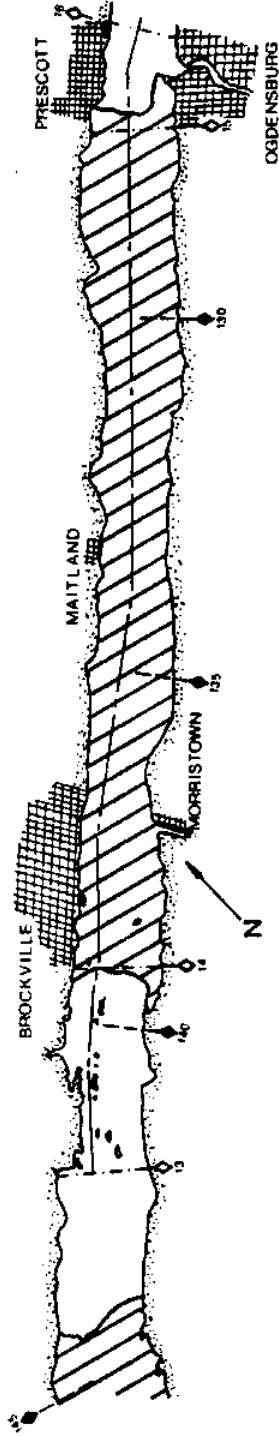
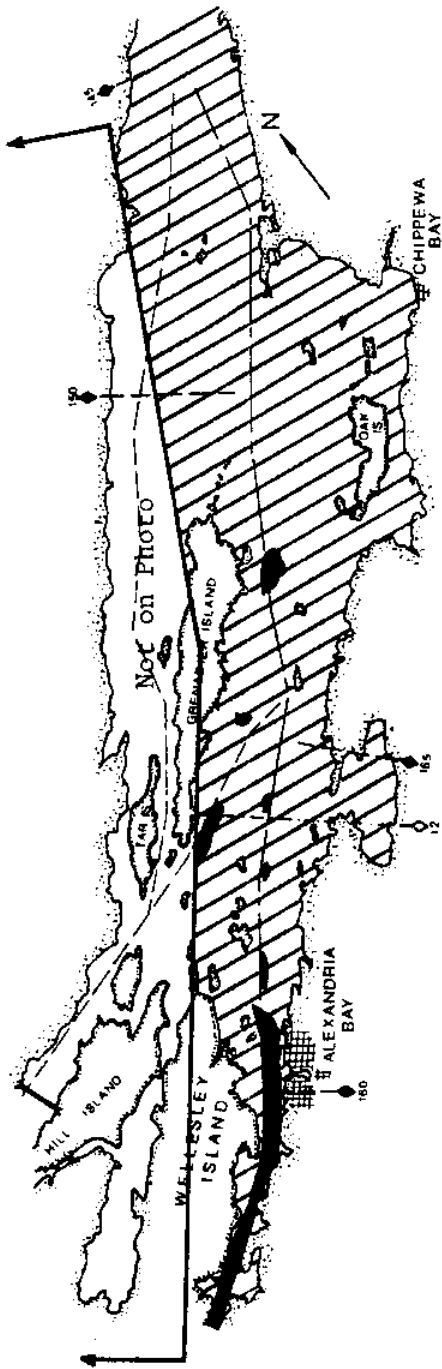


0 Scale of Miles 5

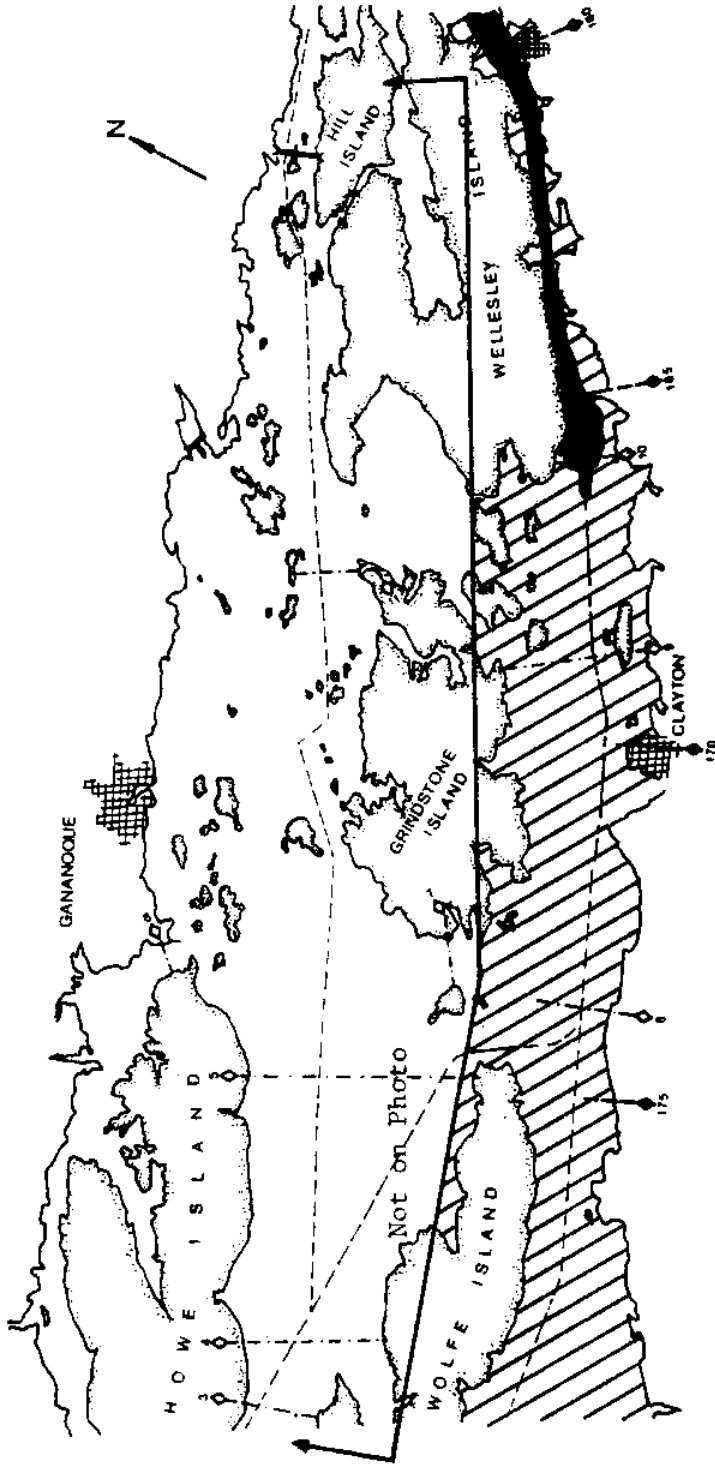
DATE Jan. 8, 1973





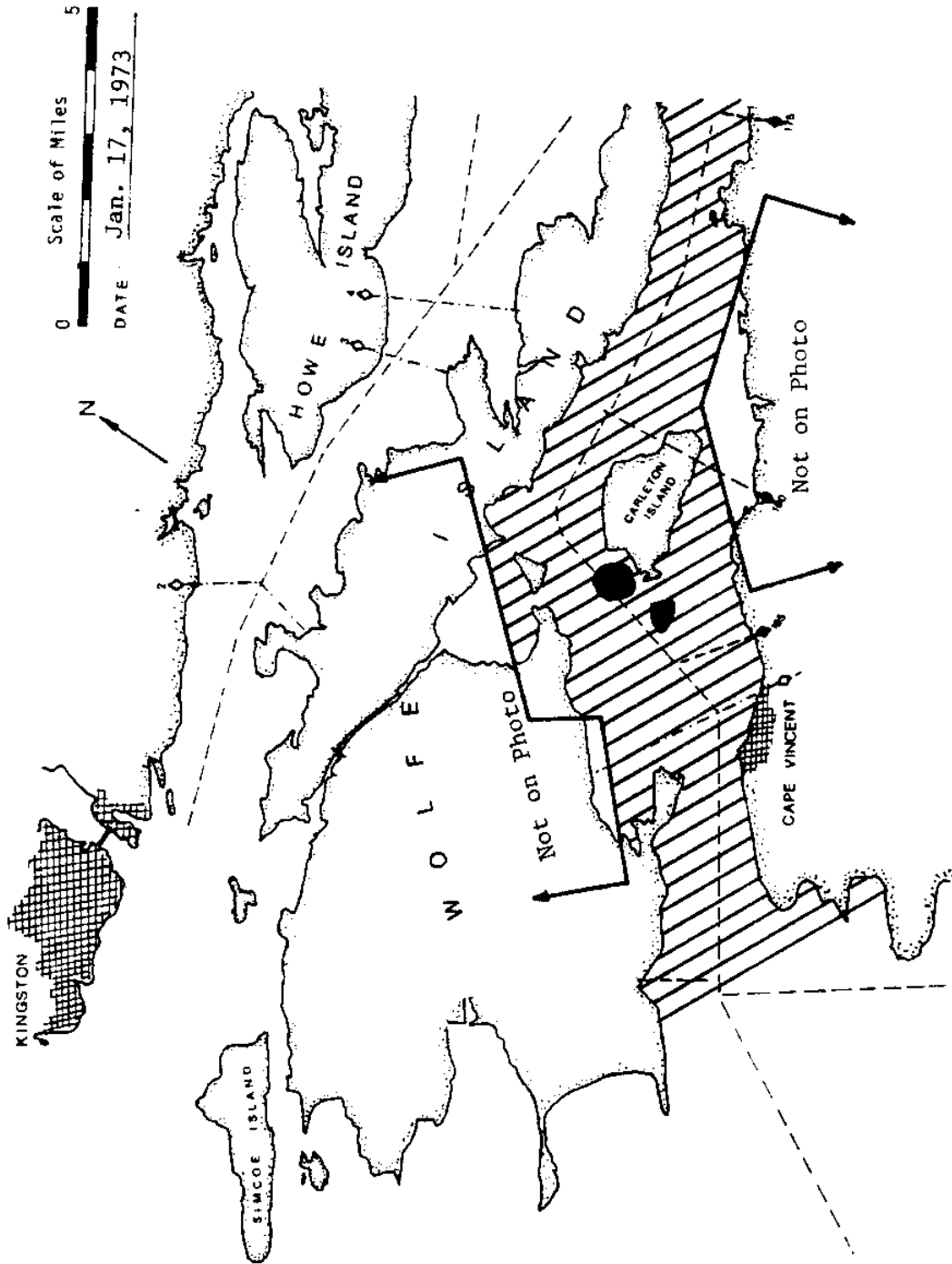


0 Scale of Miles 5
DATE Jan. 17, 1973



0 Scale of Miles 5

DATE Jan. 17, 1973



Scale of Miles 5
DATE: Jan. 17, 1973

KINGSTON

SIMCOE ISLAND

HOWE ISLAND

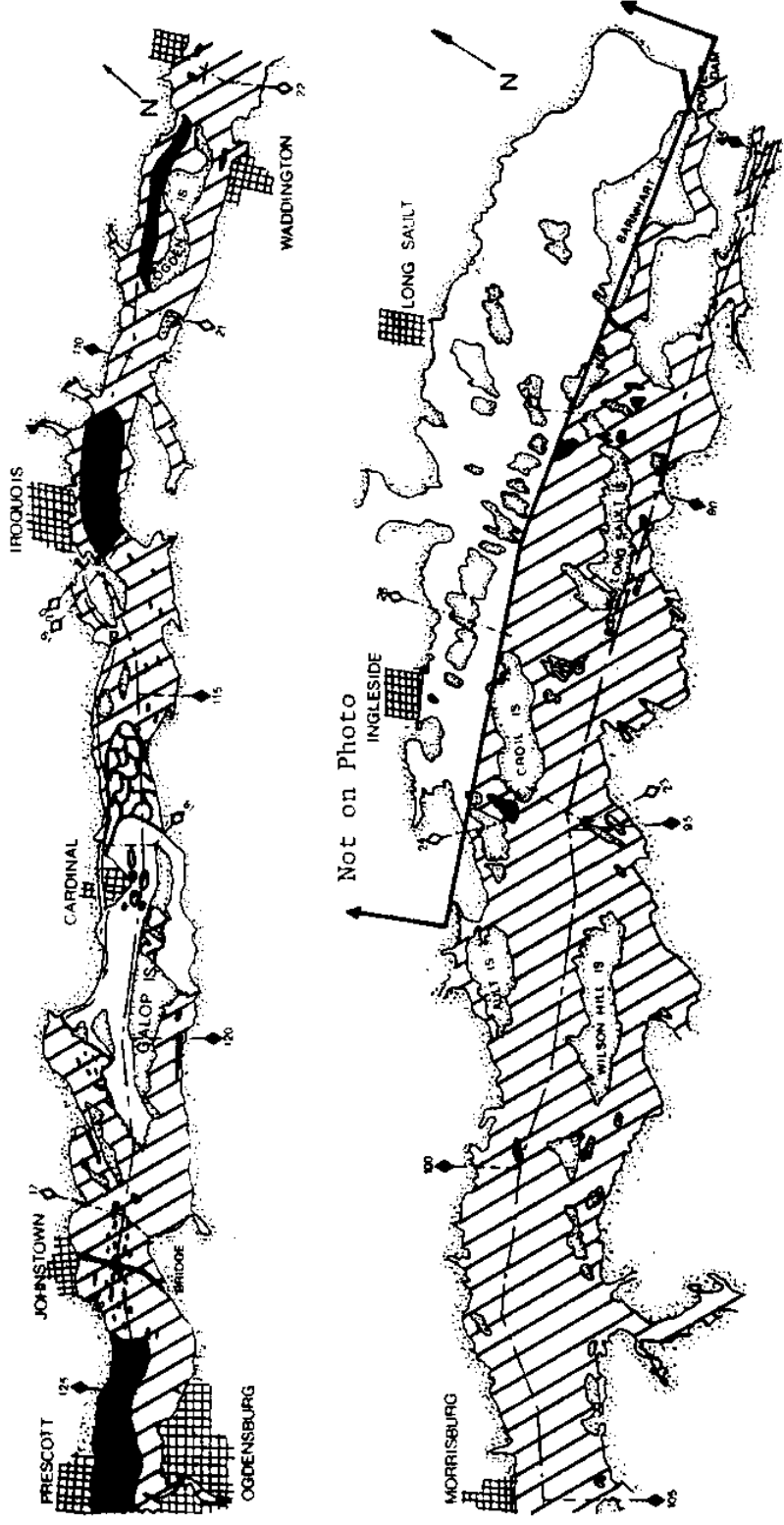
CARLETON ISLAND

CAPE VINCENT

W O L F E

Not on Photo

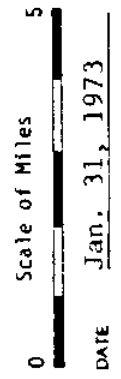
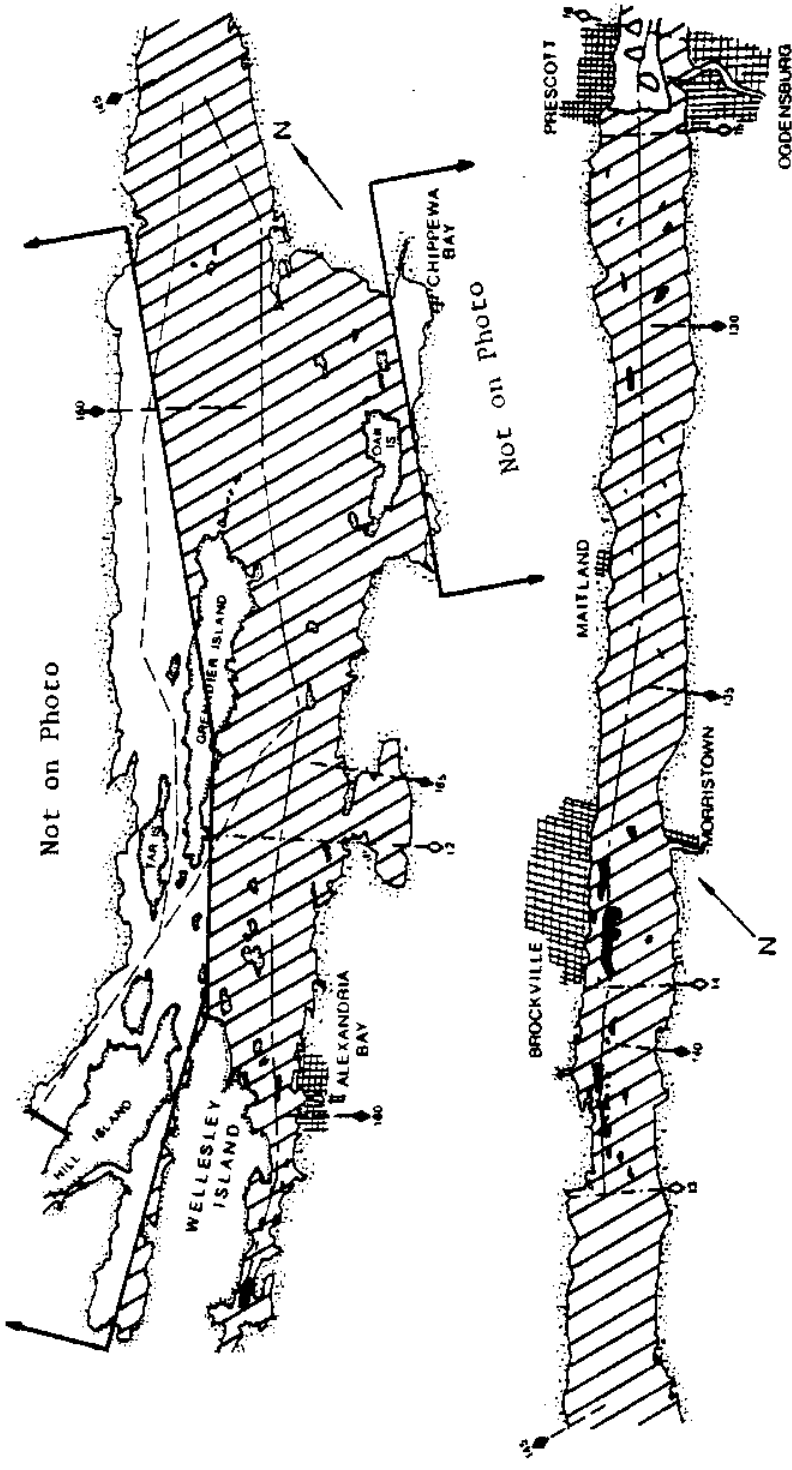
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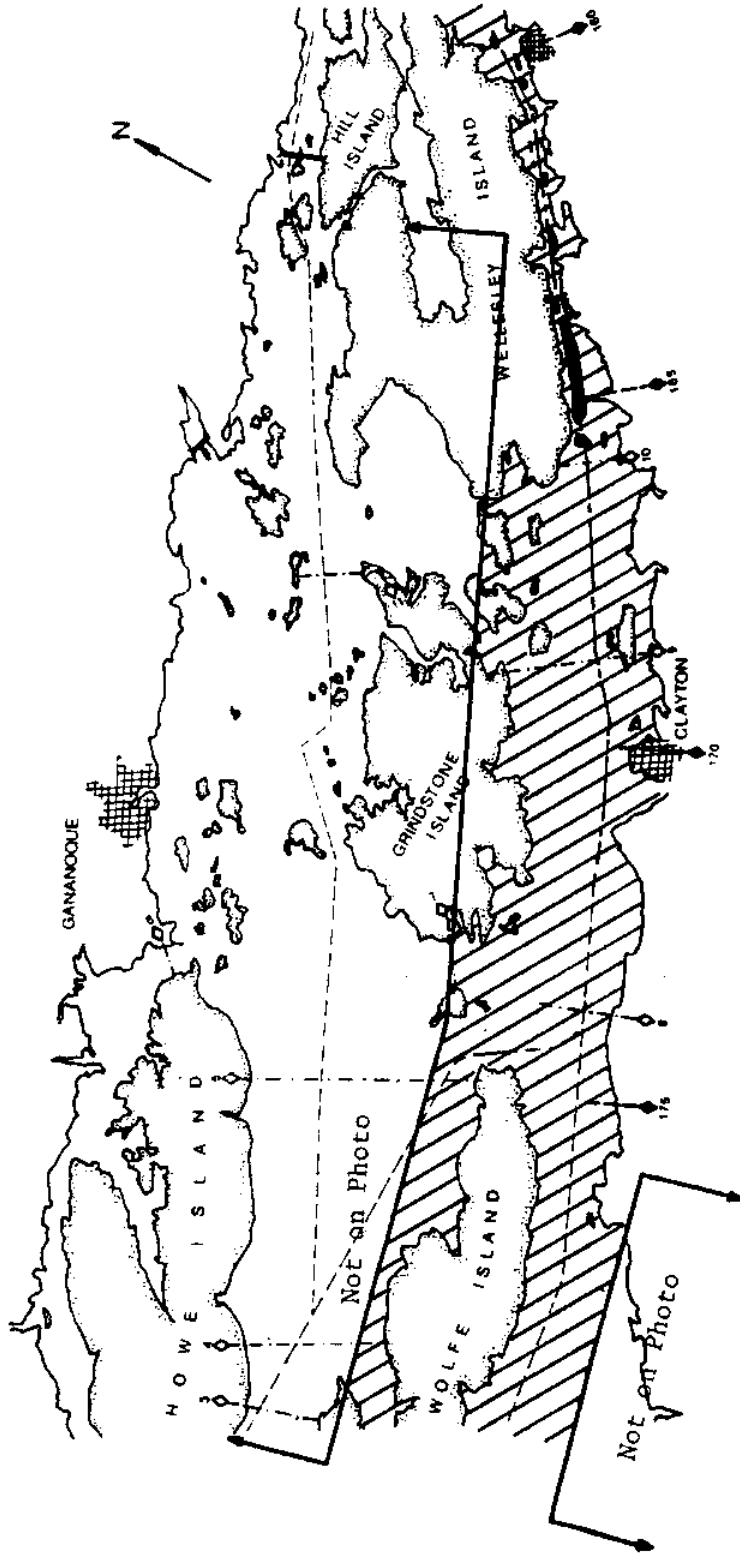


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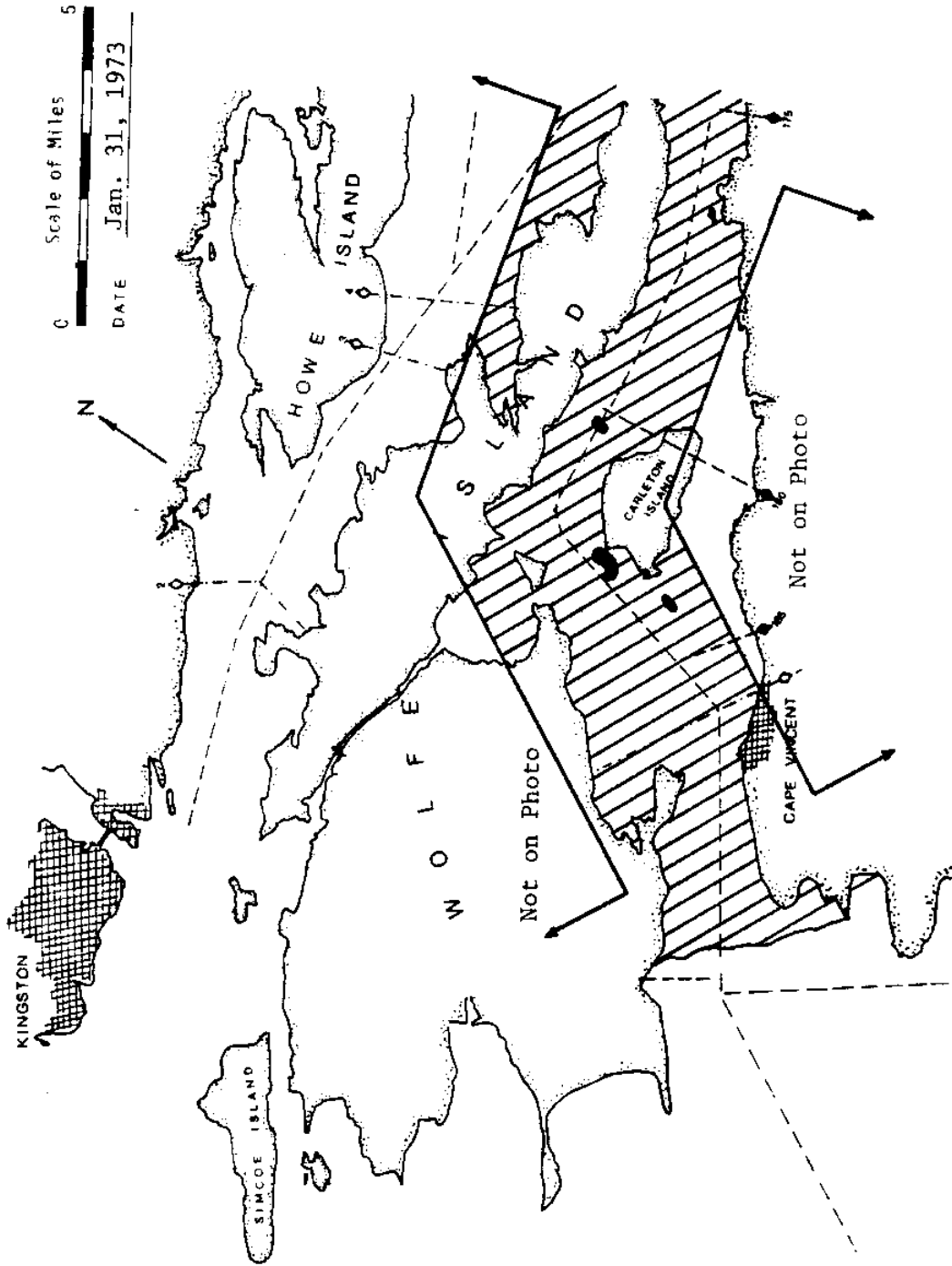
DATE Jan. 31, 1973

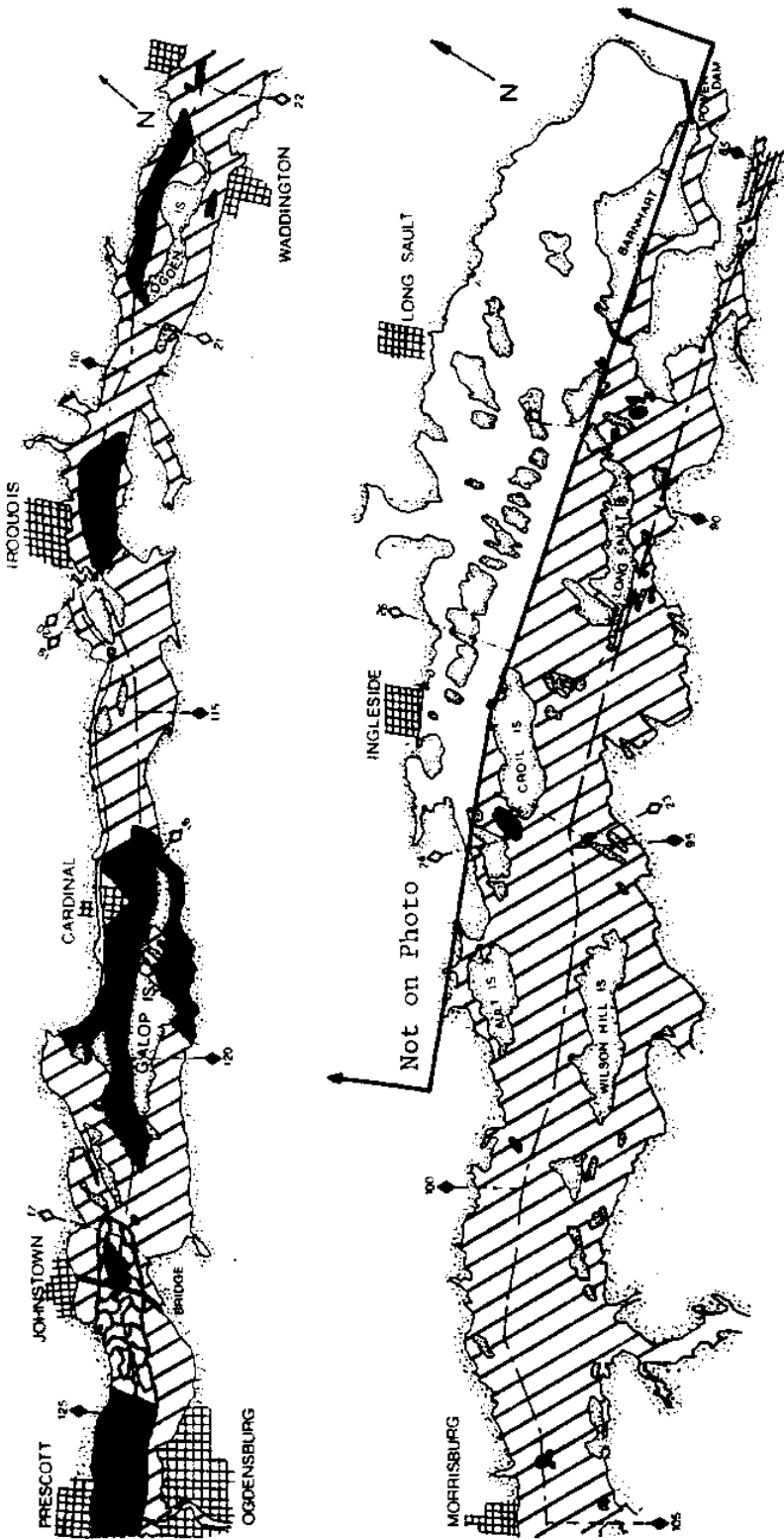




0 Scale of Miles 5

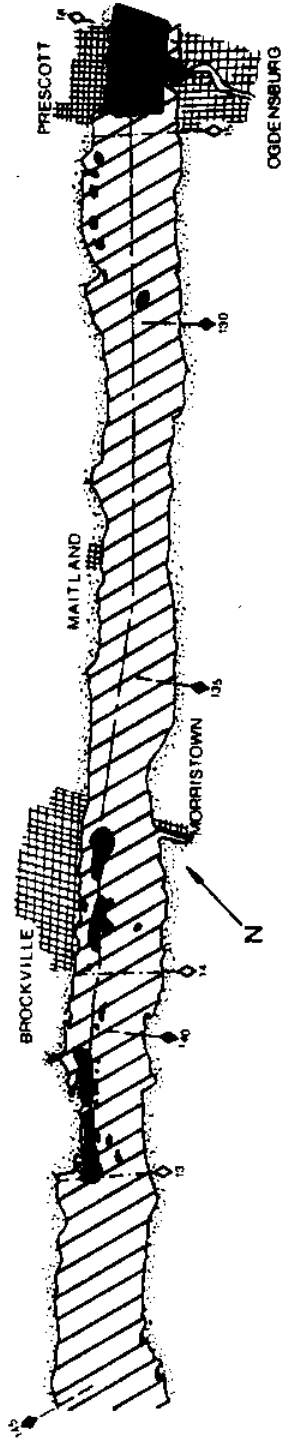
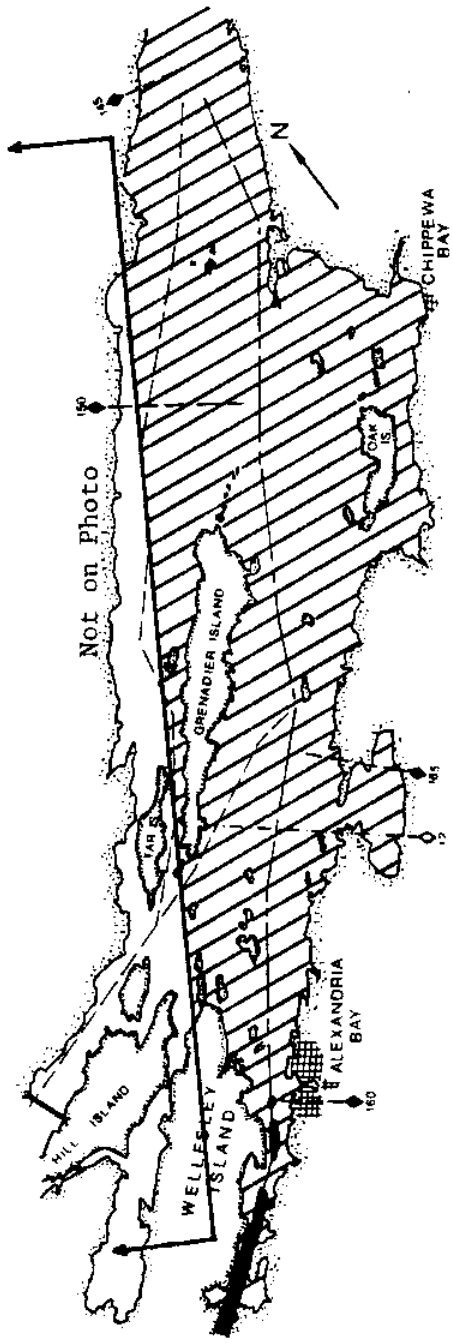
DATE Jan. 31, 1973



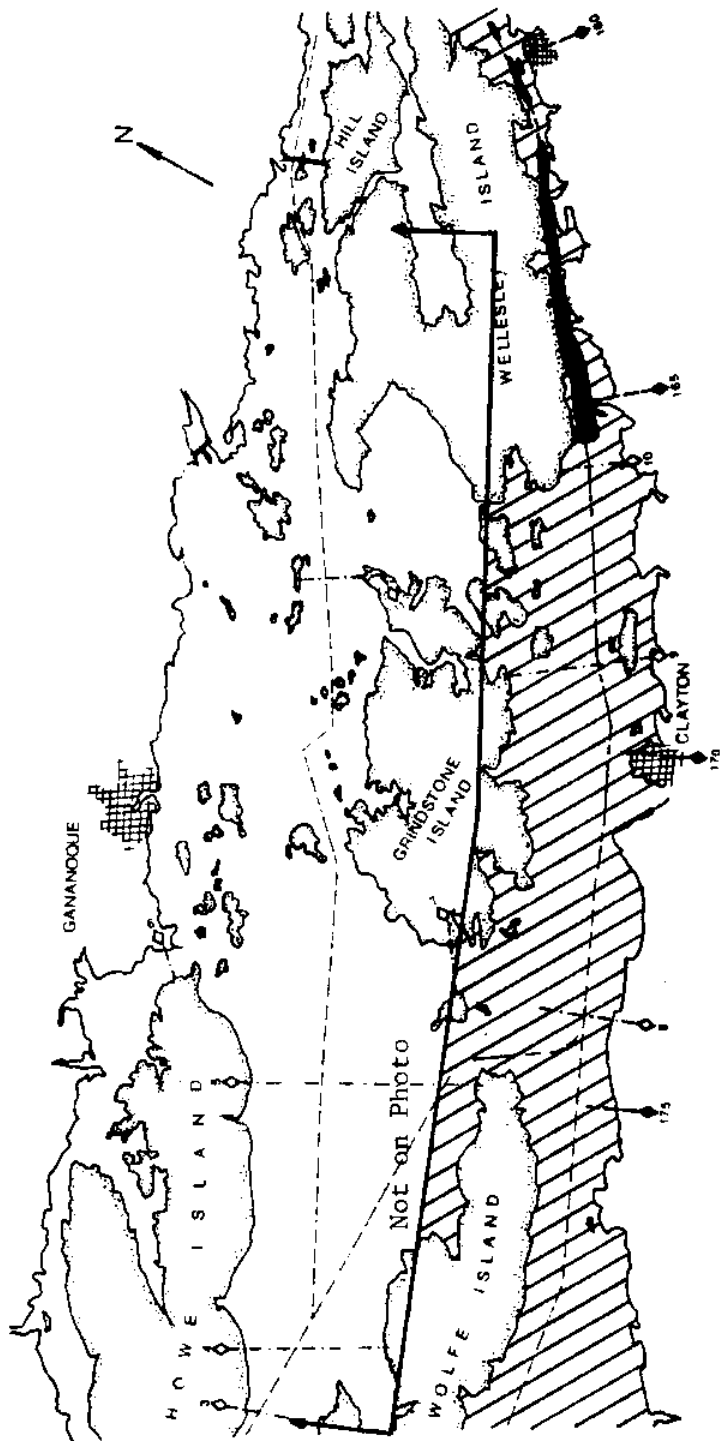


0 Scale of Miles 5

DATE Feb. 5, 1973

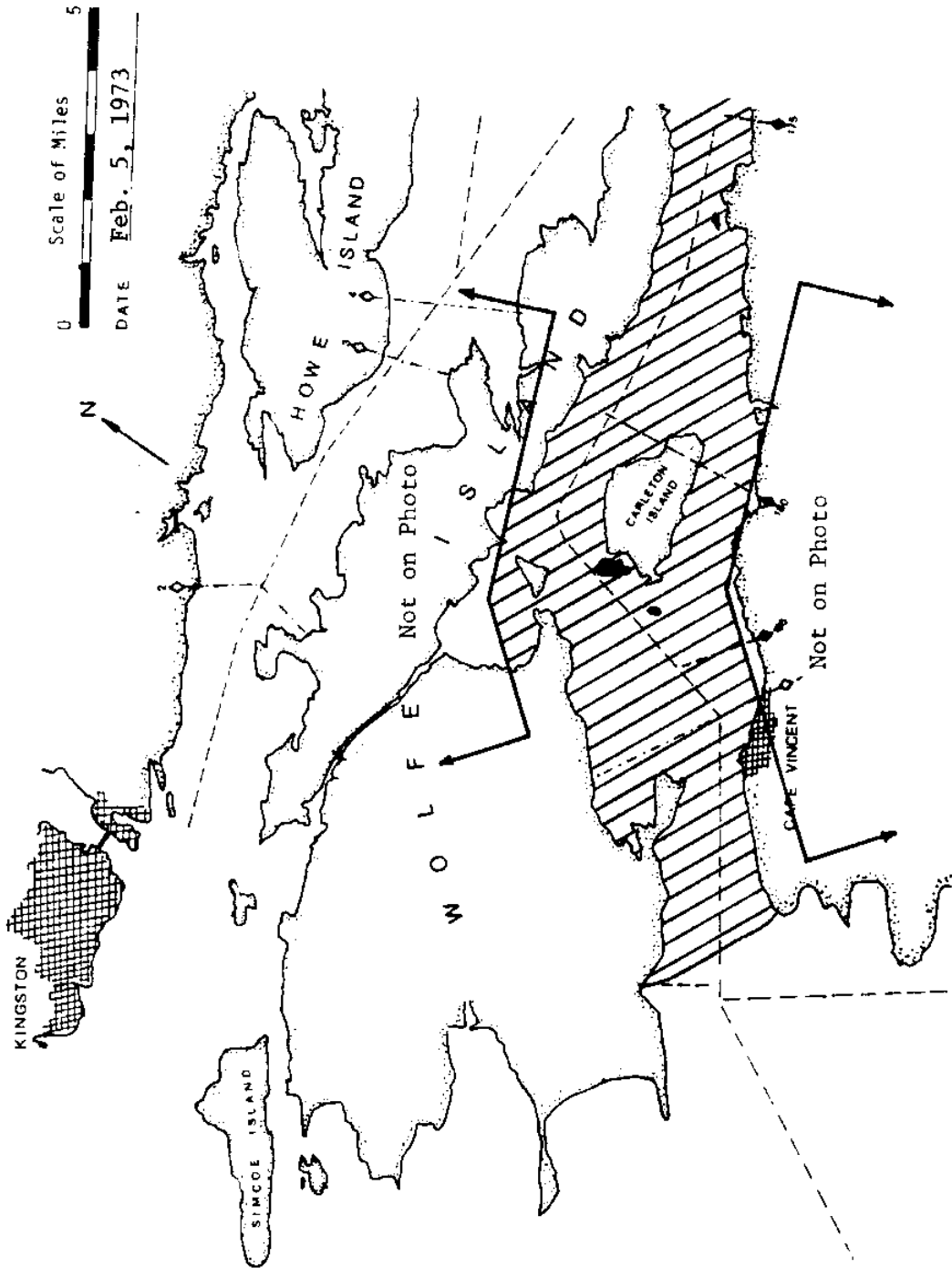


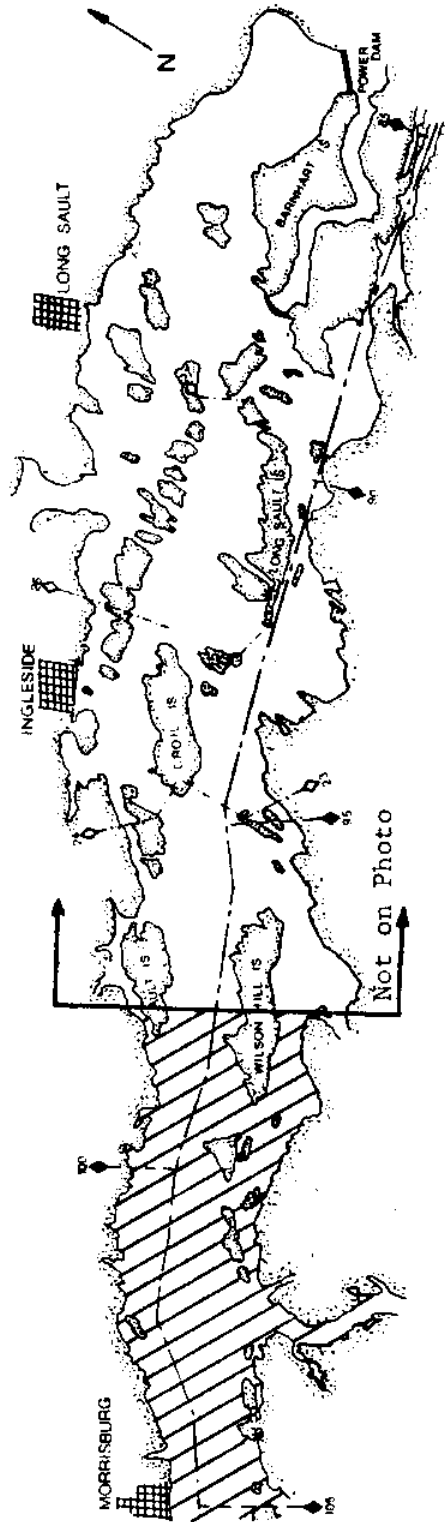
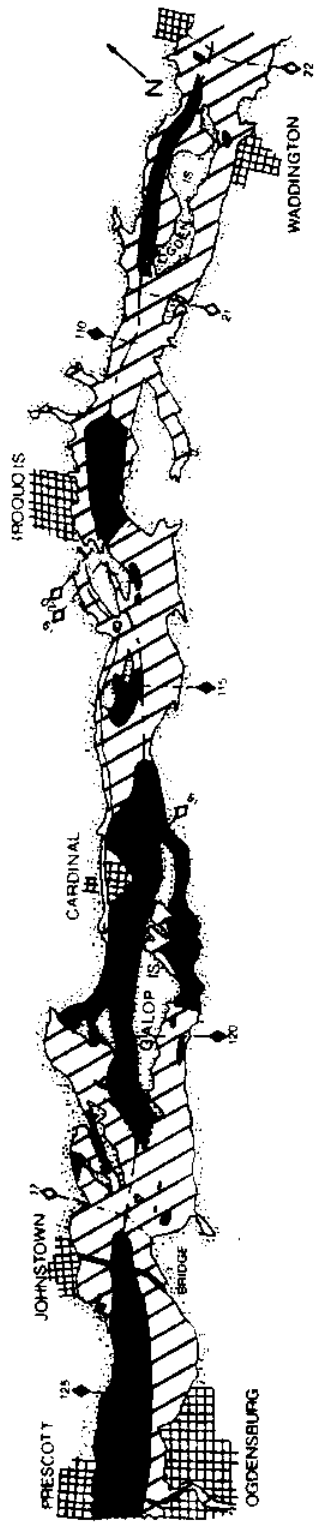
0 Scale of Miles 5
 DATE Feb. 5, 1973



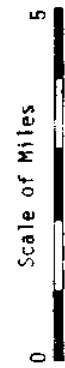
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DATE: Feb. 5, 1973

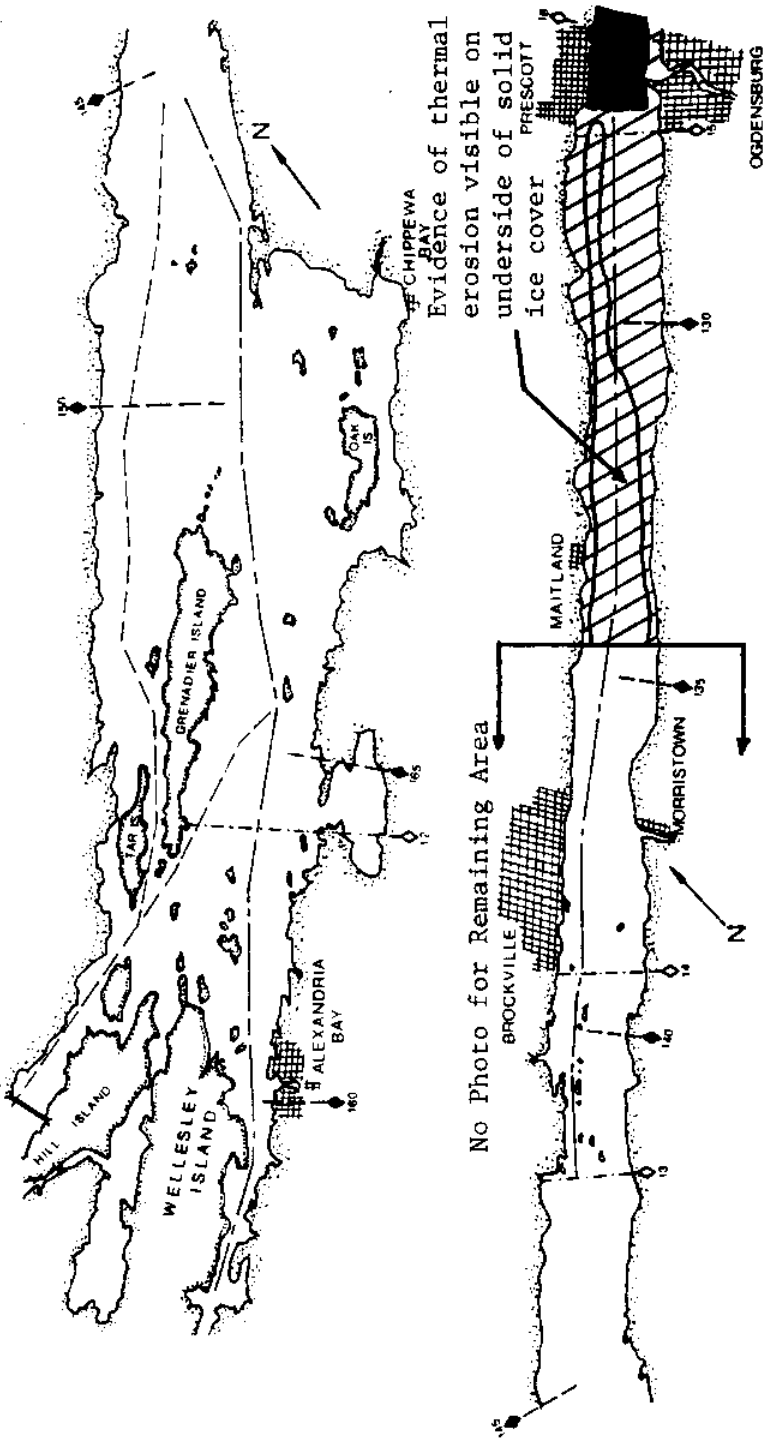




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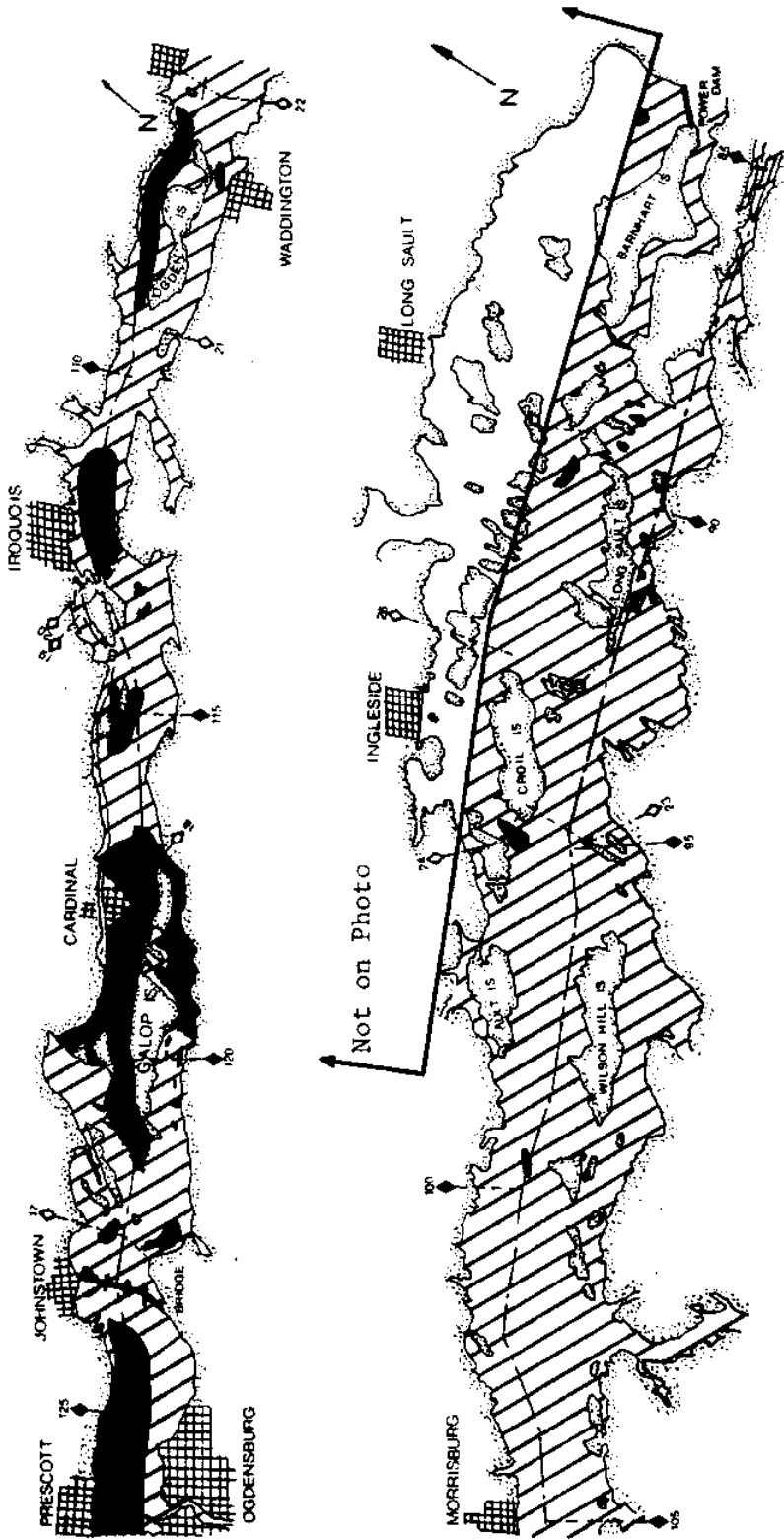


DATE Feb. 12, 1973



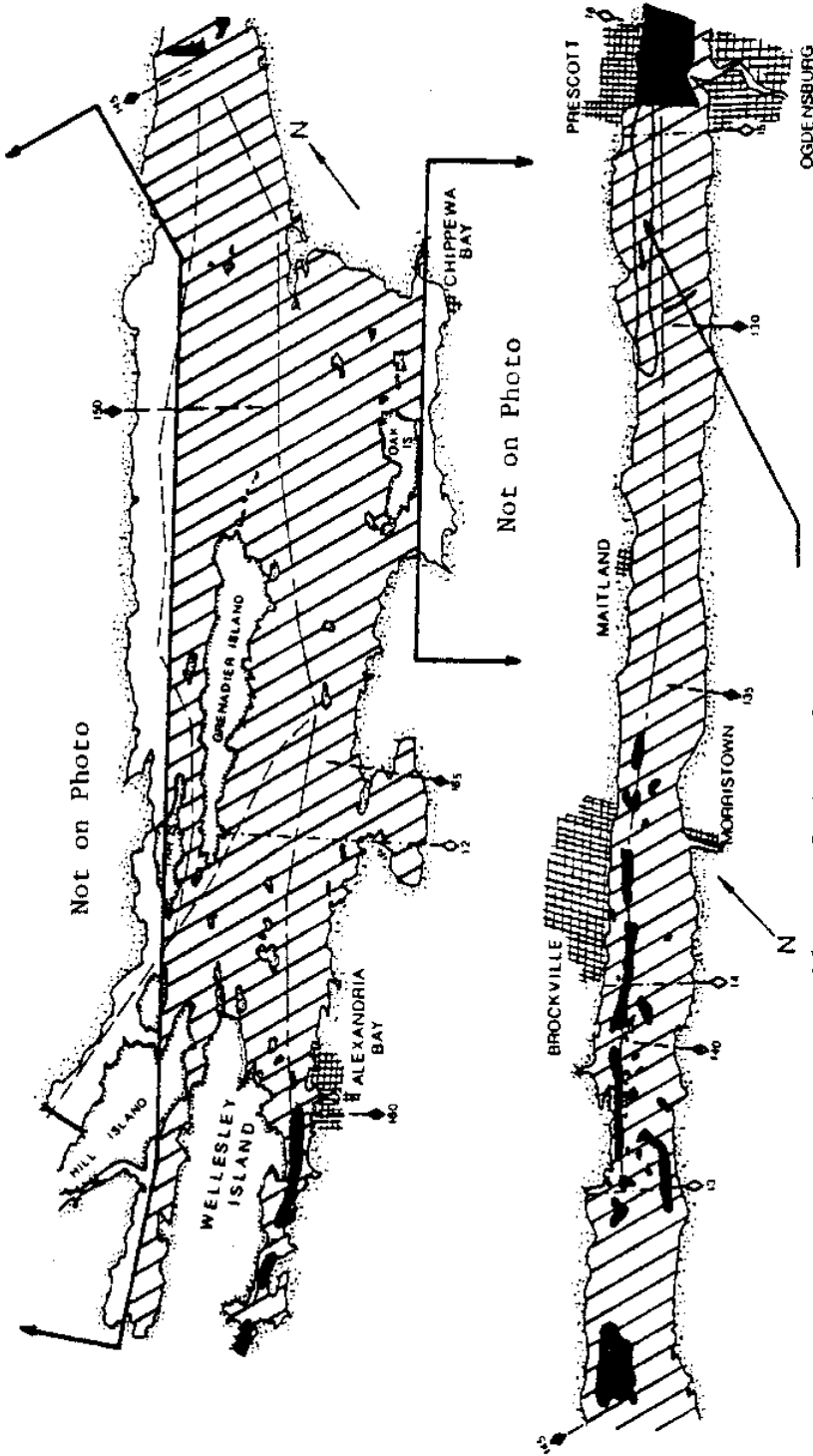
0 Scale of Miles 5

DATE Feb. 12, 1973

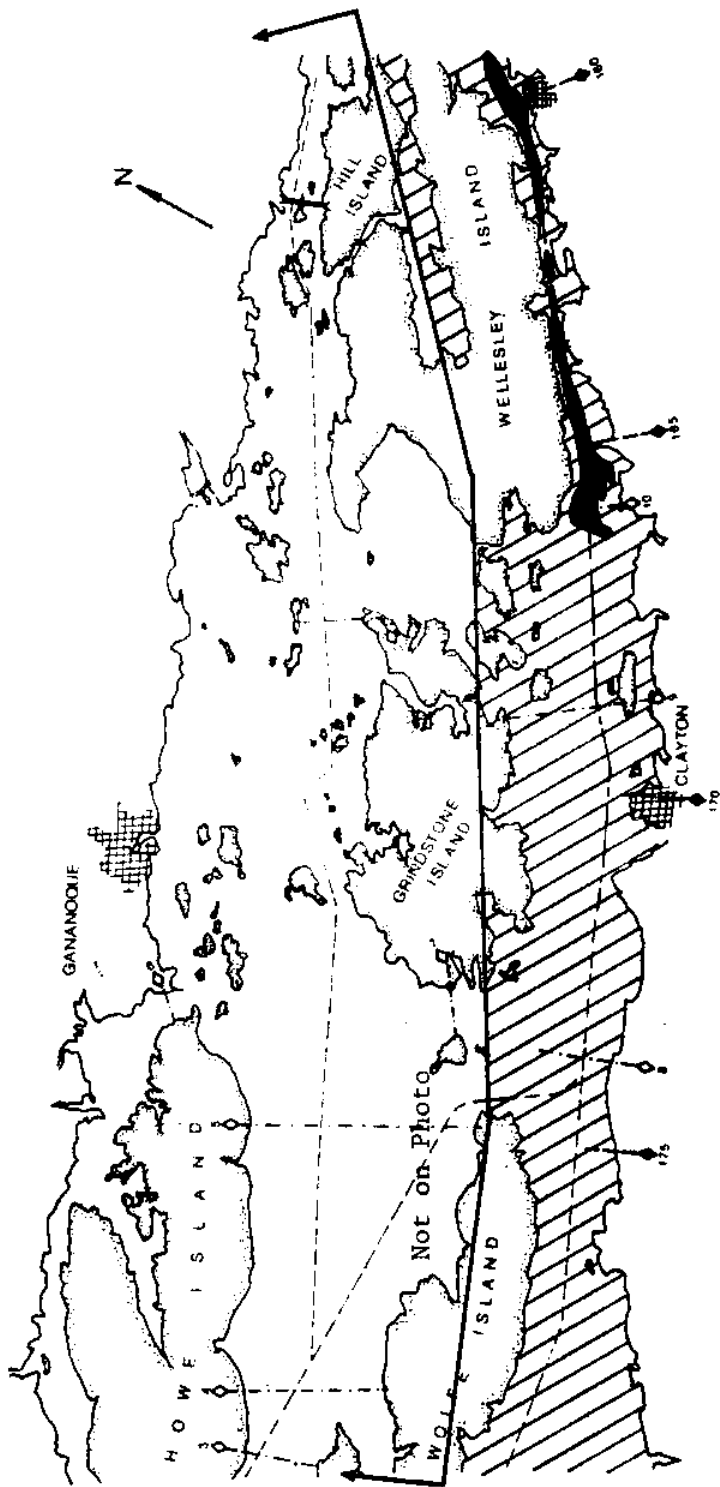


0 Scale of Miles 5

DATE Feb. 27, 1973

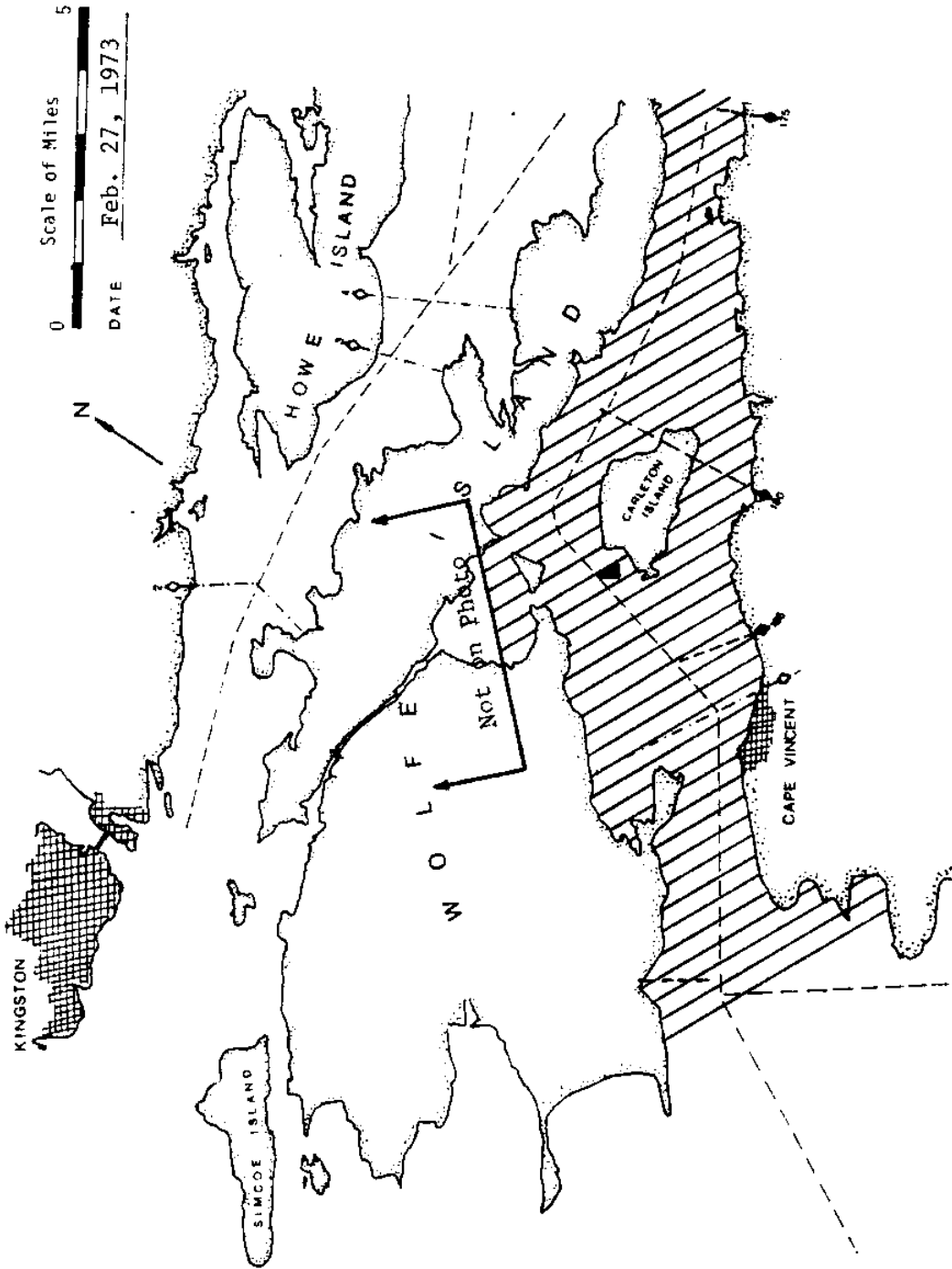


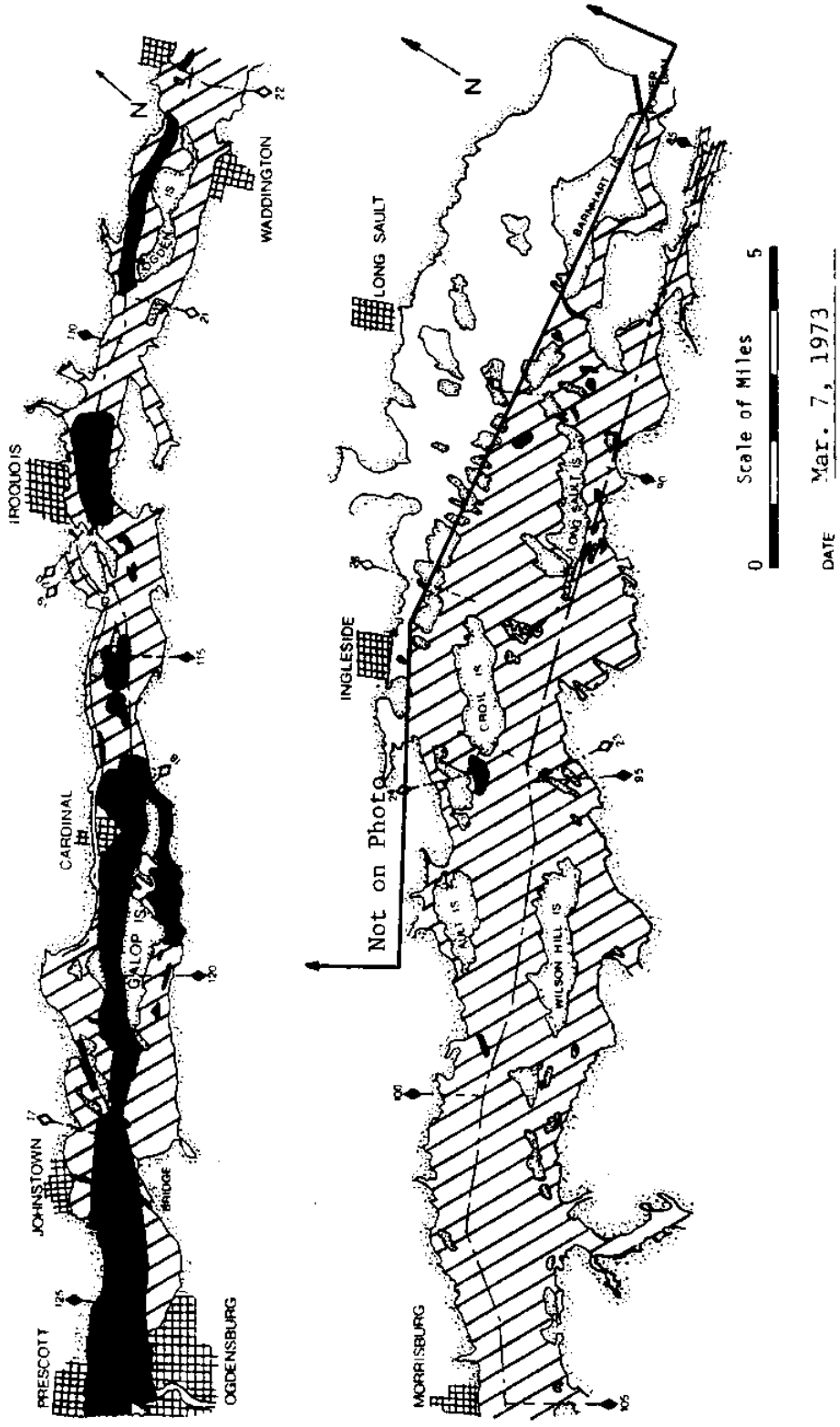
Evidence of thermal erosion visible on underside of solid ice cover

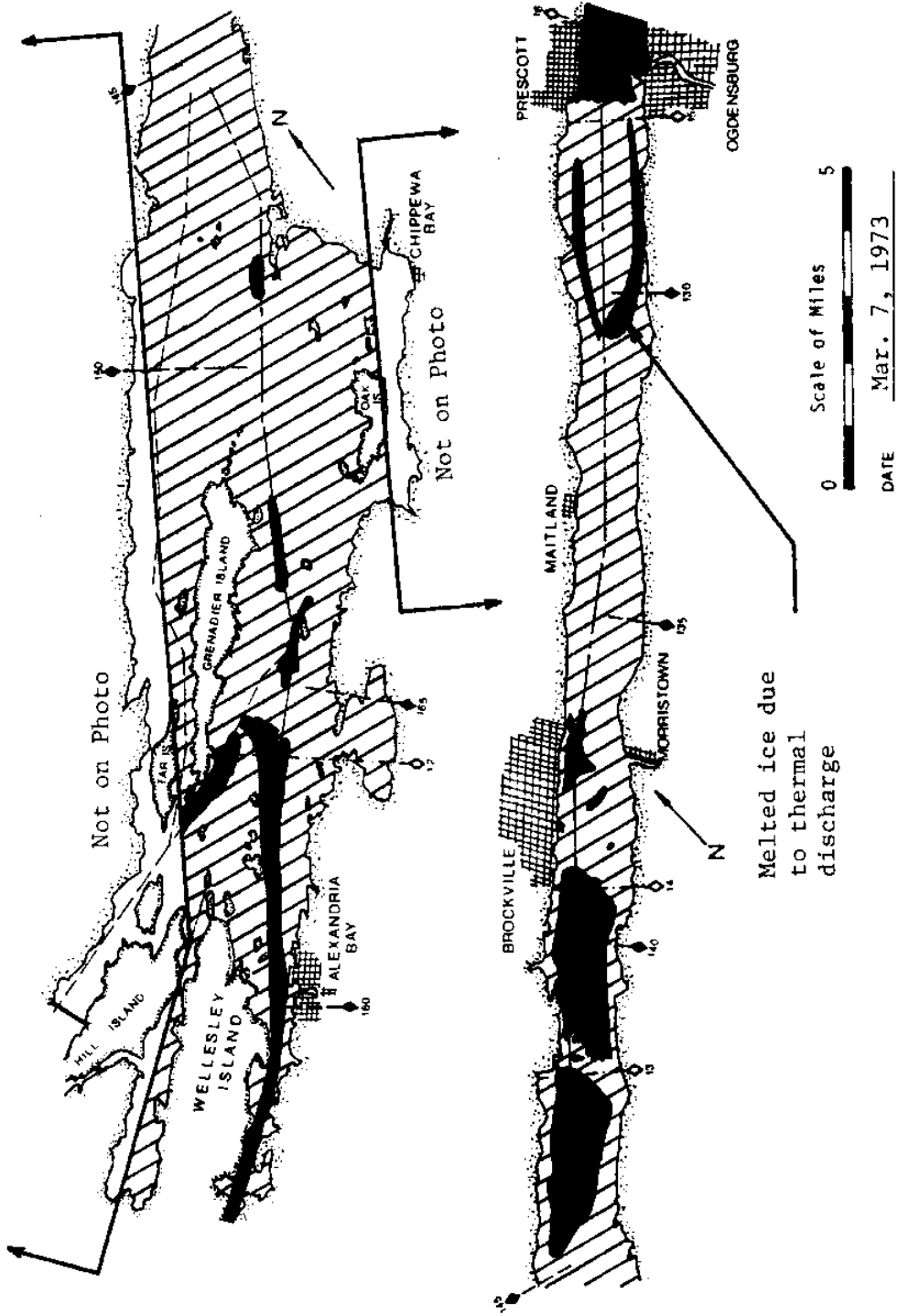


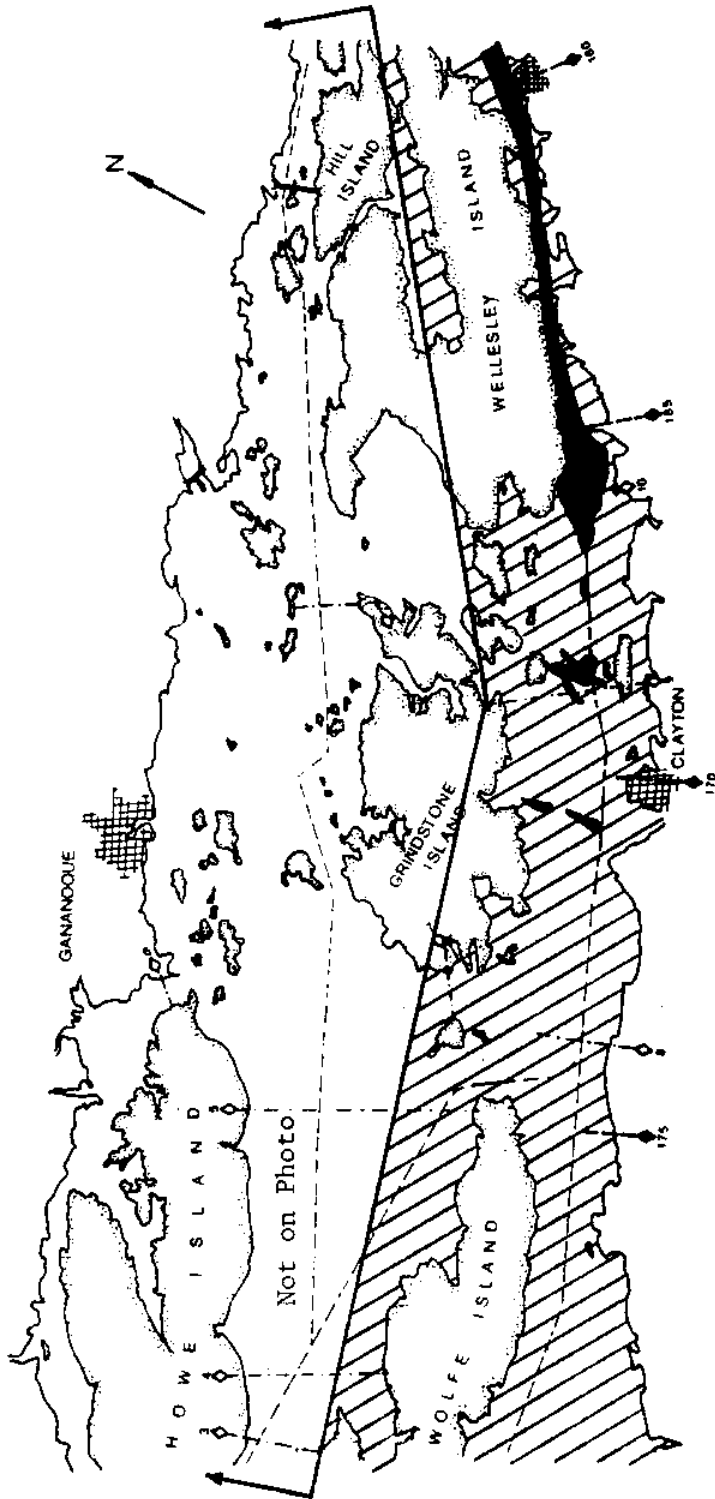
0 Scale of Miles 5

DATE Feb. 27, 1973



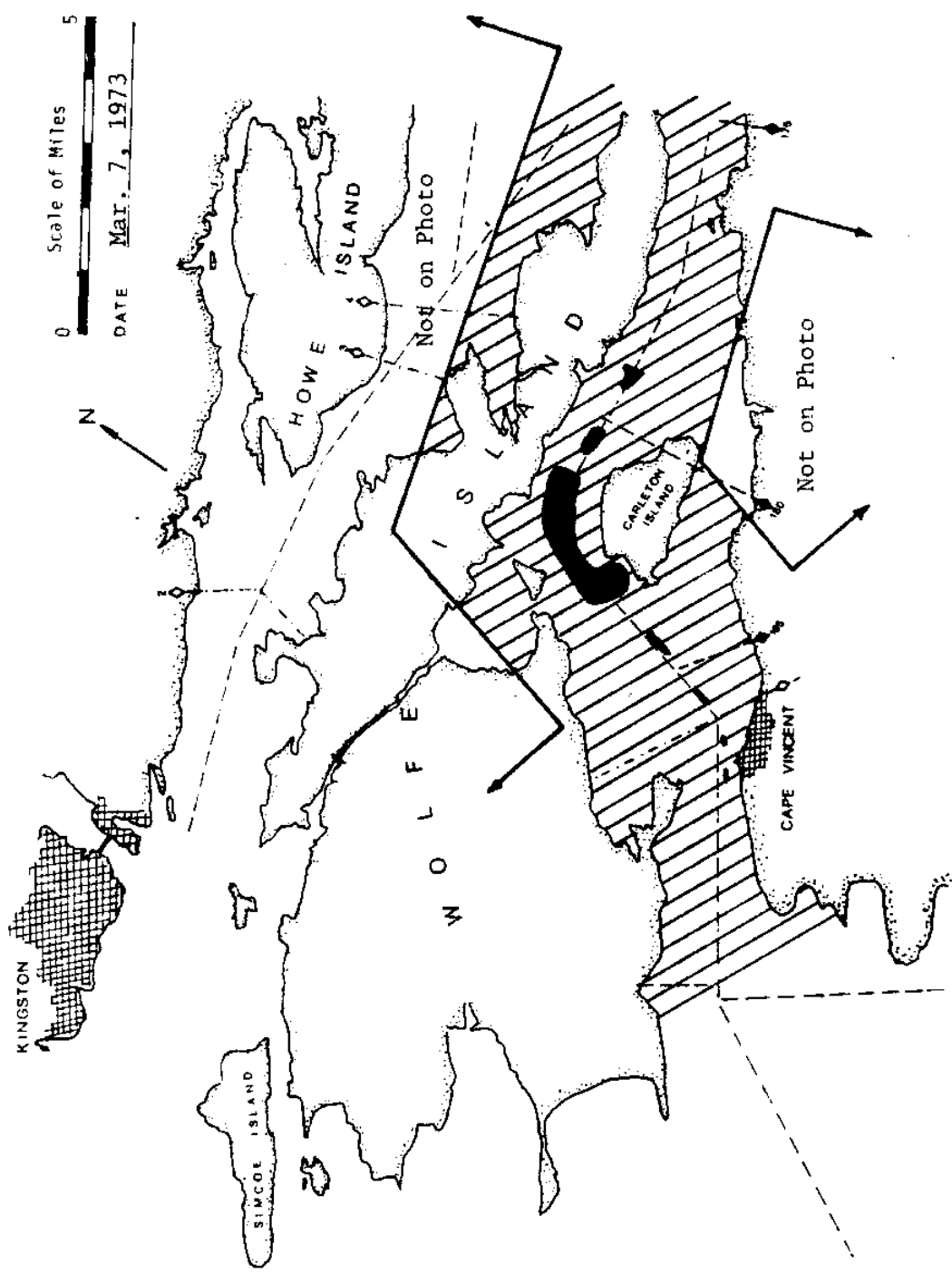


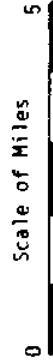
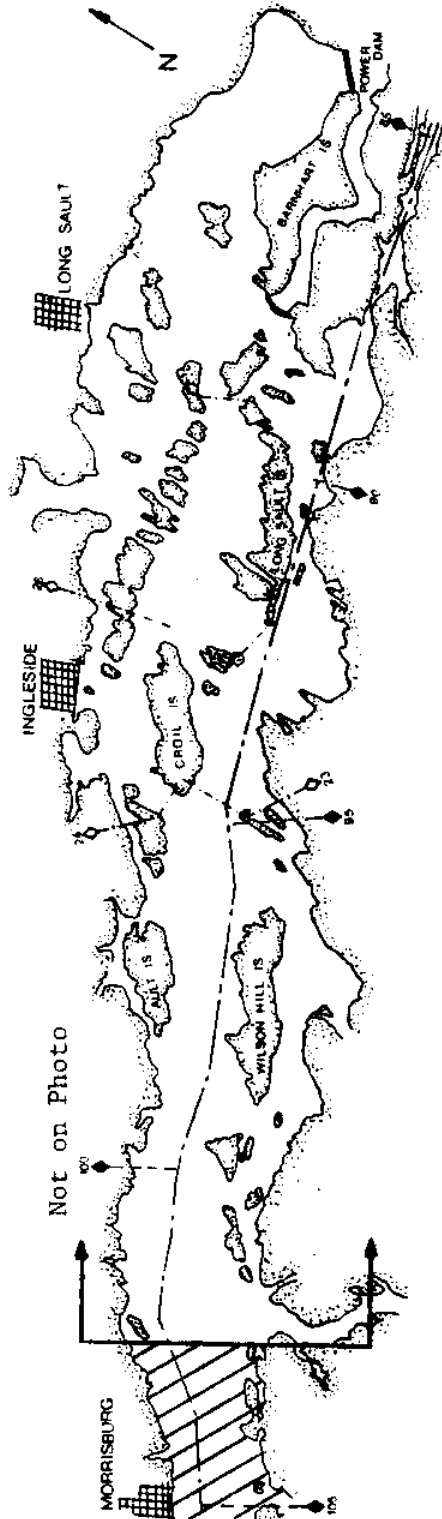
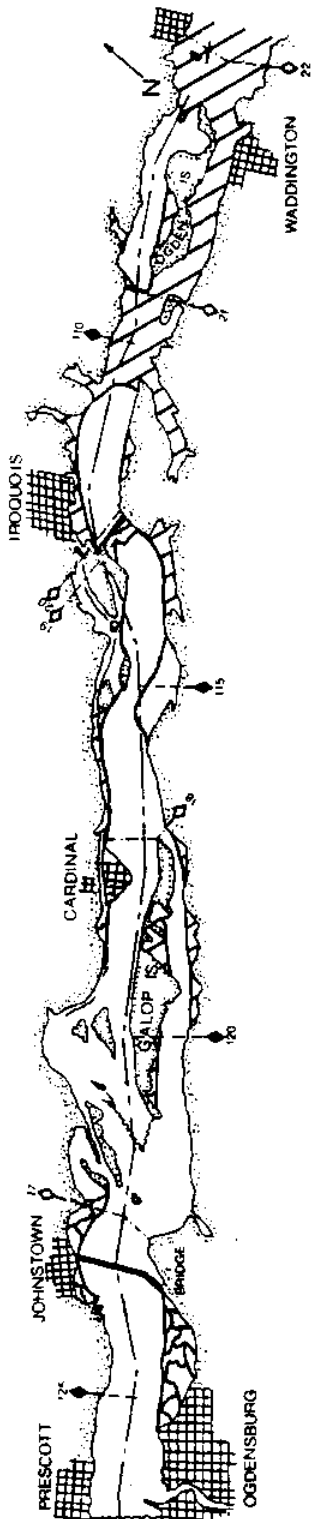




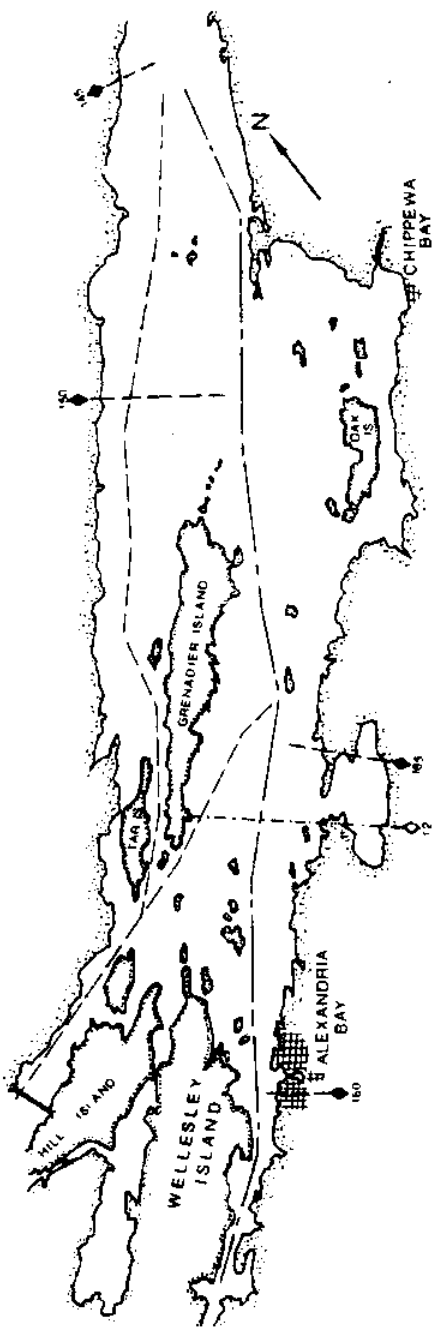
0 Scale of Miles 5

DATE Mar. 7, 1973

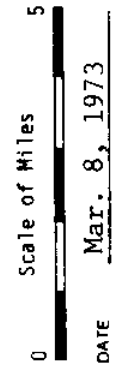
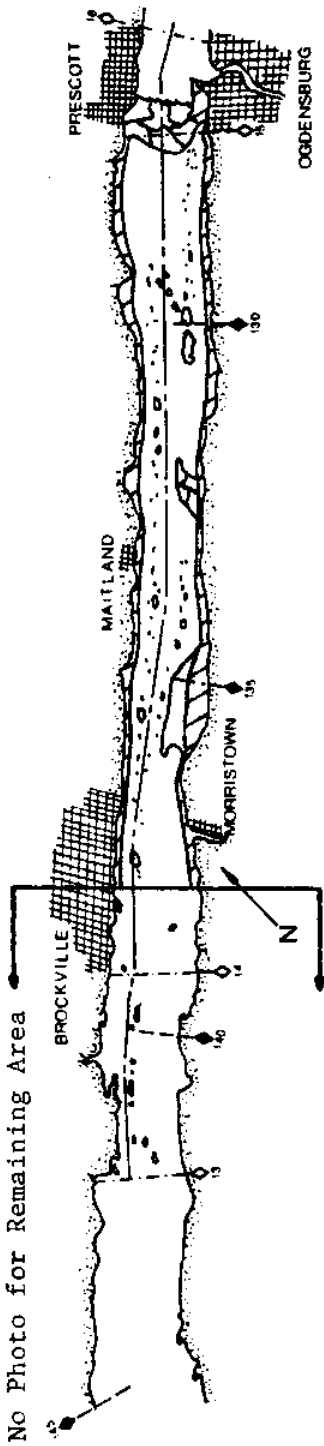




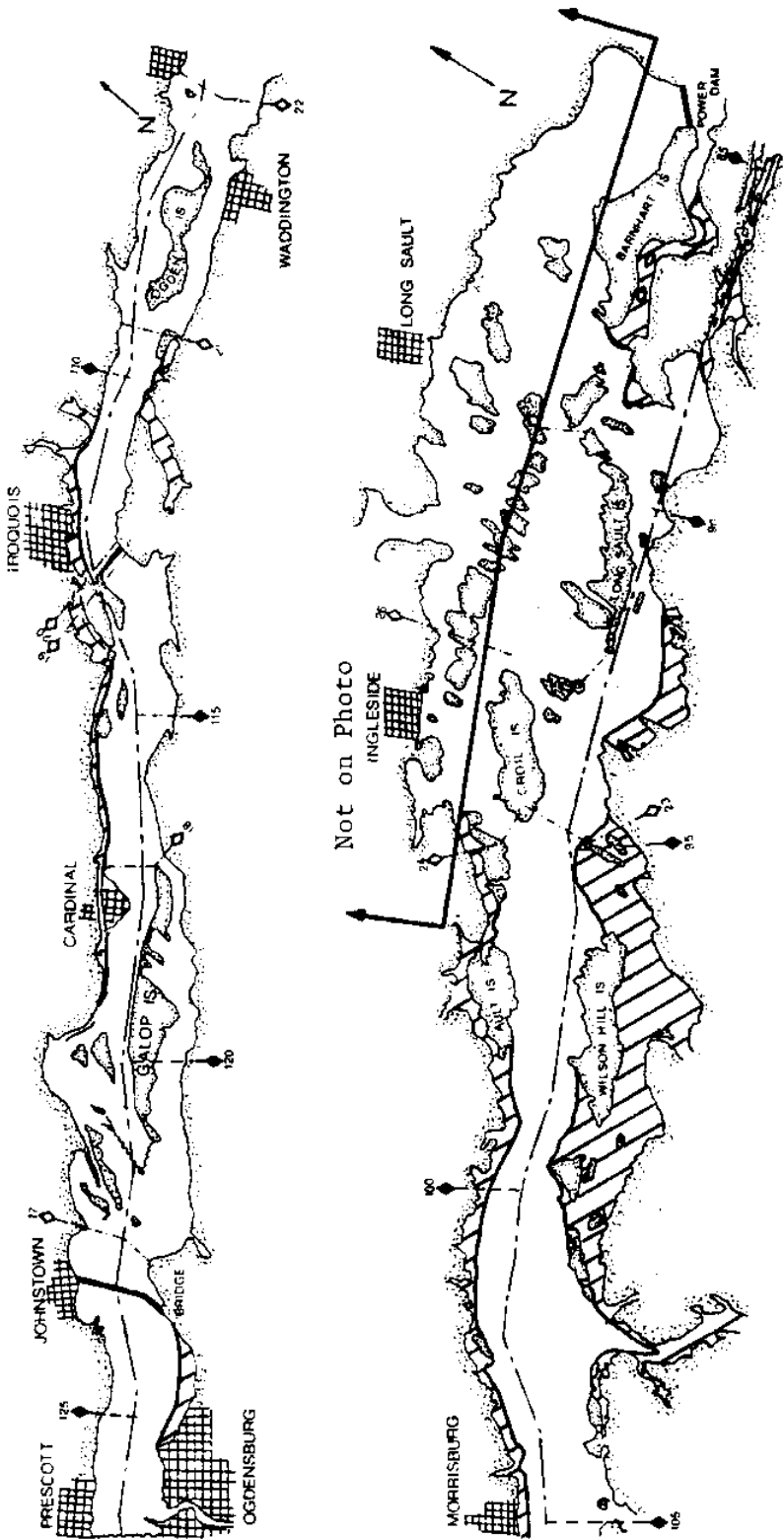
DATE Mar. 8, 1973



No Photo for Remaining Area

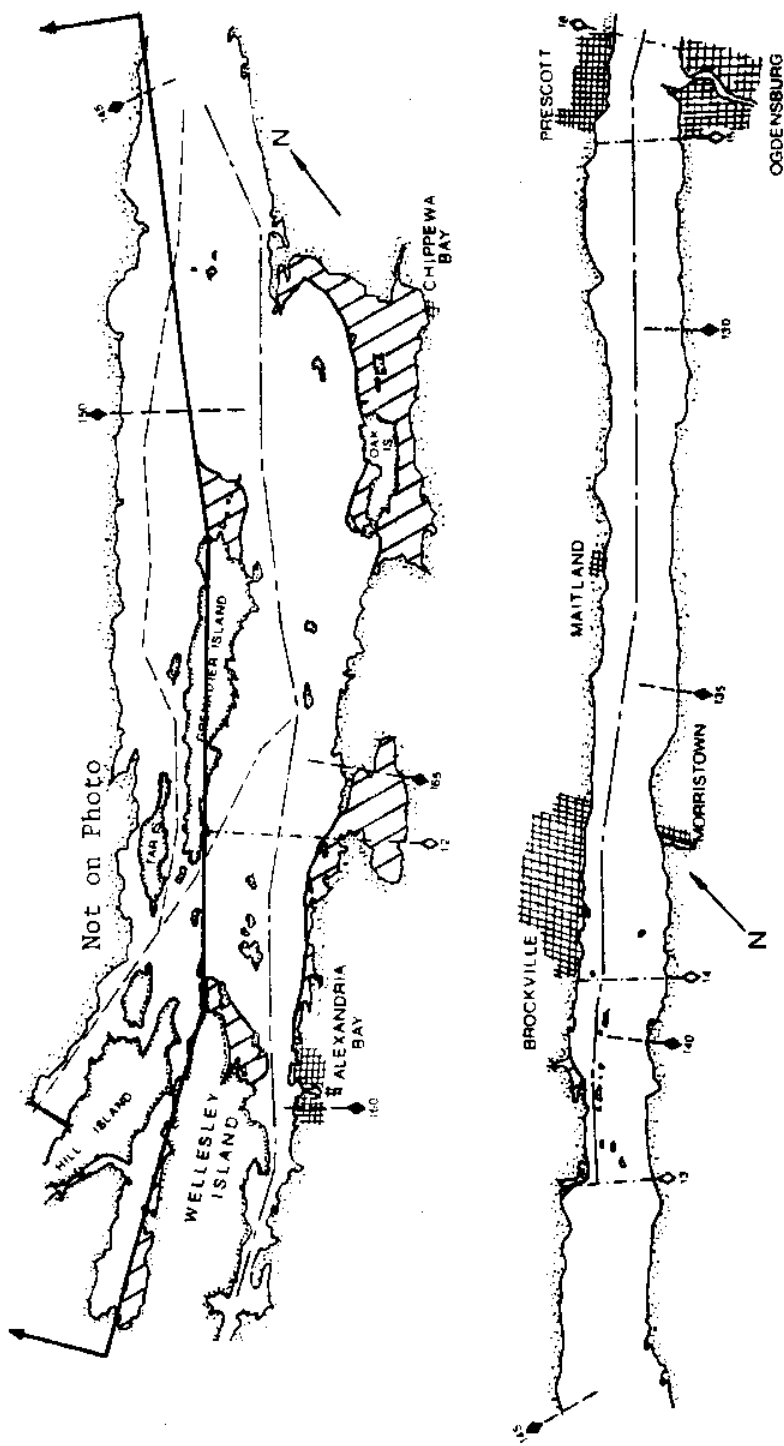


Winter of 1973-74



0 Scale of Miles 5

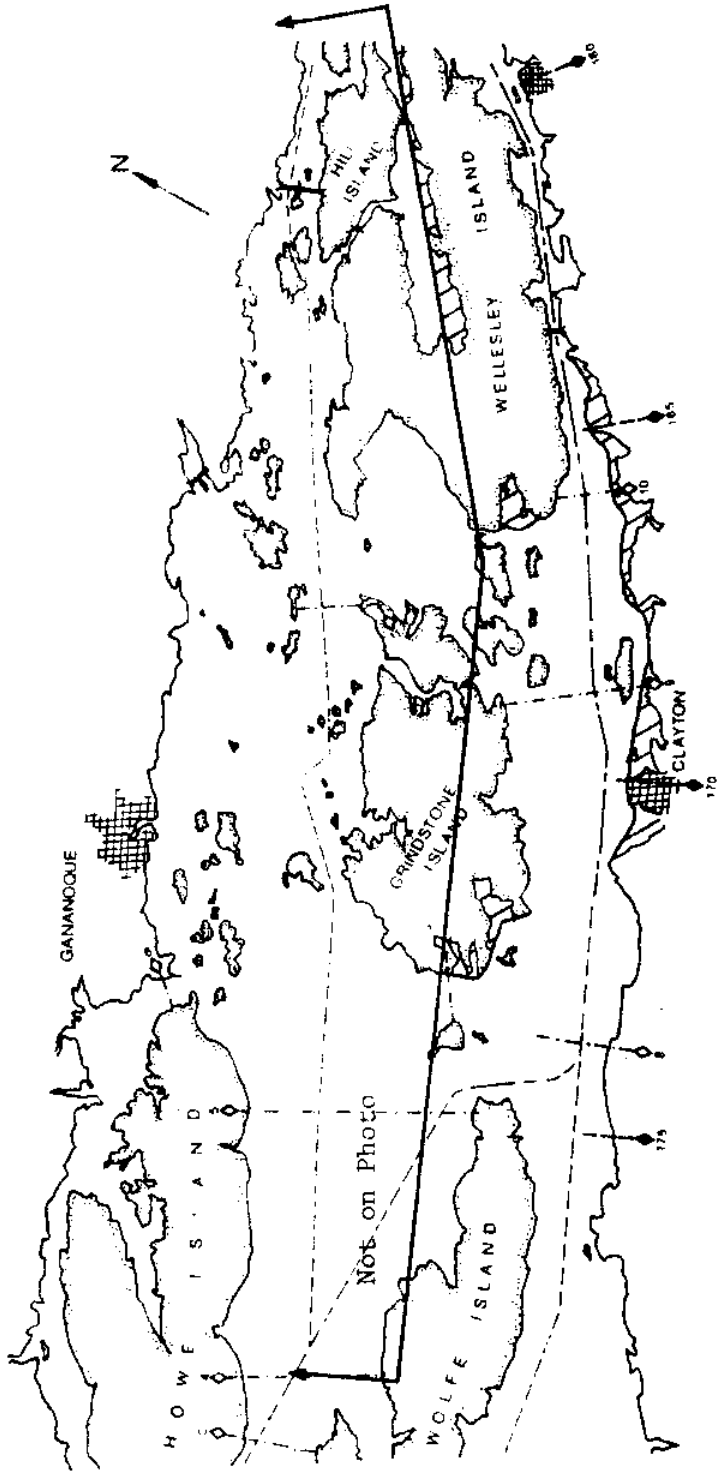
DATE Dec. 18, 1973



Not on Photo

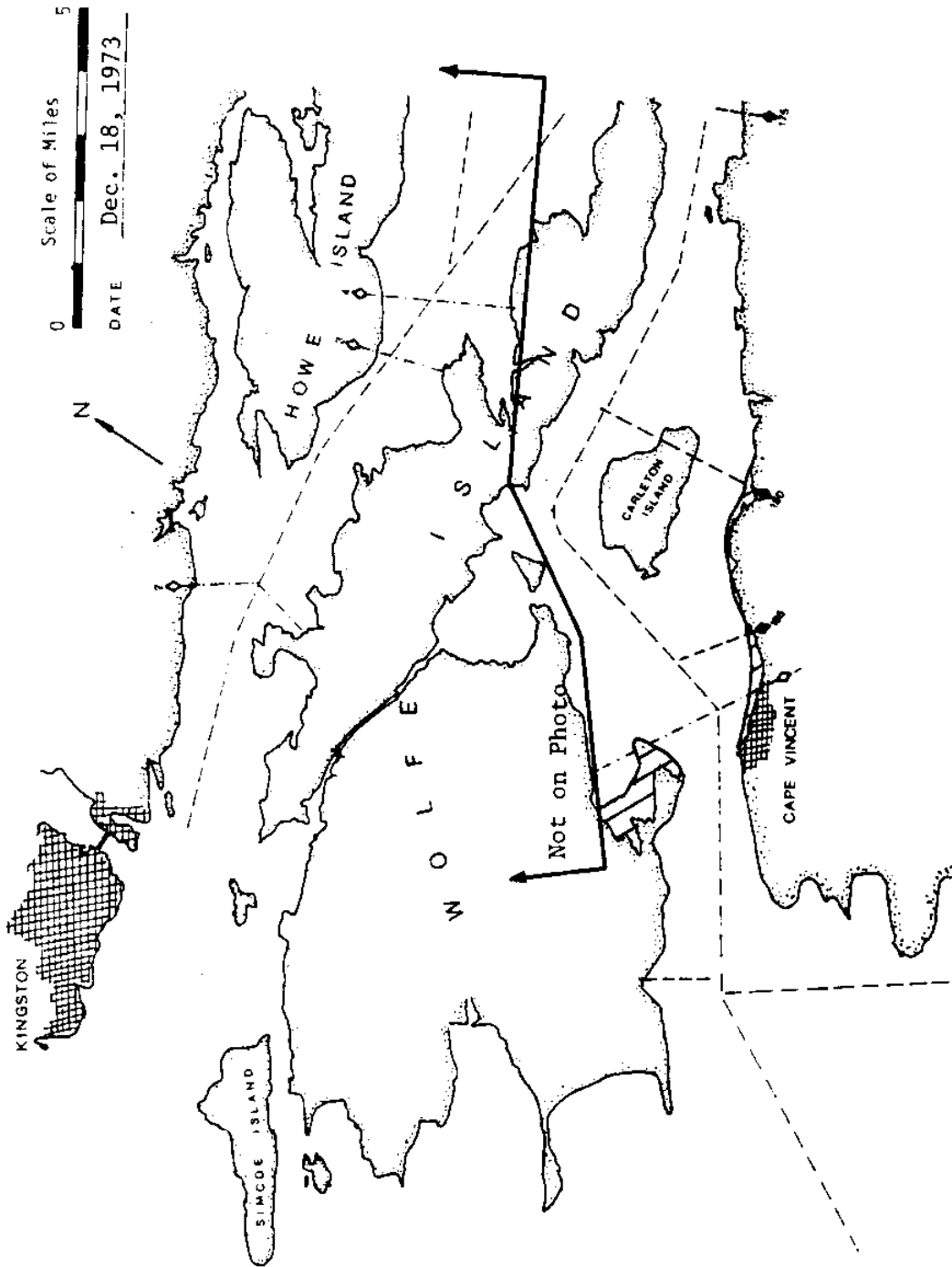
0 Scale of Miles 5

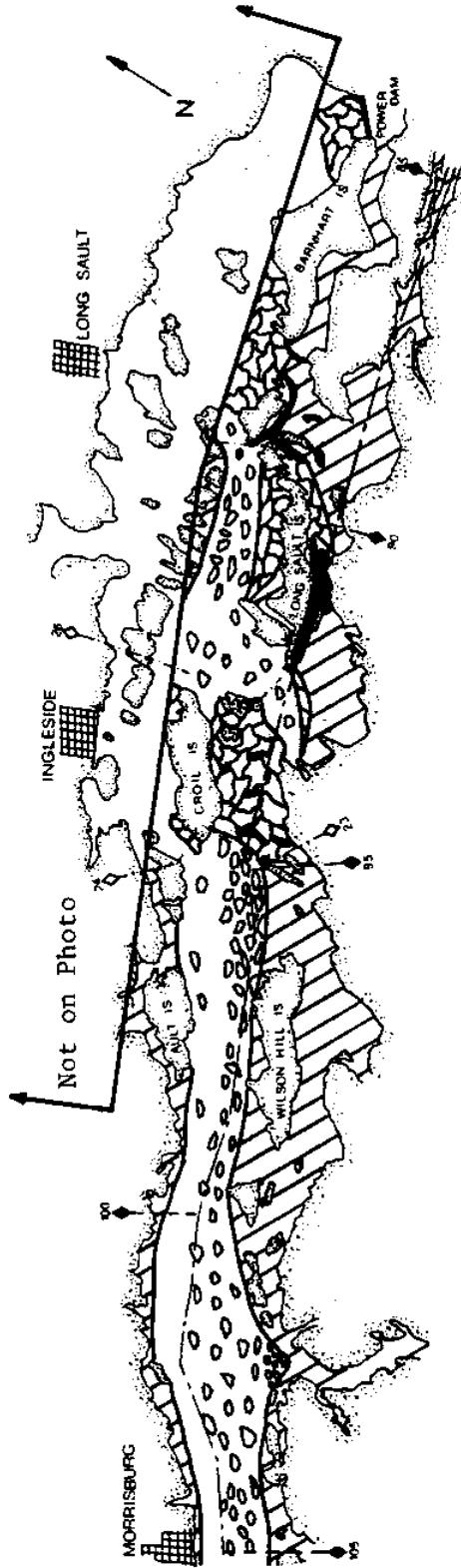
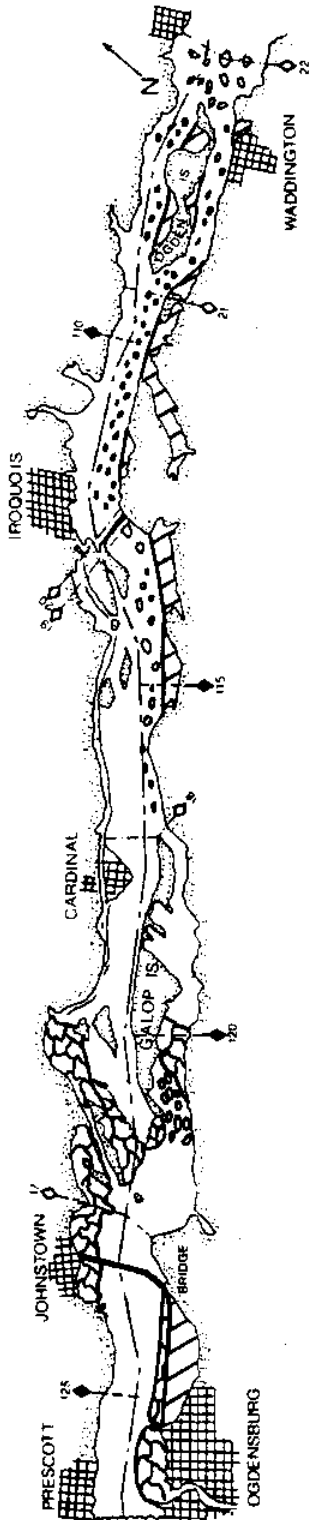
DATE Dec. 18, 1973



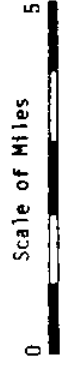
0 Scale of Miles 5

DATE Dec. 18, 1973

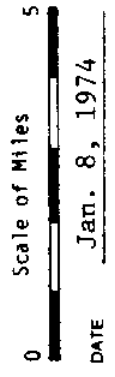
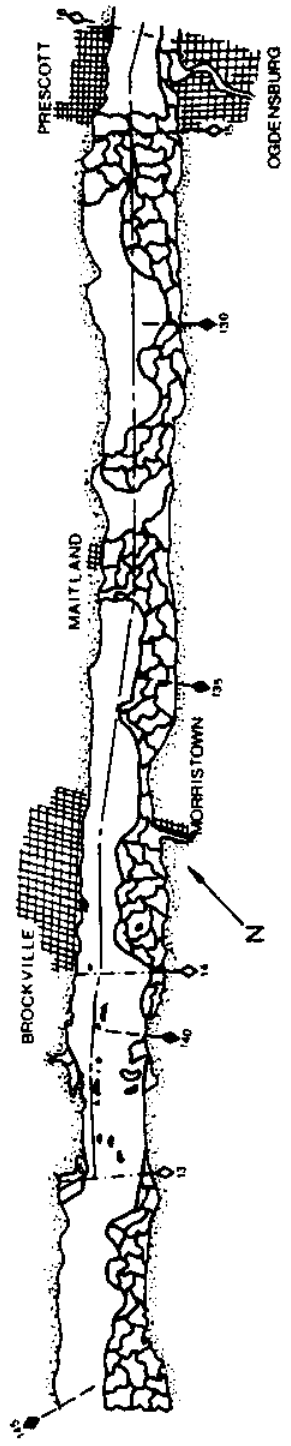
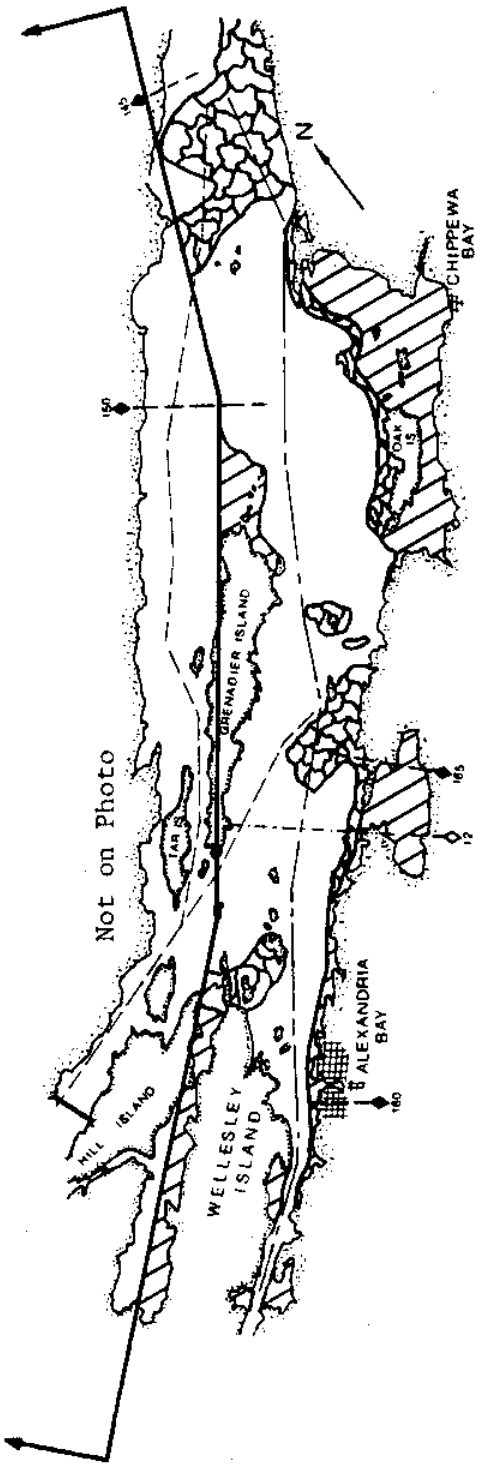


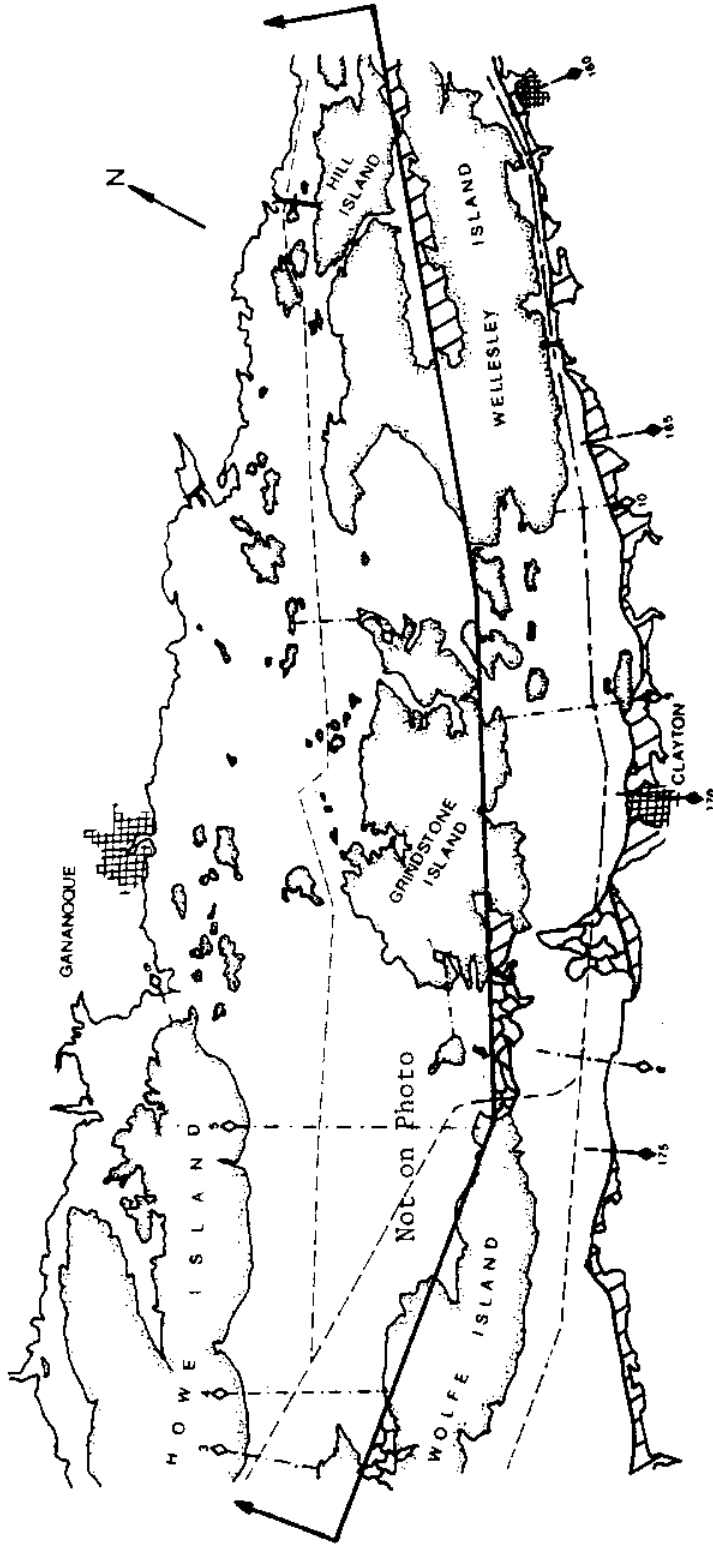


Not on Photo



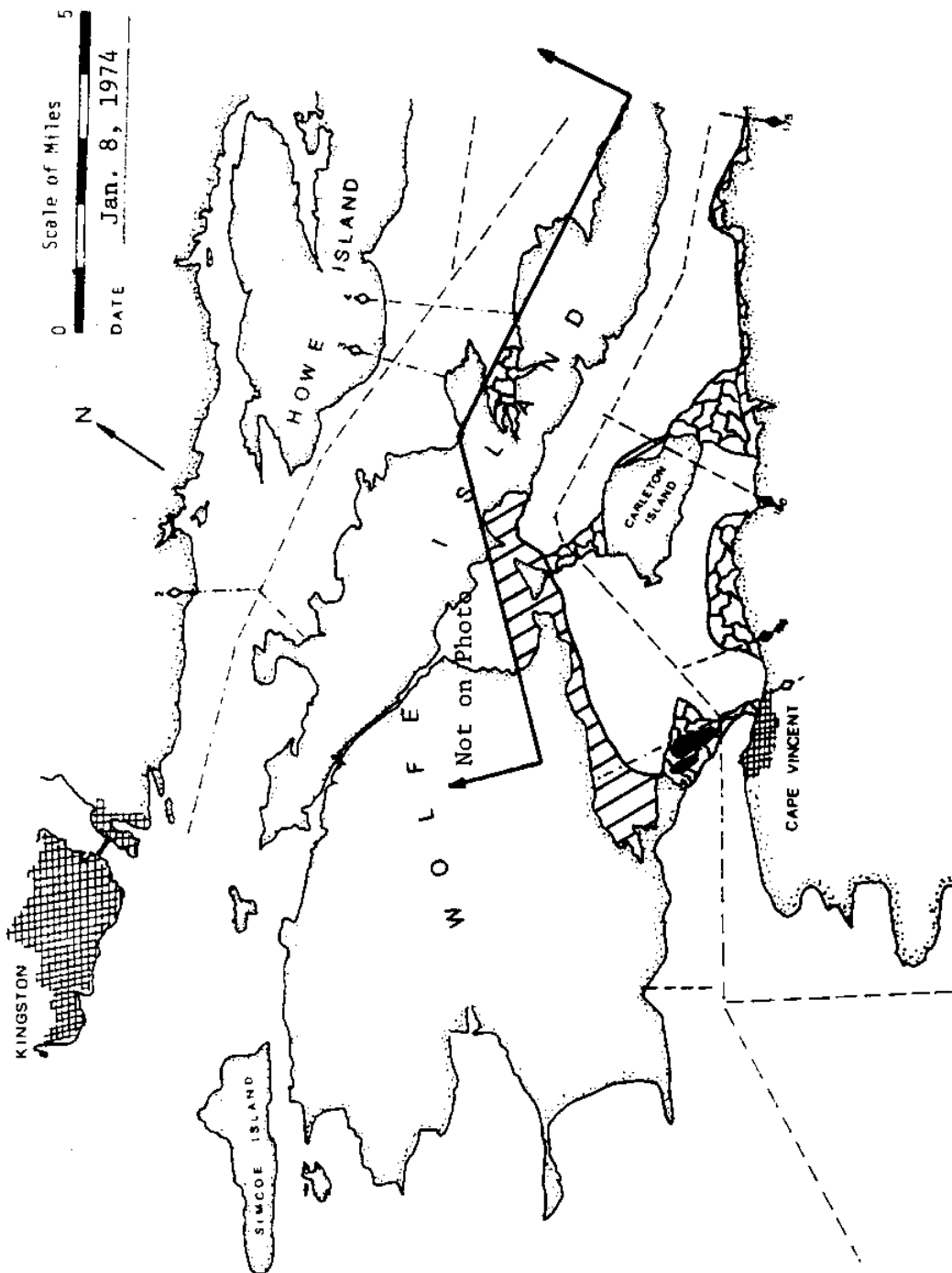
DATE Jan. 8, 1974

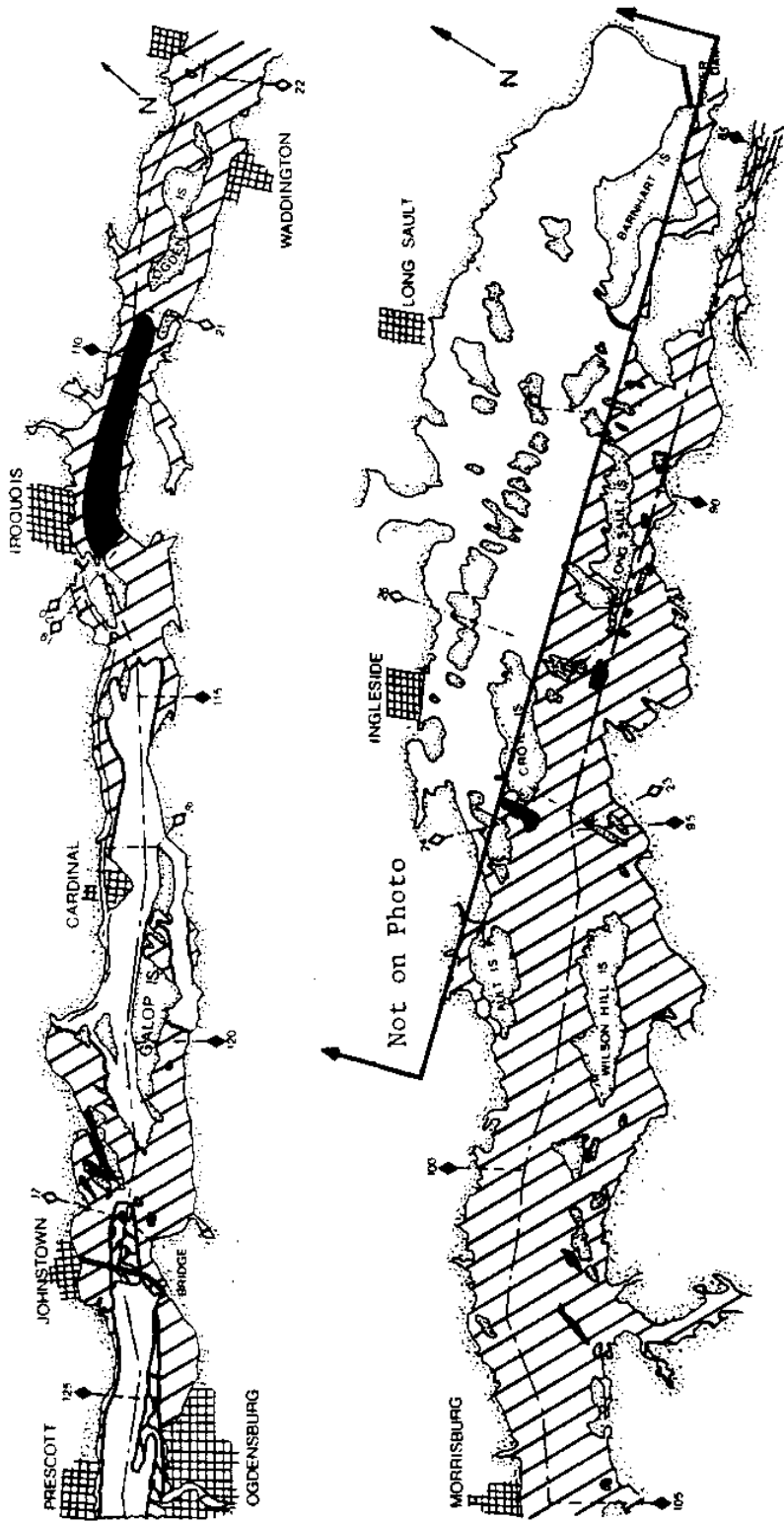


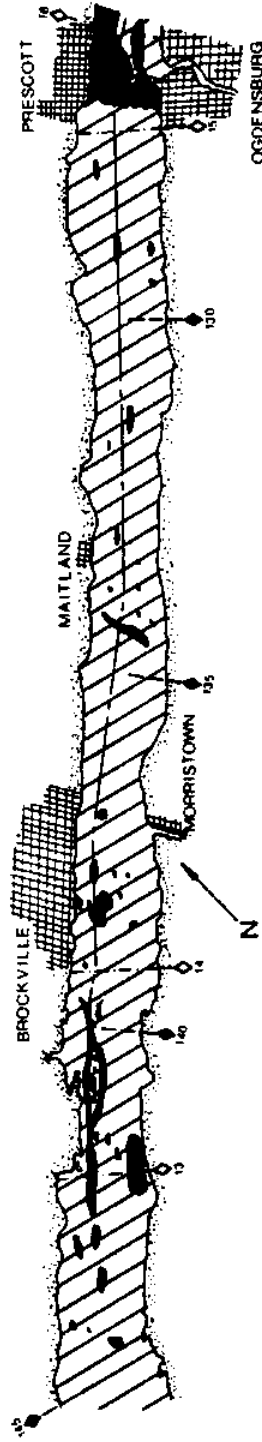
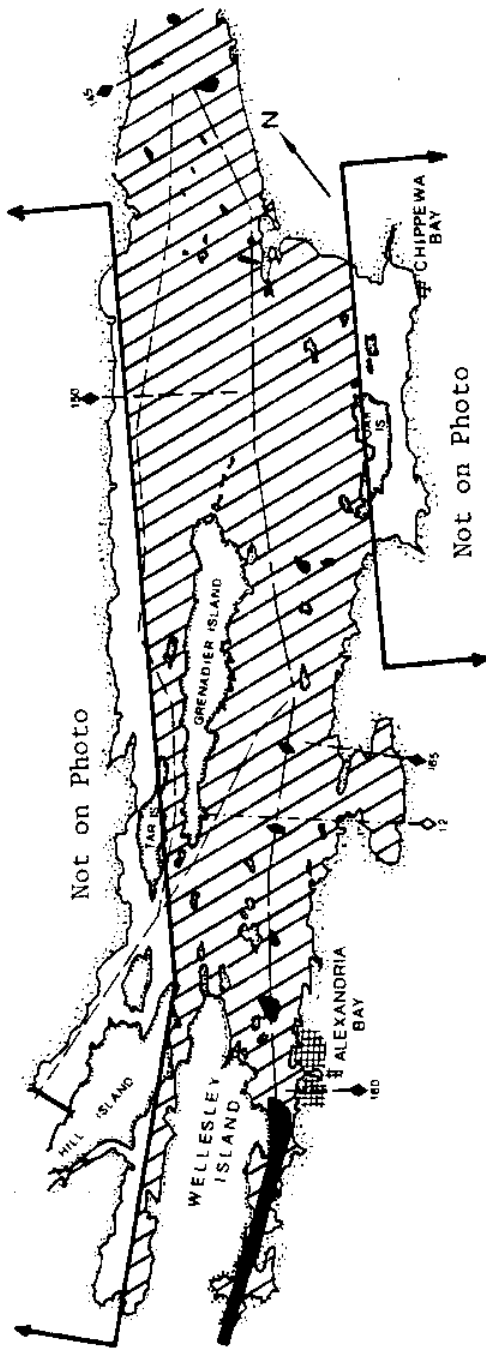


0 Scale of Miles 5

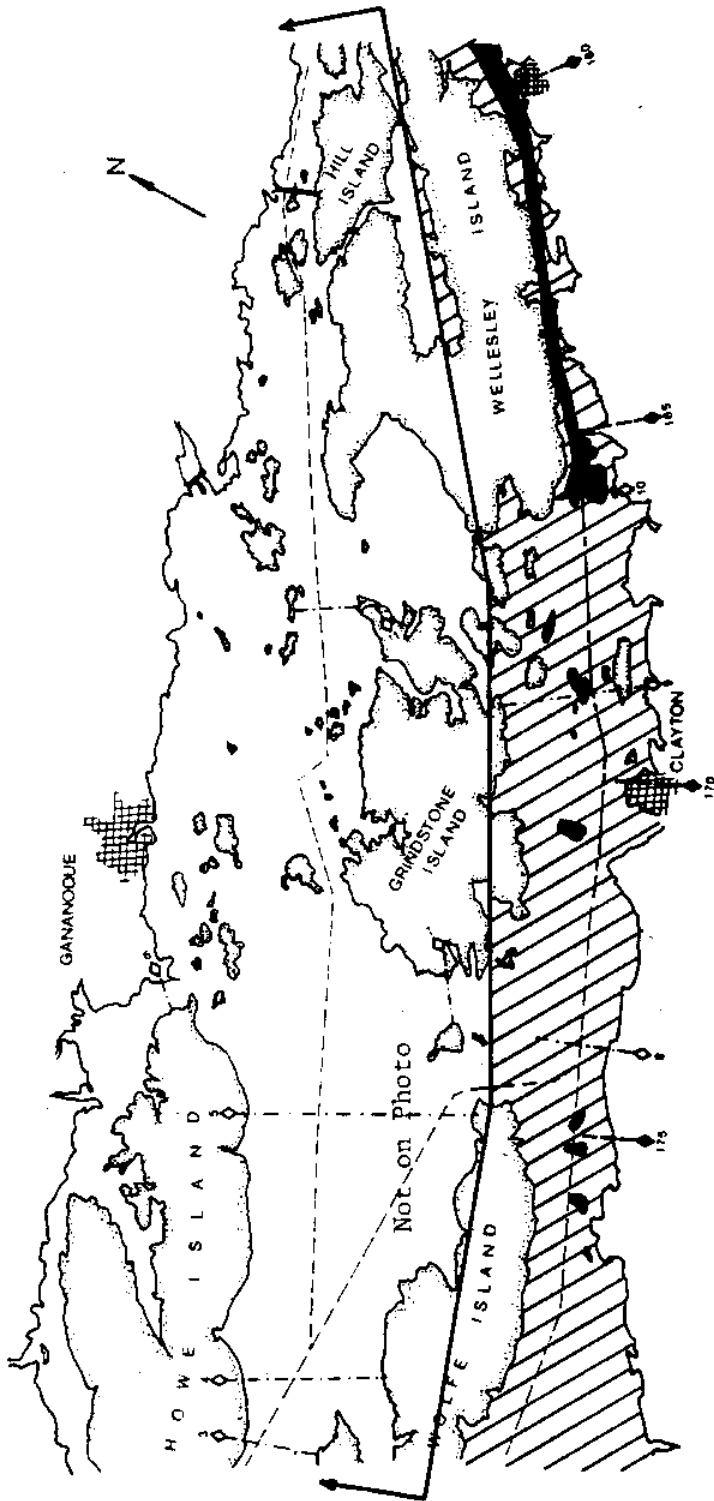
DATE Jan. 8, 1974





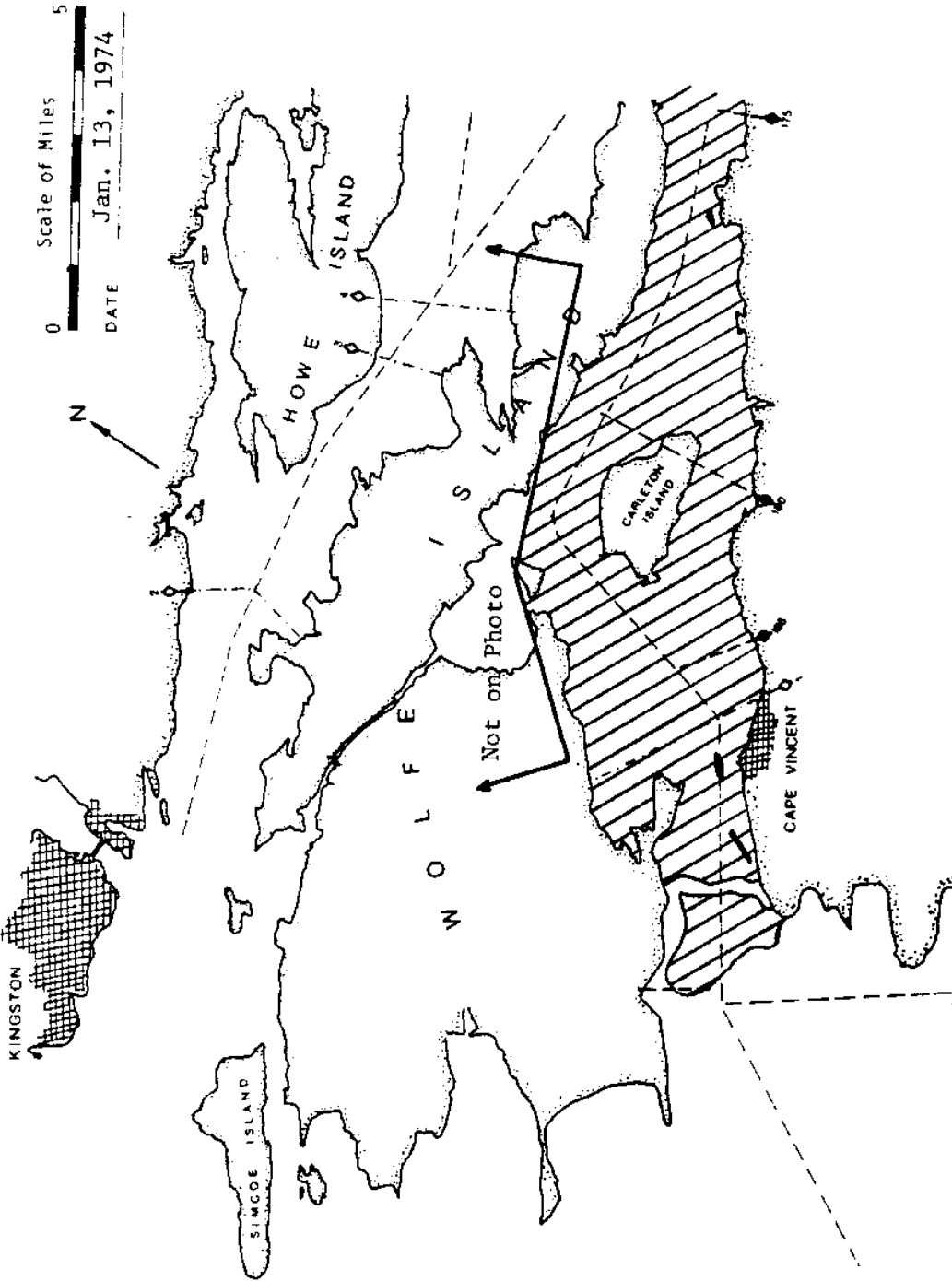


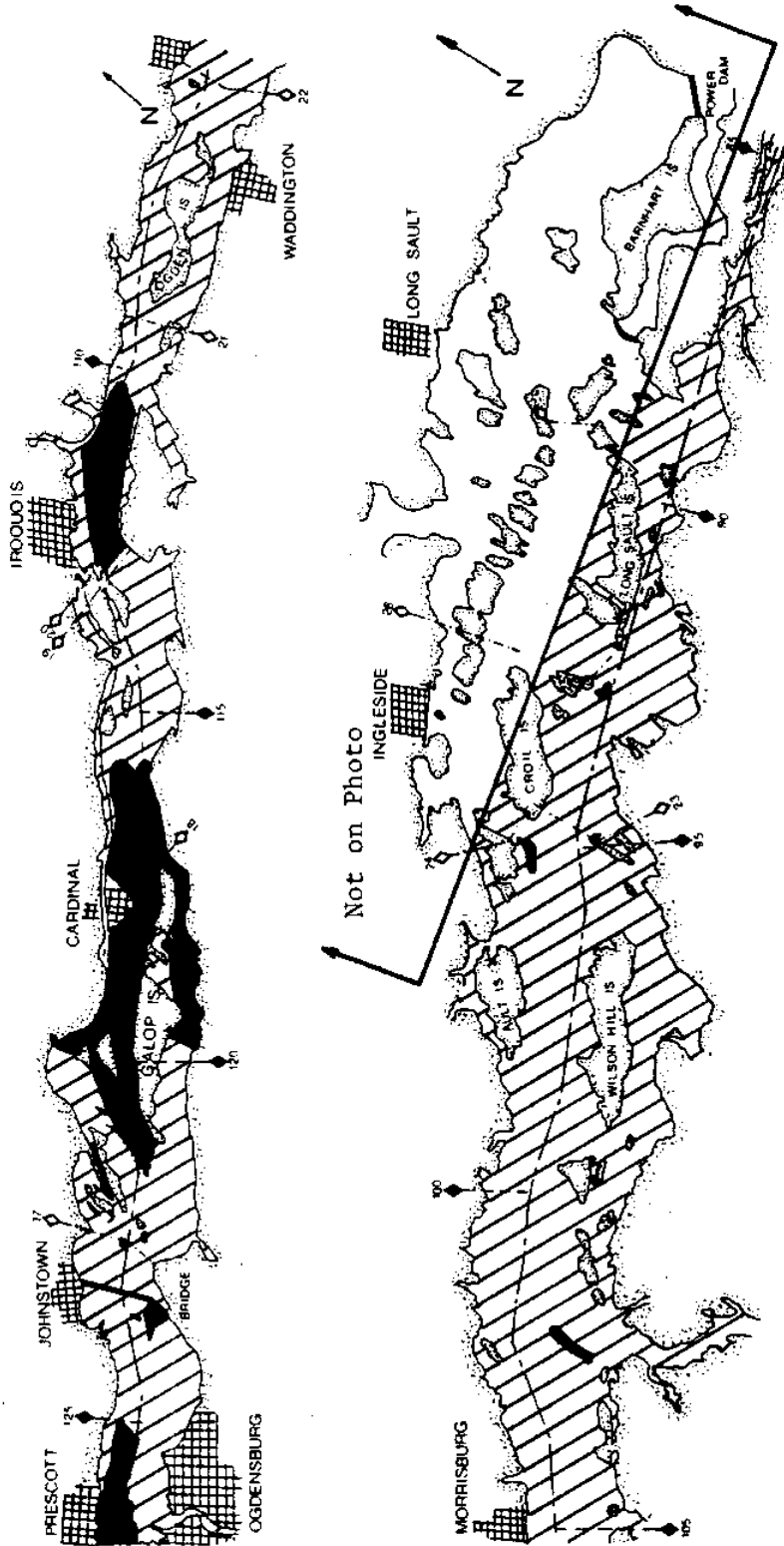
0 Scale of Miles 5
DATE Jan. 13, 1974



0 Scale of Miles 5

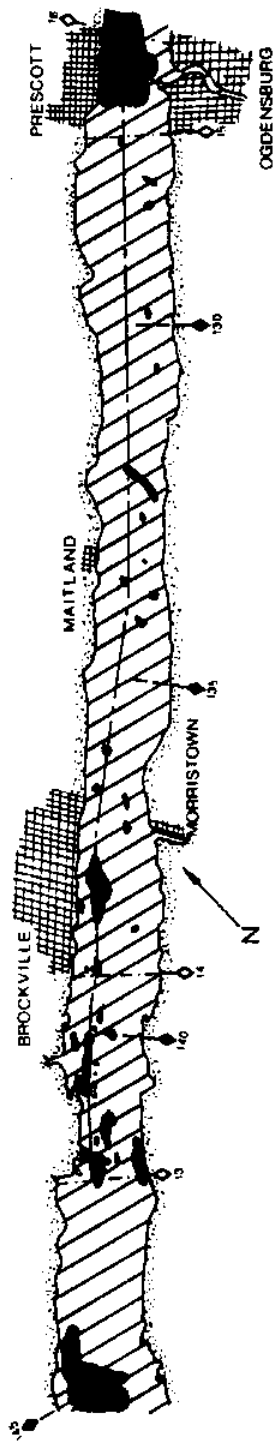
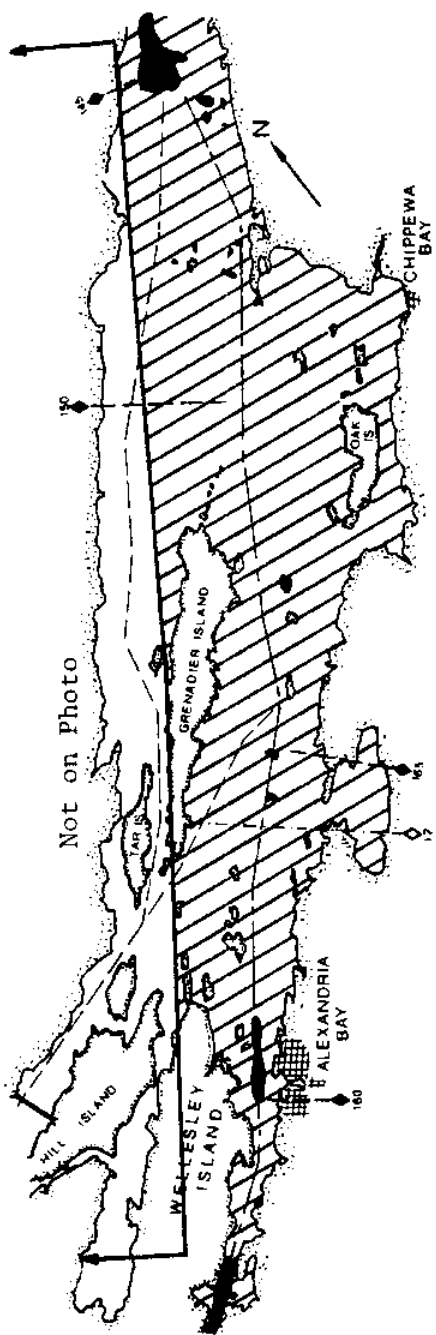
DATE Jan. 13, 1974





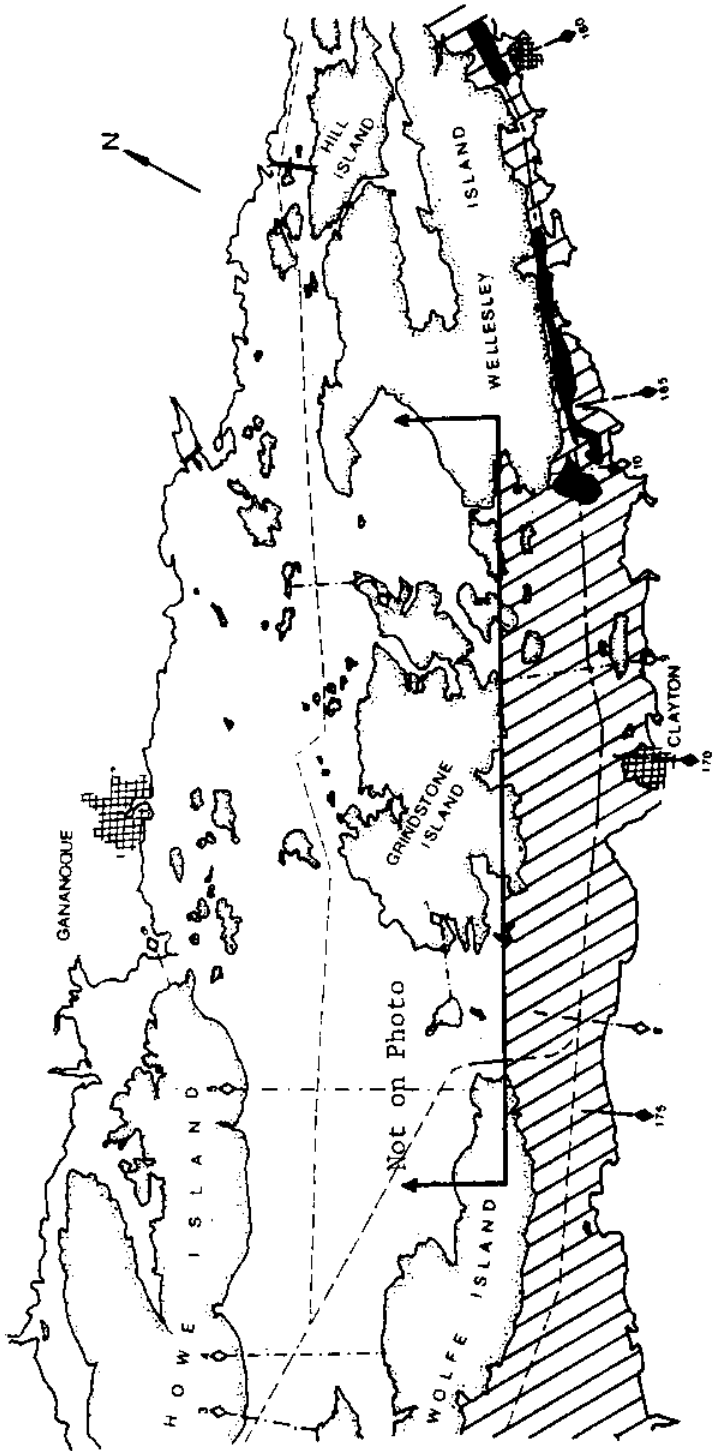
0 Scale of Miles 5

DATE Jan. 17, 1974



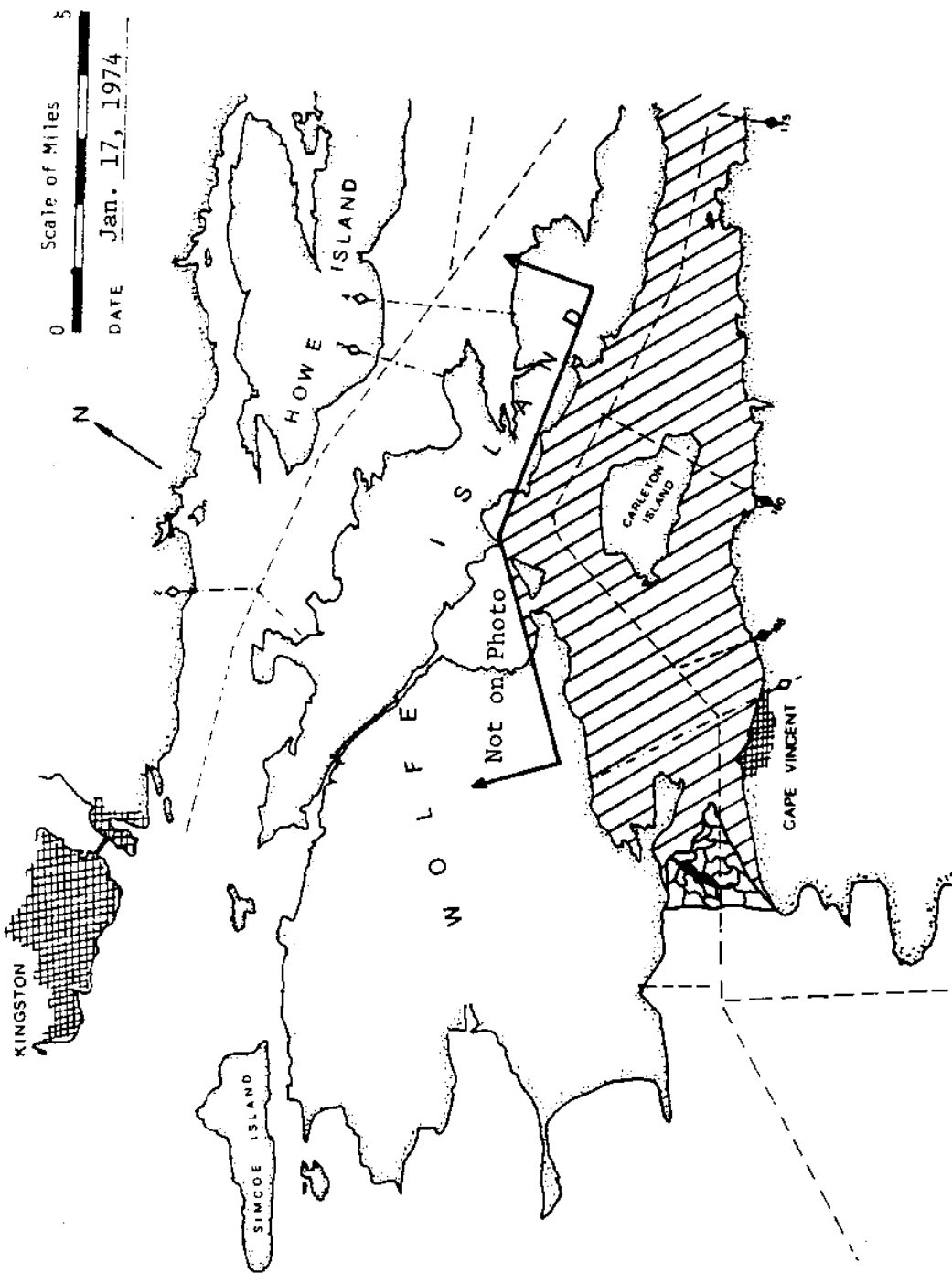
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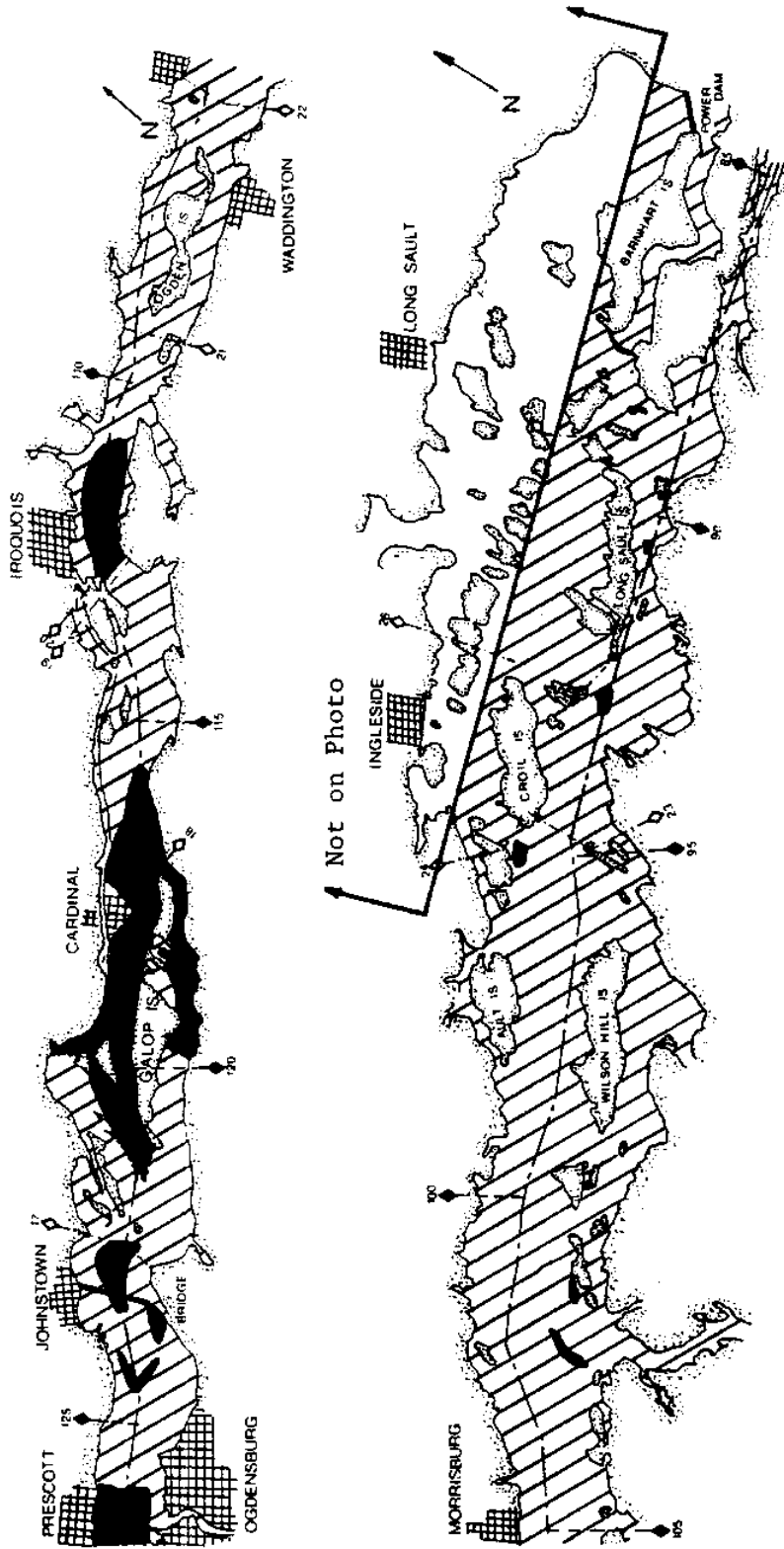
DATE Jan. 17, 1974

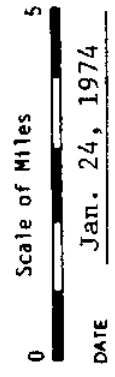
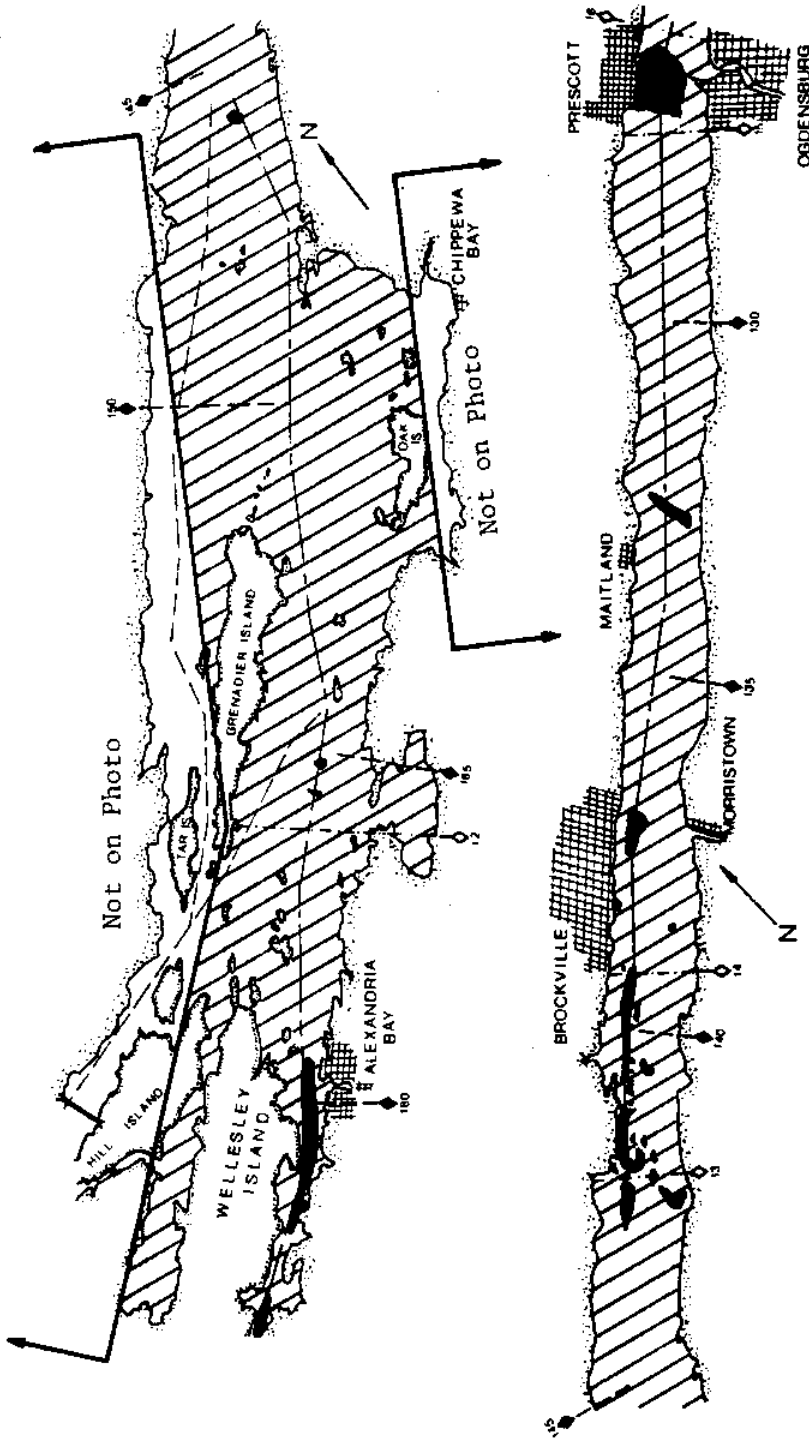


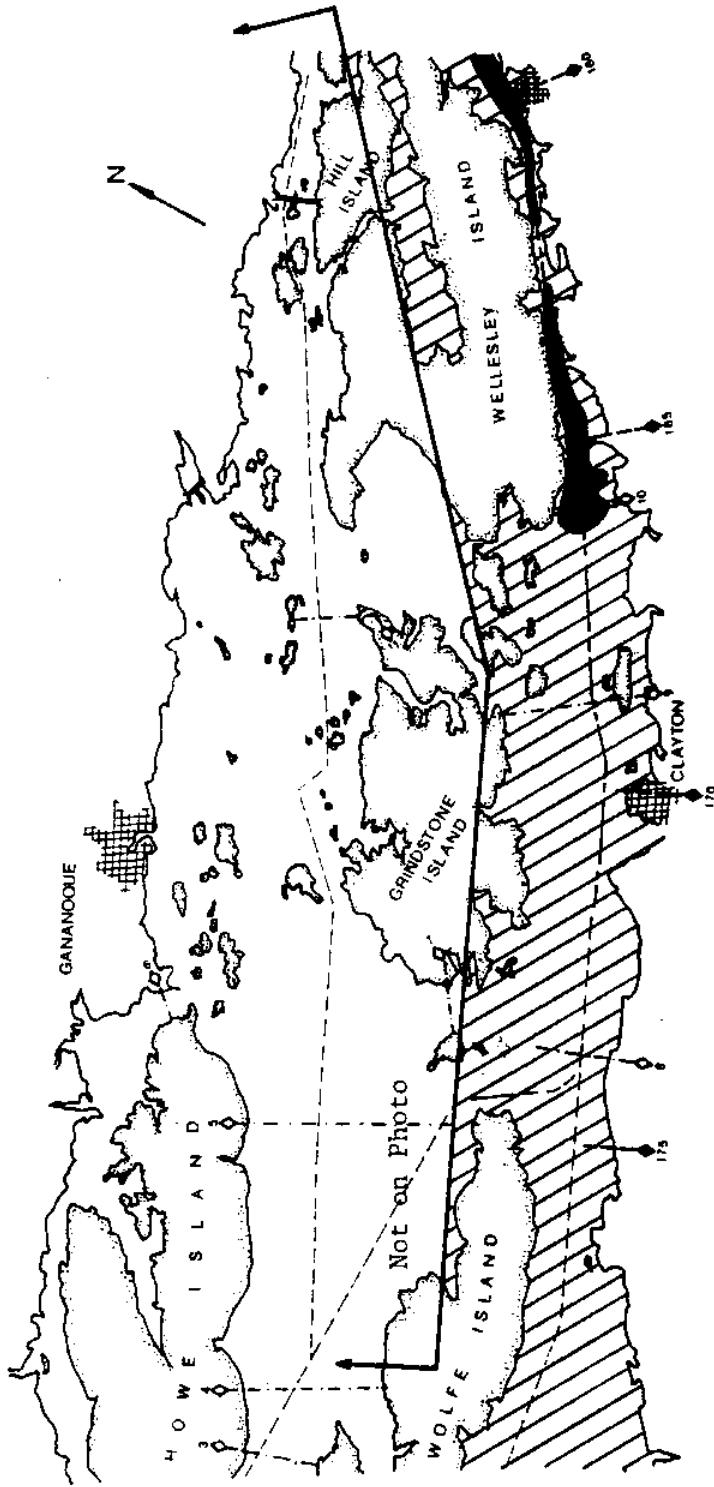
0 Scale of Miles 5

DATE Jan. 17, 1974



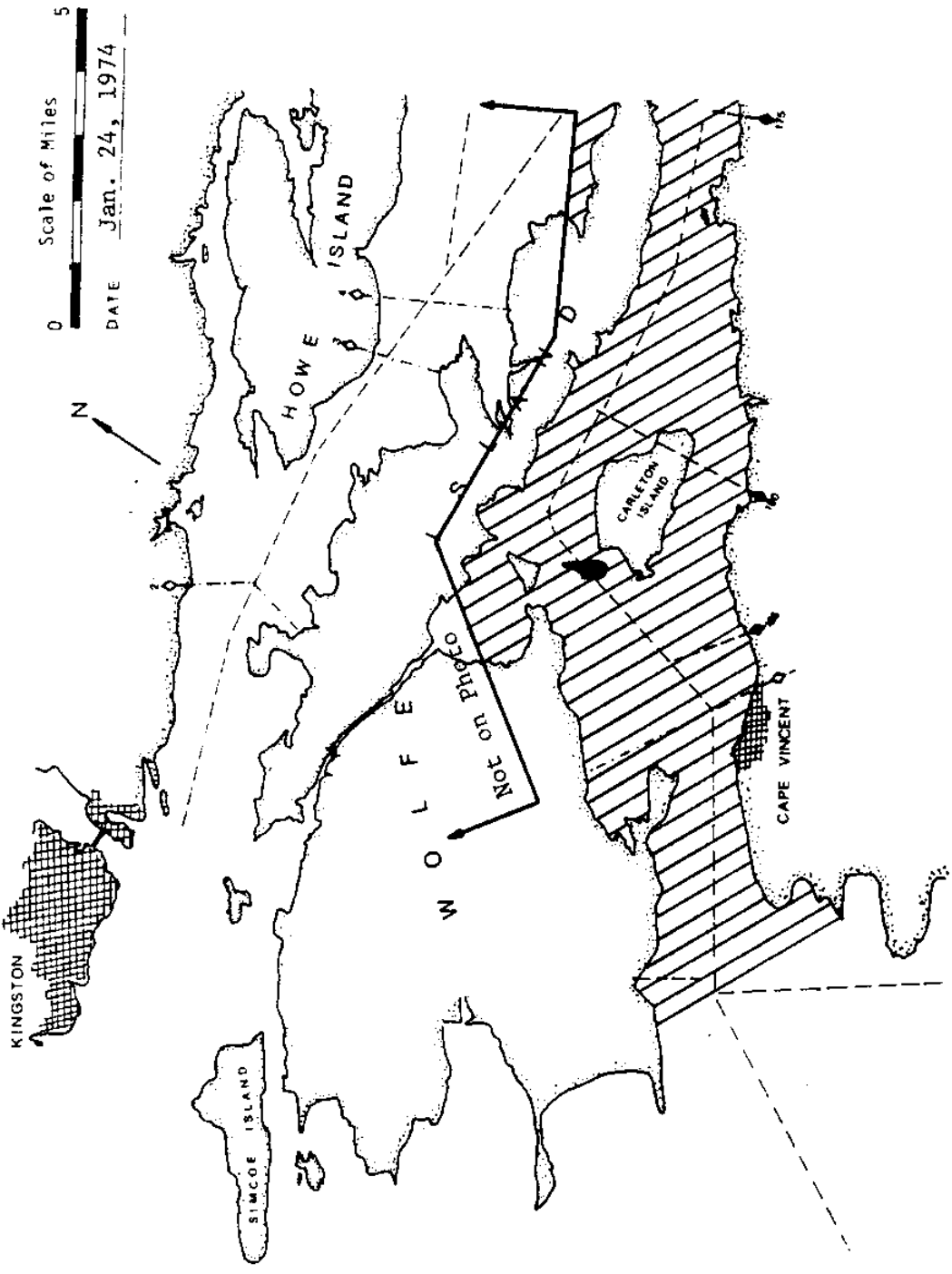


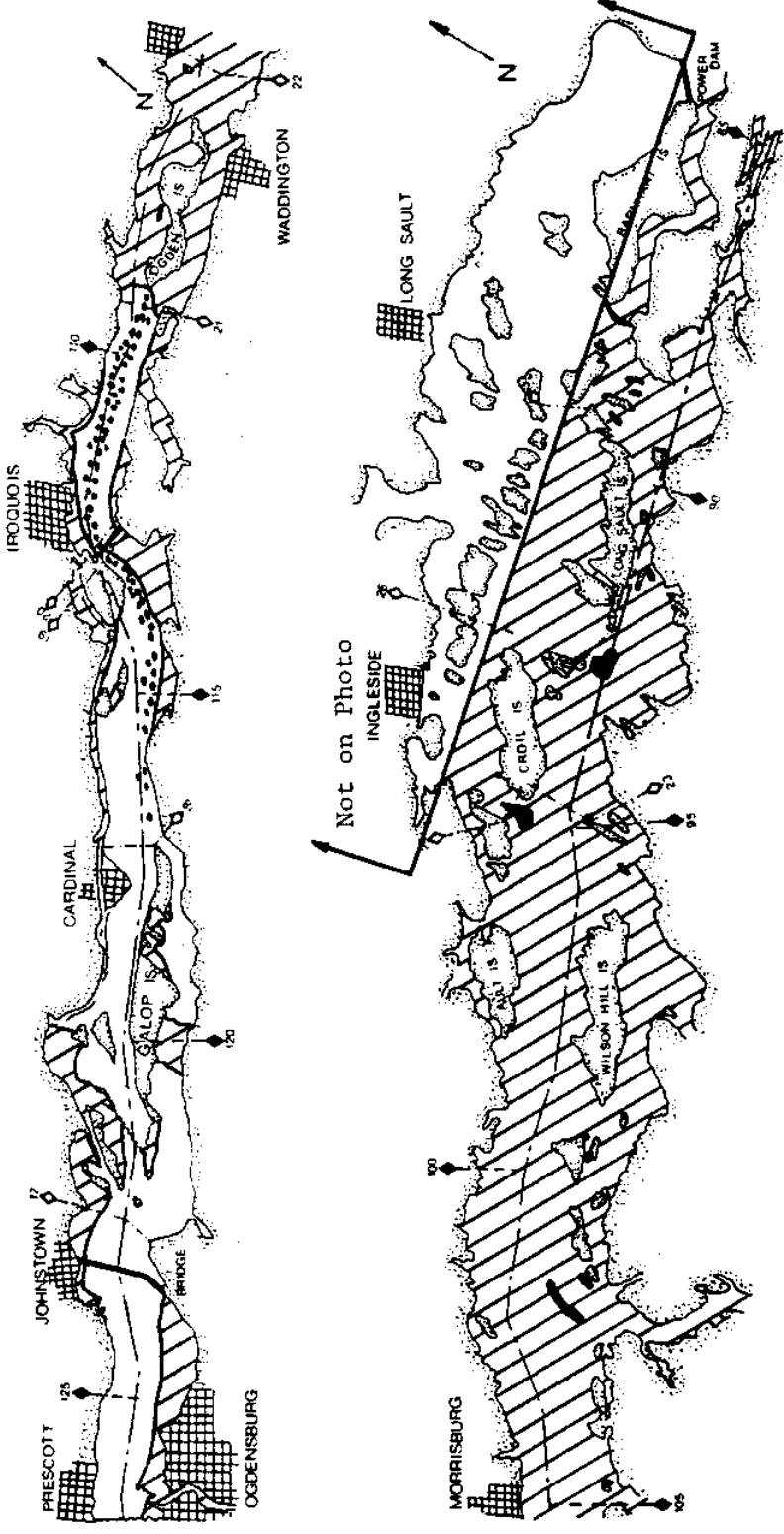




Scale of Miles 0 5

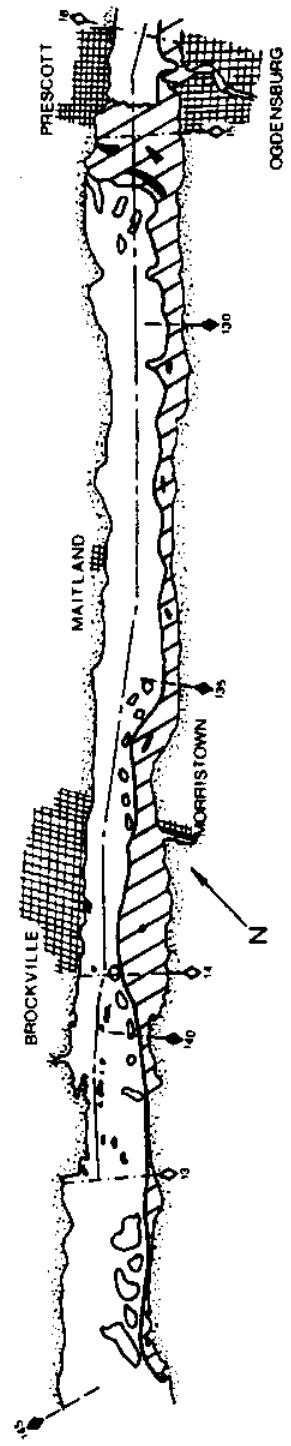
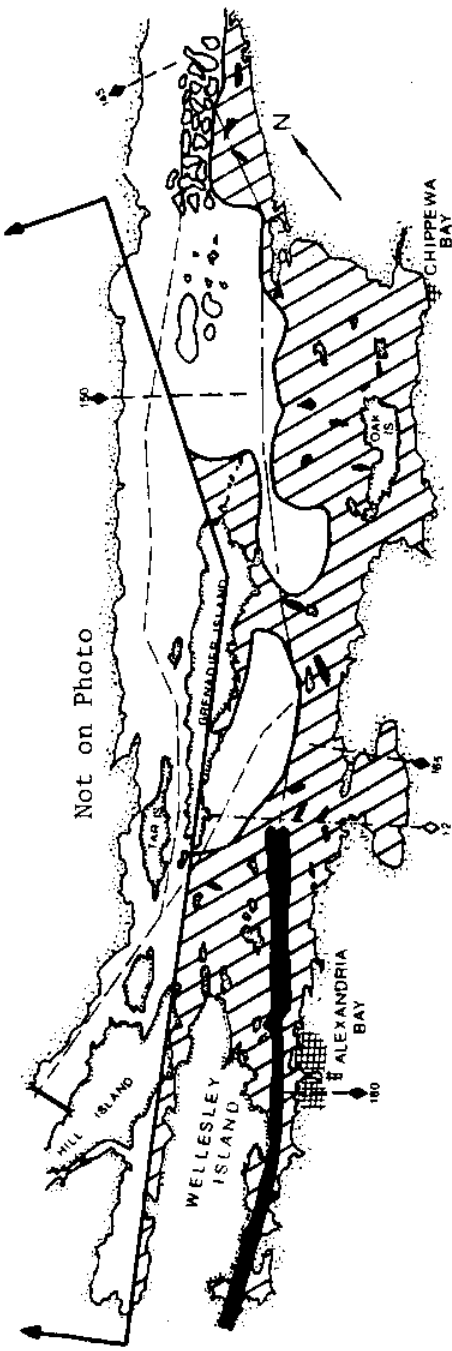
DATE: Jan. 24, 1974





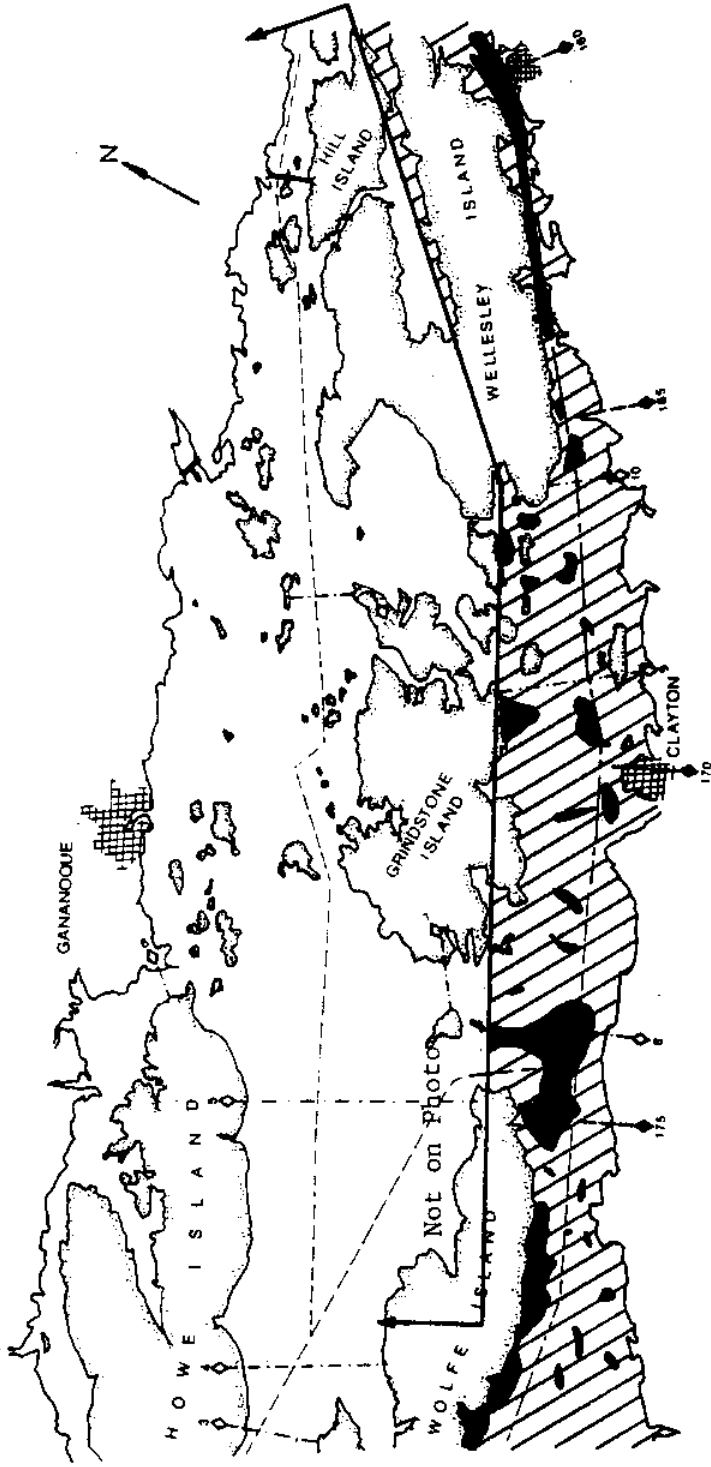
0 Scale of Miles 5

DATE Feb. 1, 1974



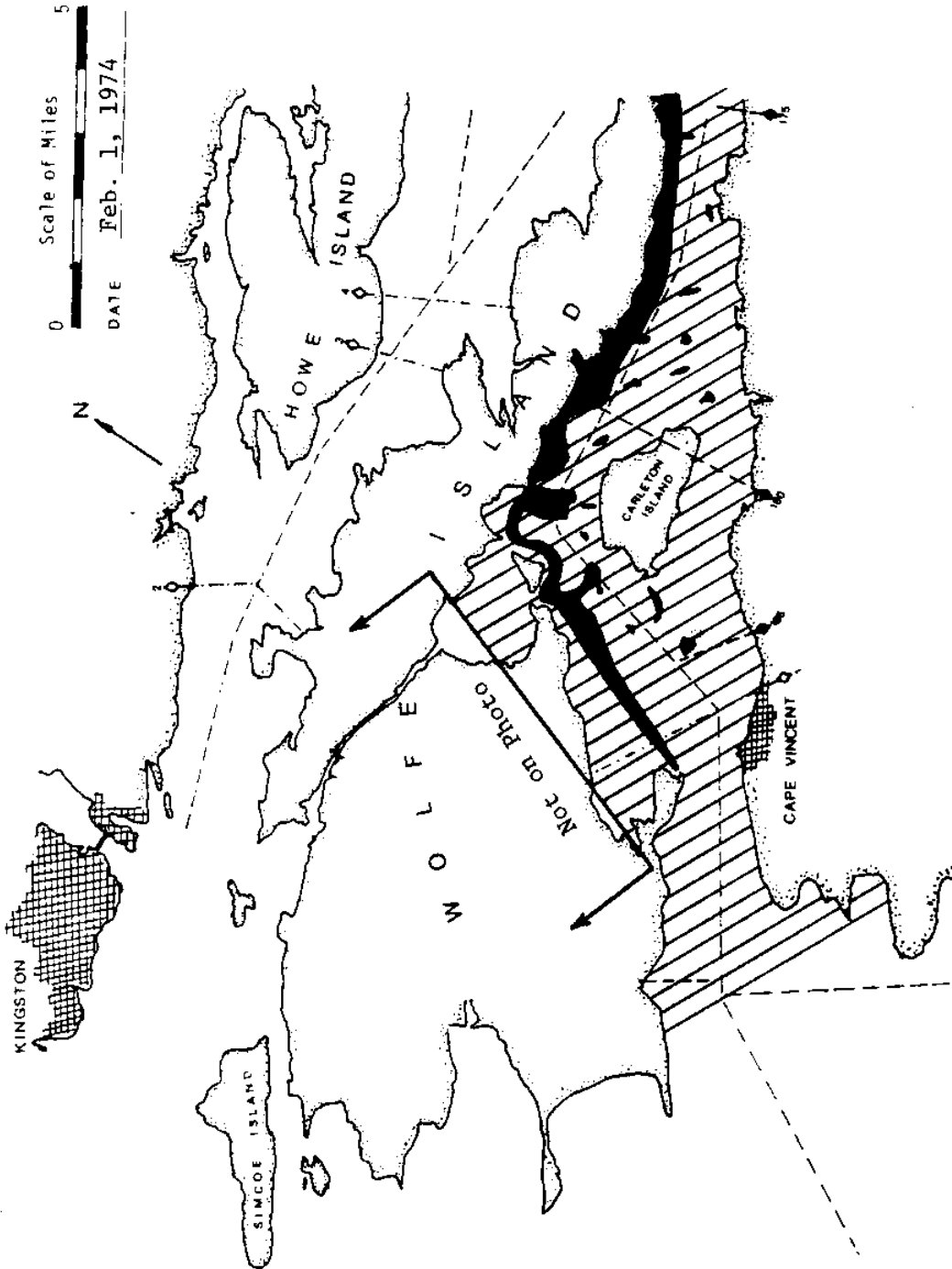
0 Scale of Miles 5

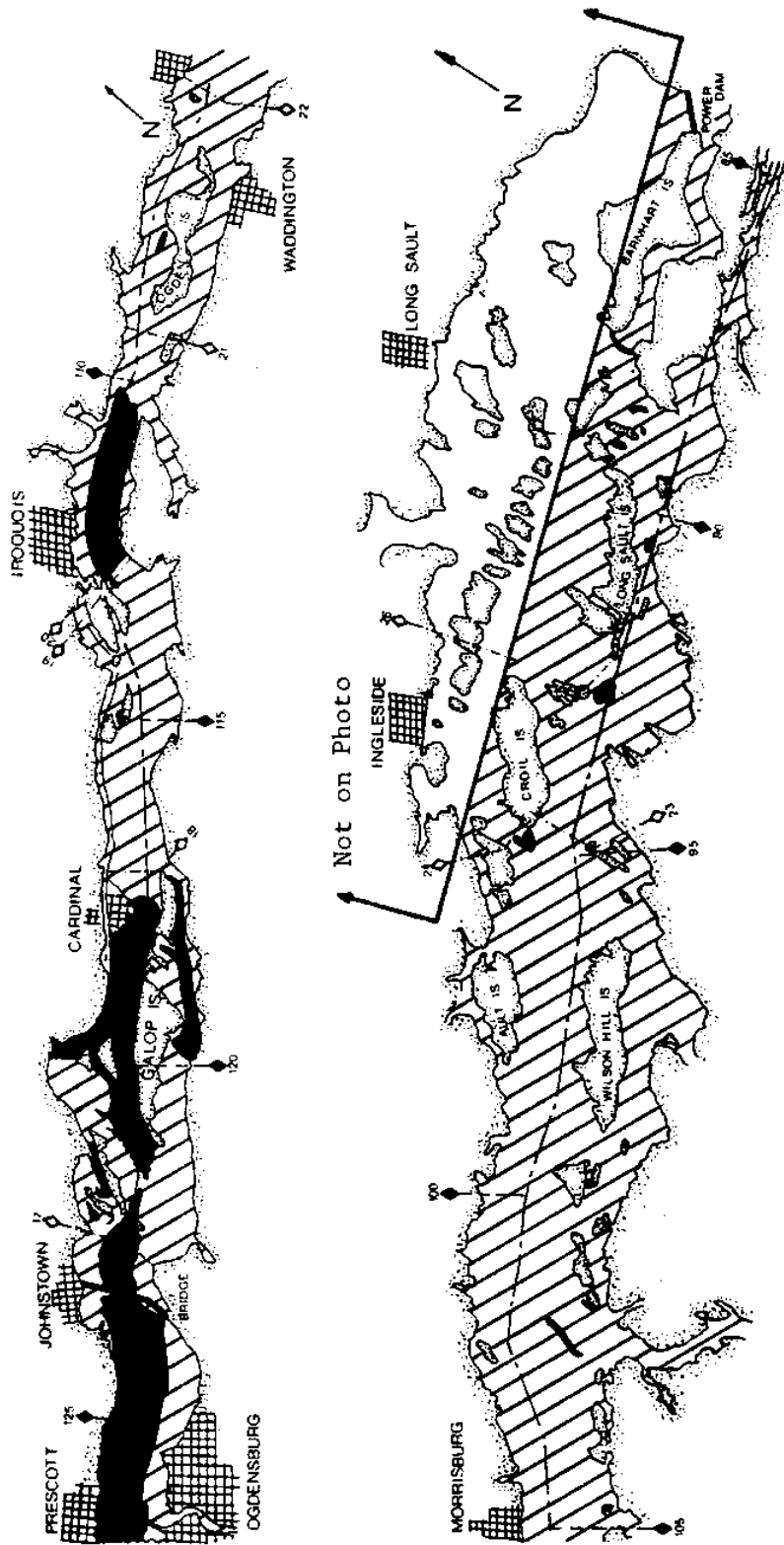
DATE Feb. 1, 1974



0 Scale of Miles 5

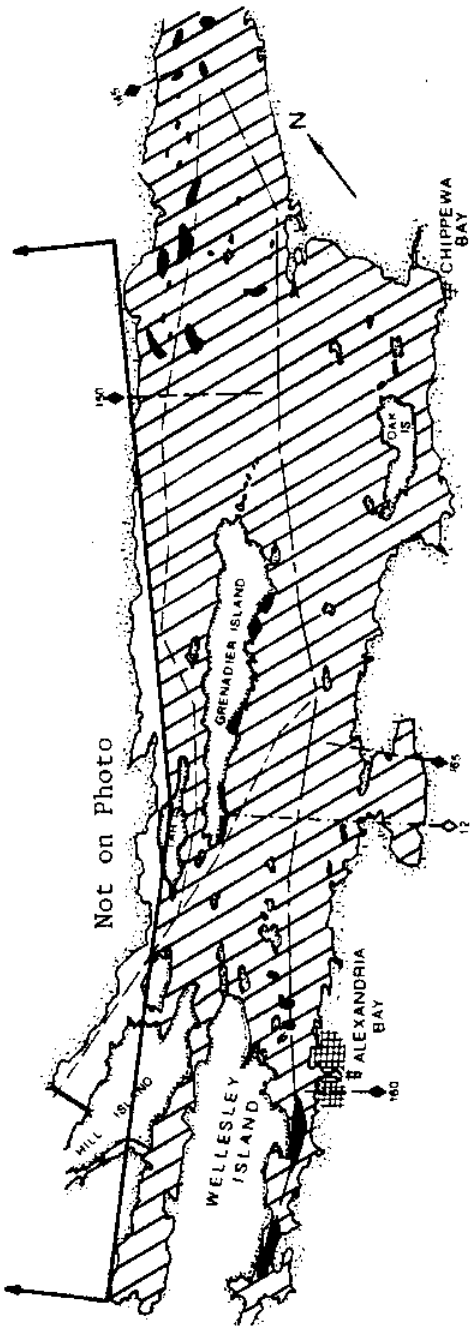
DATE Feb. 1, 1974



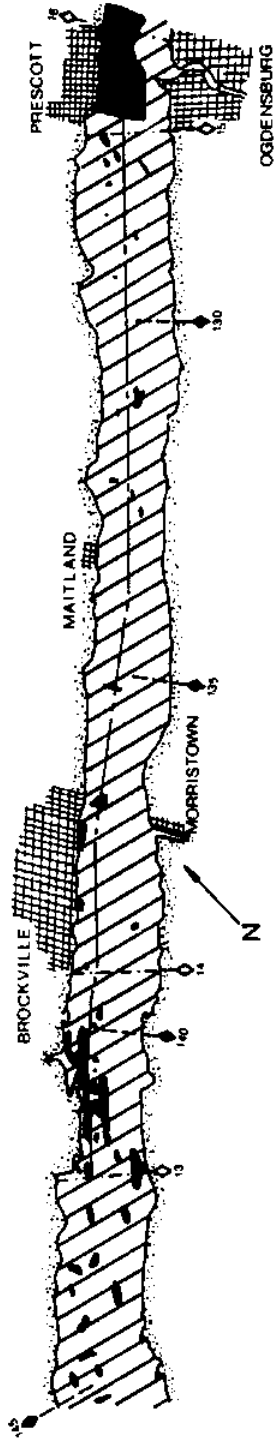


0 Scale of Miles 5

DATE Feb. 6, 1974

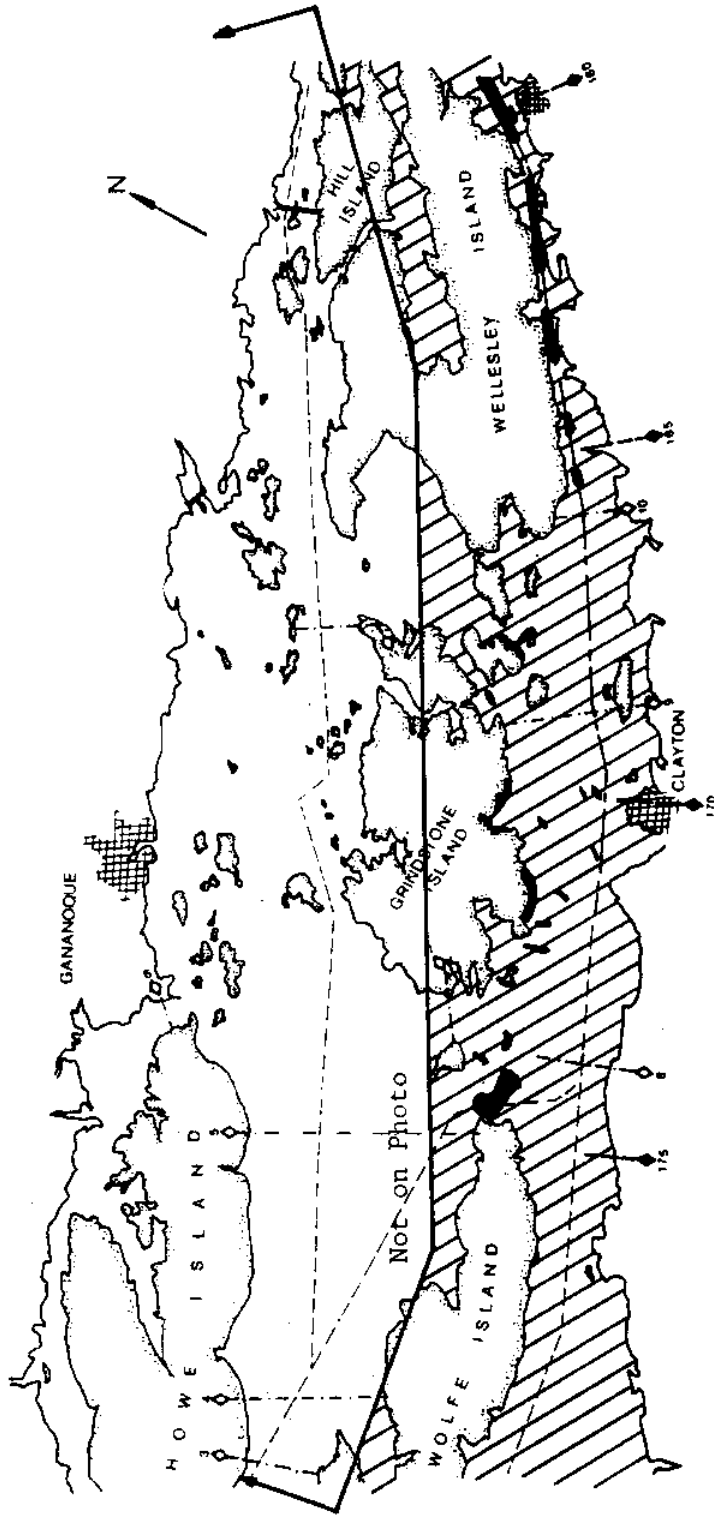


Not on Photo



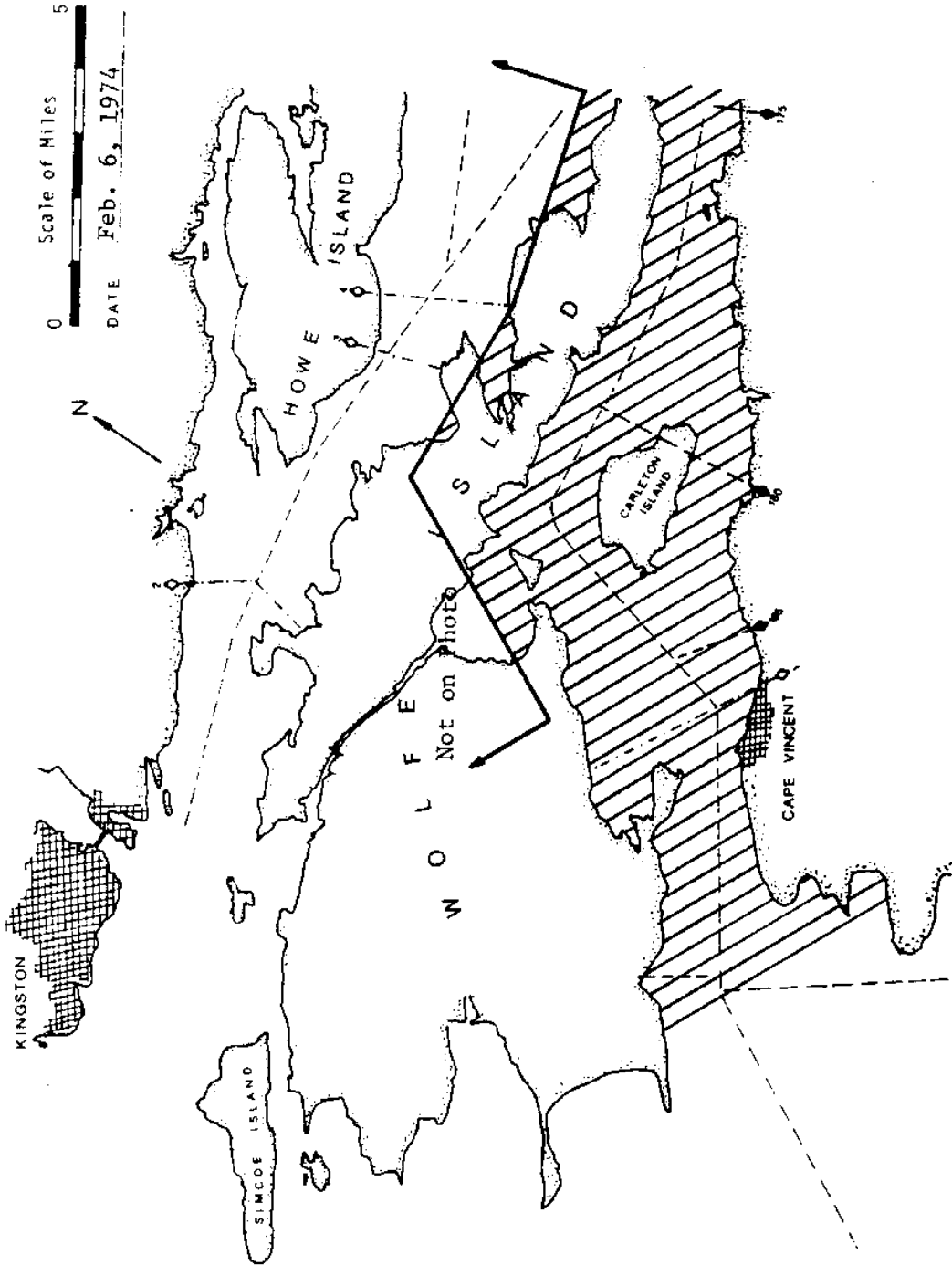
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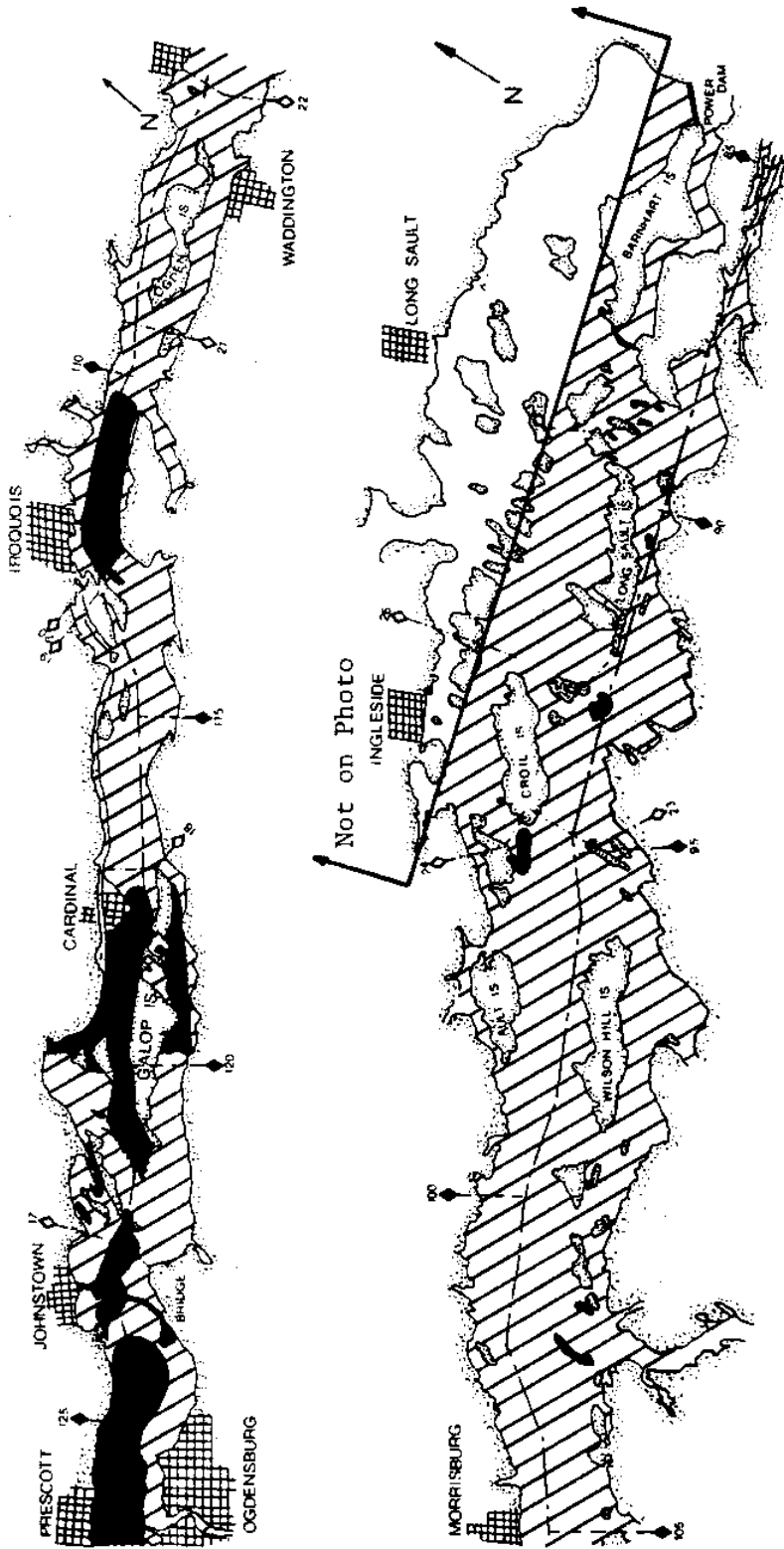
DATE Feb. 6, 1974



Scale of Miles 0 5

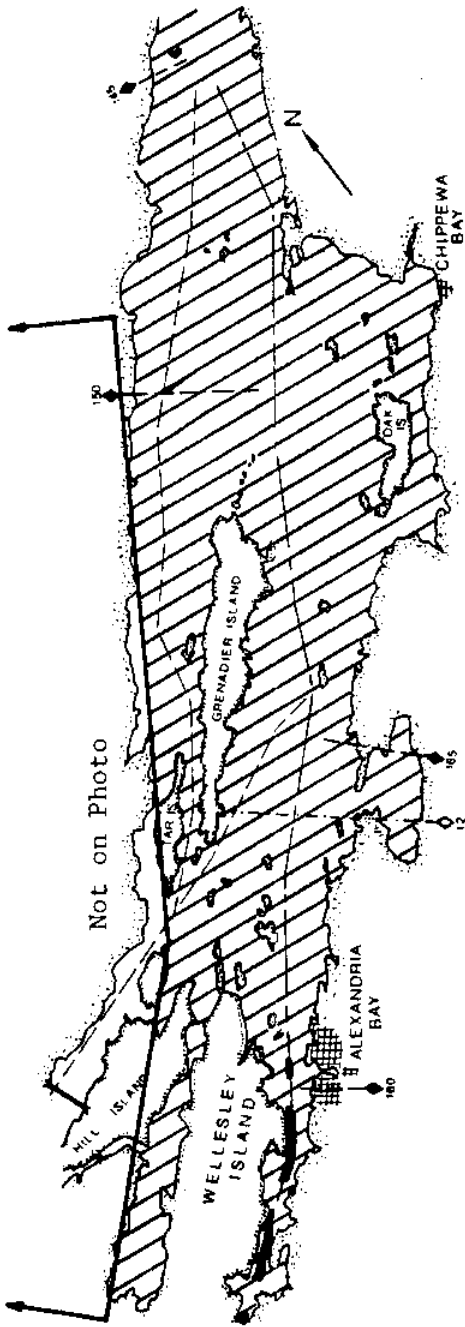
DATE Feb. 6, 1974



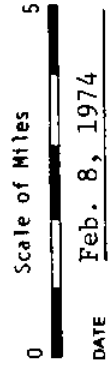
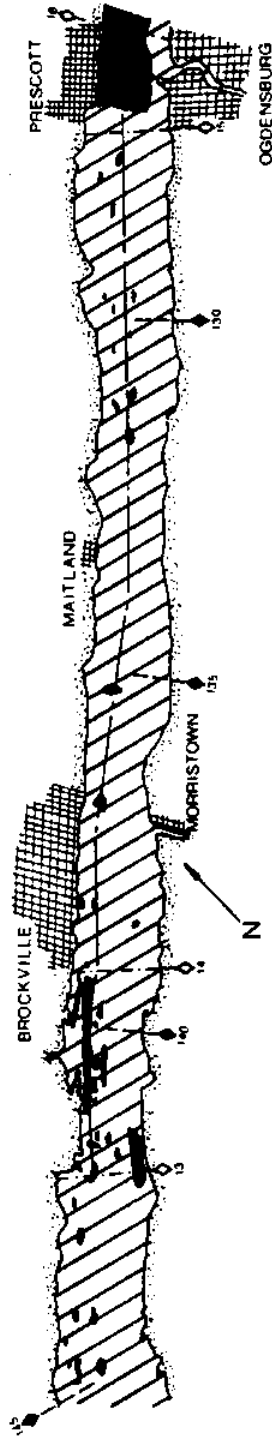


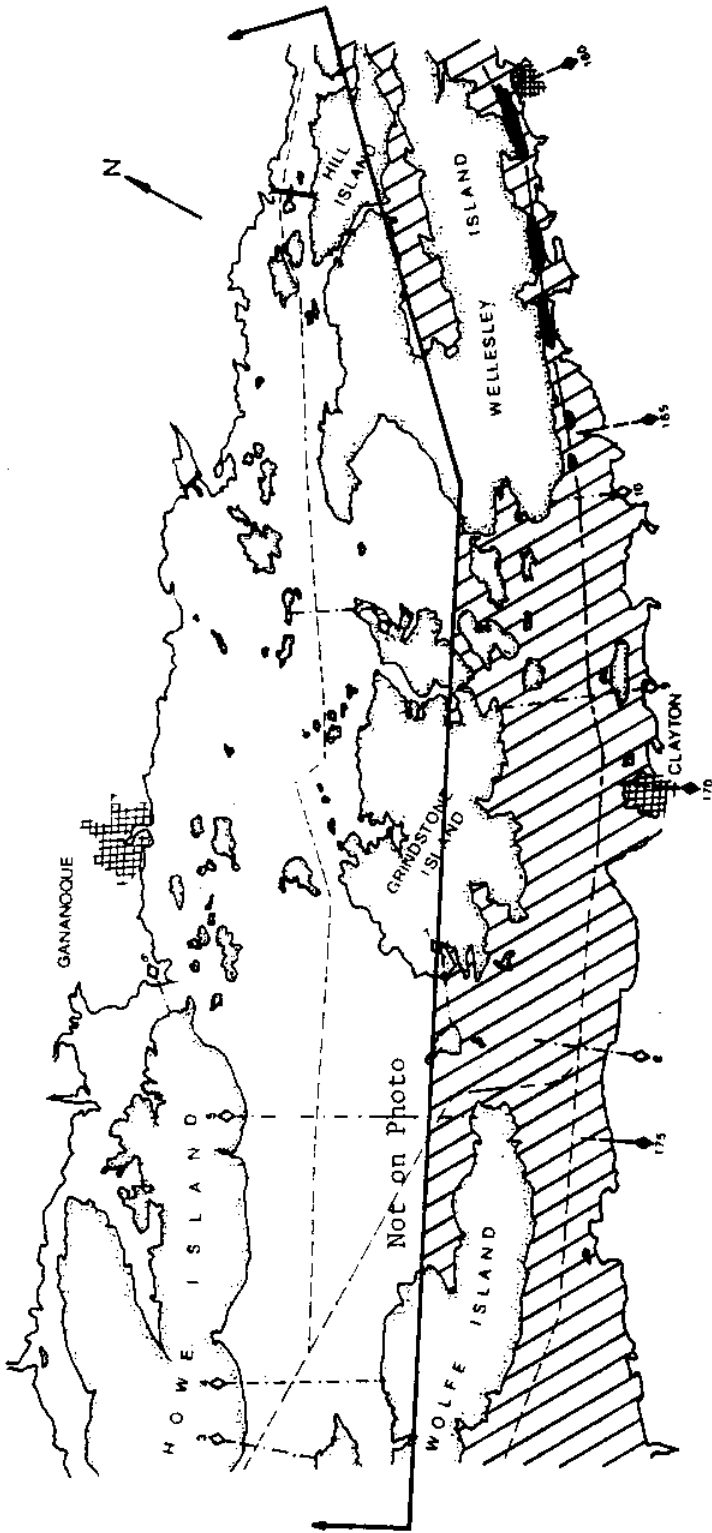
0 Scale of Miles 5

DATE Feb. 8, 1974



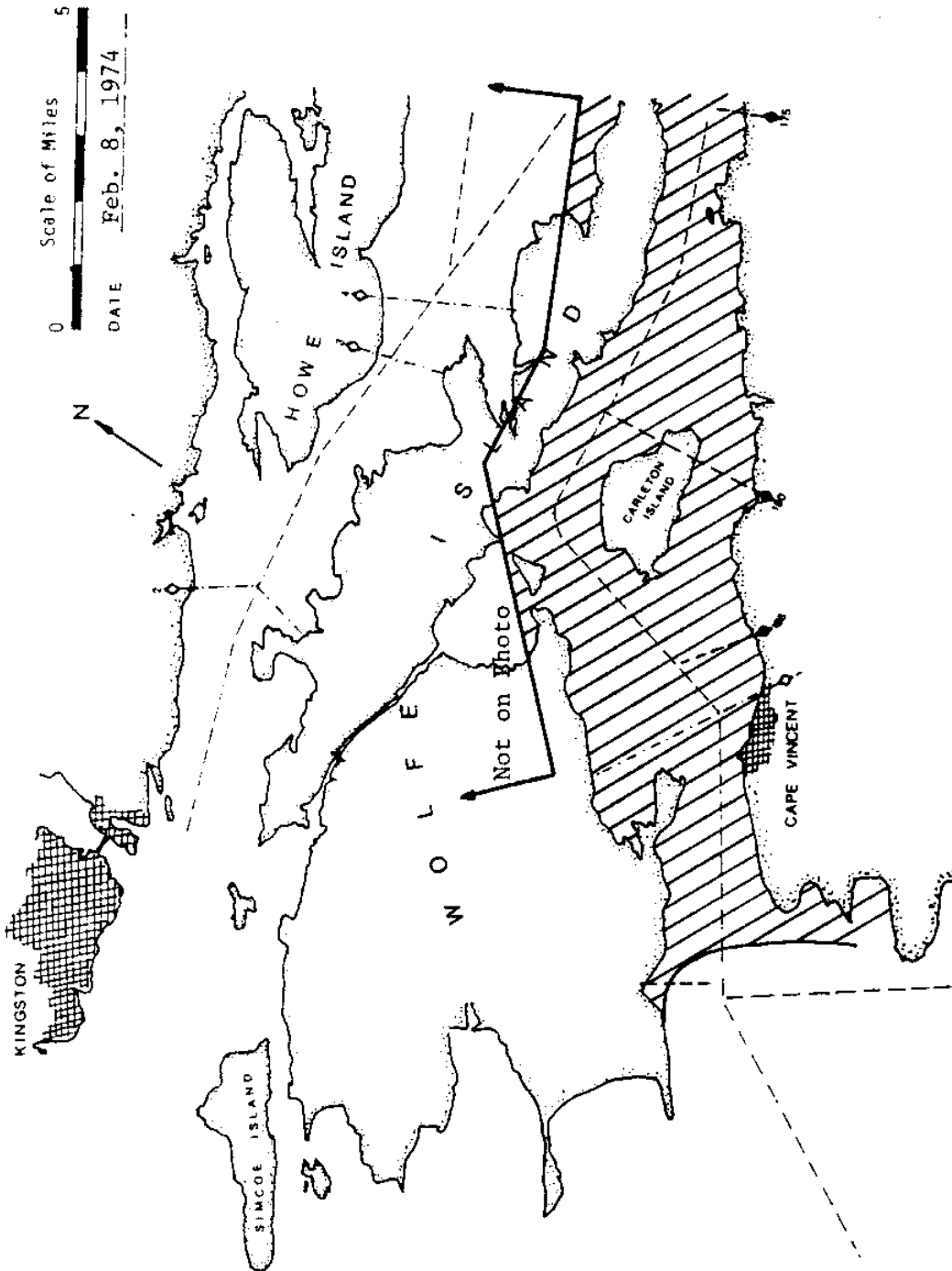
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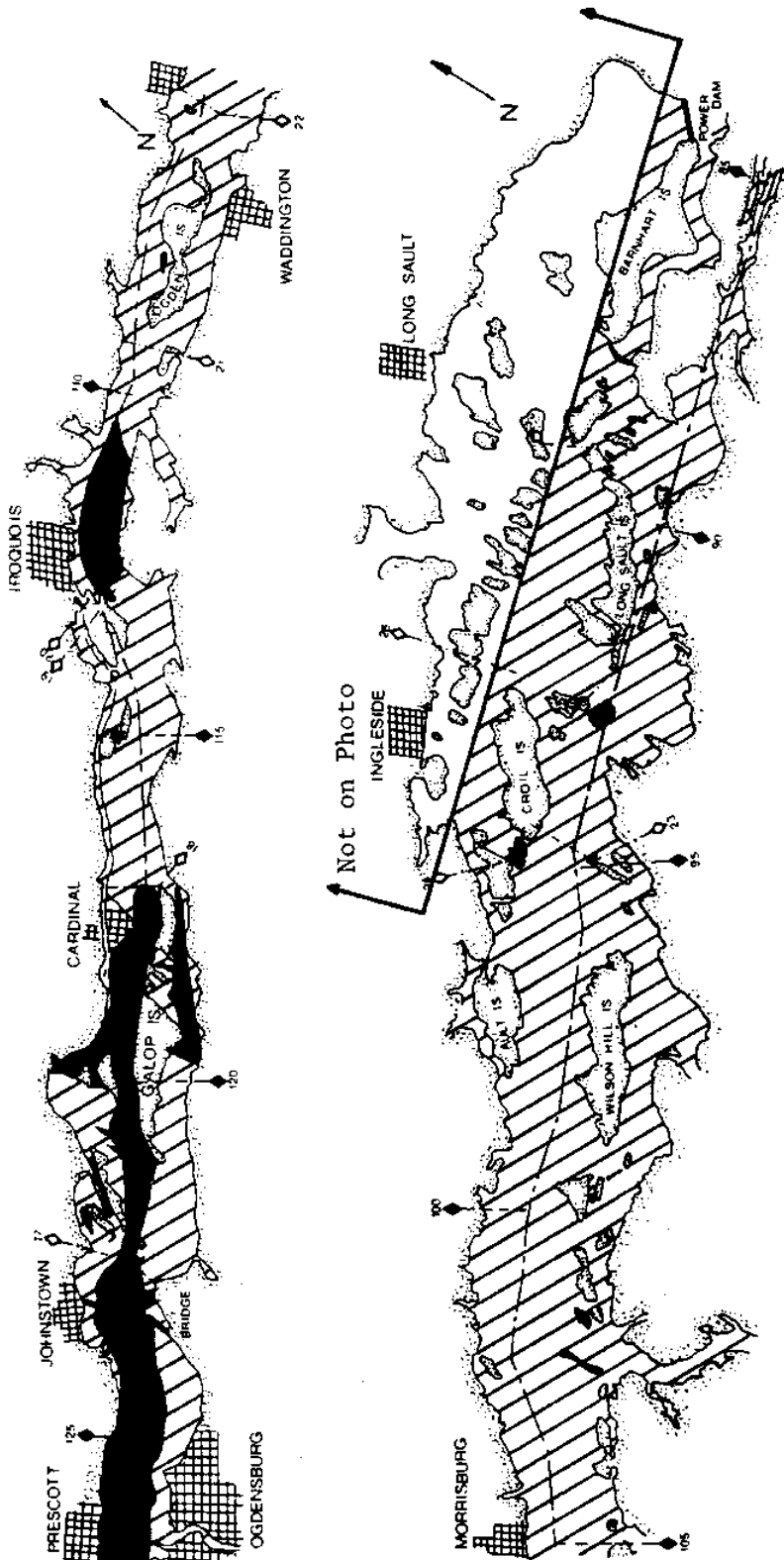




0 Scale of Miles 5

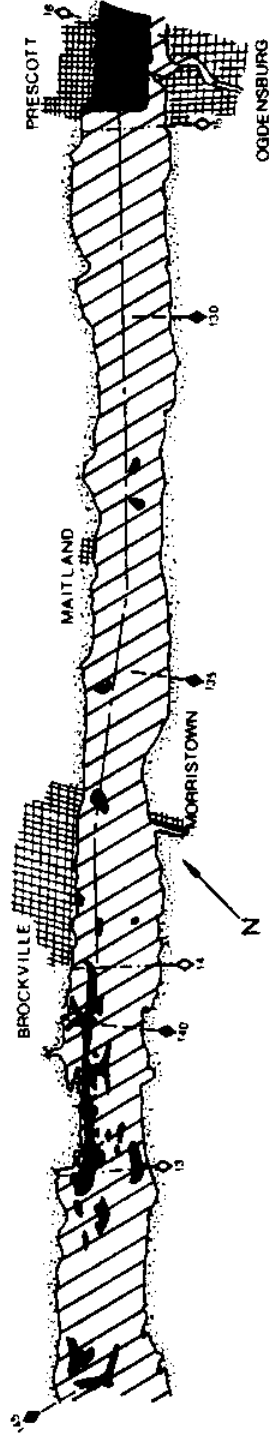
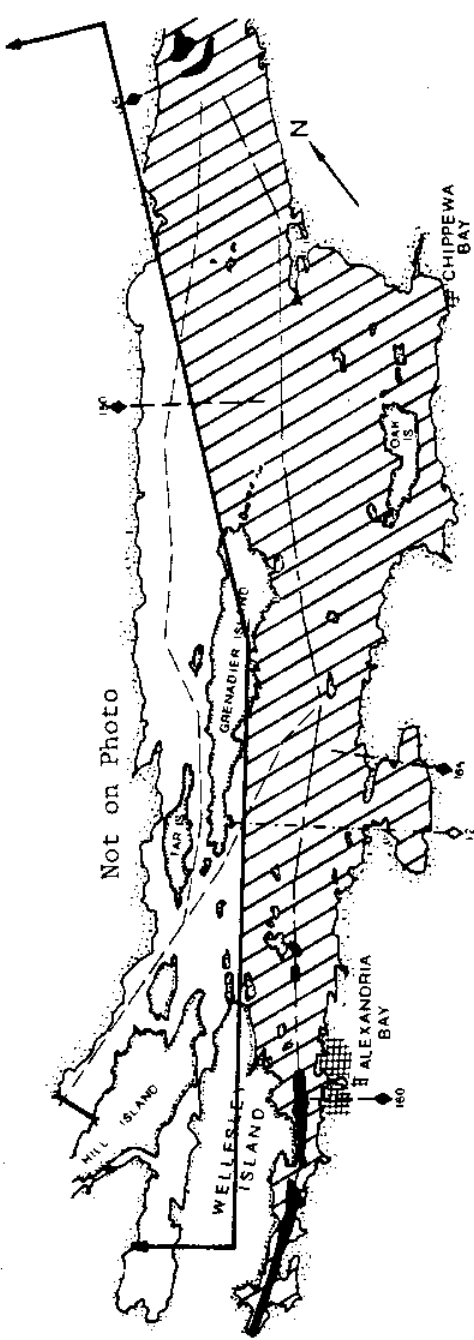
DATE Feb. 8, 1974





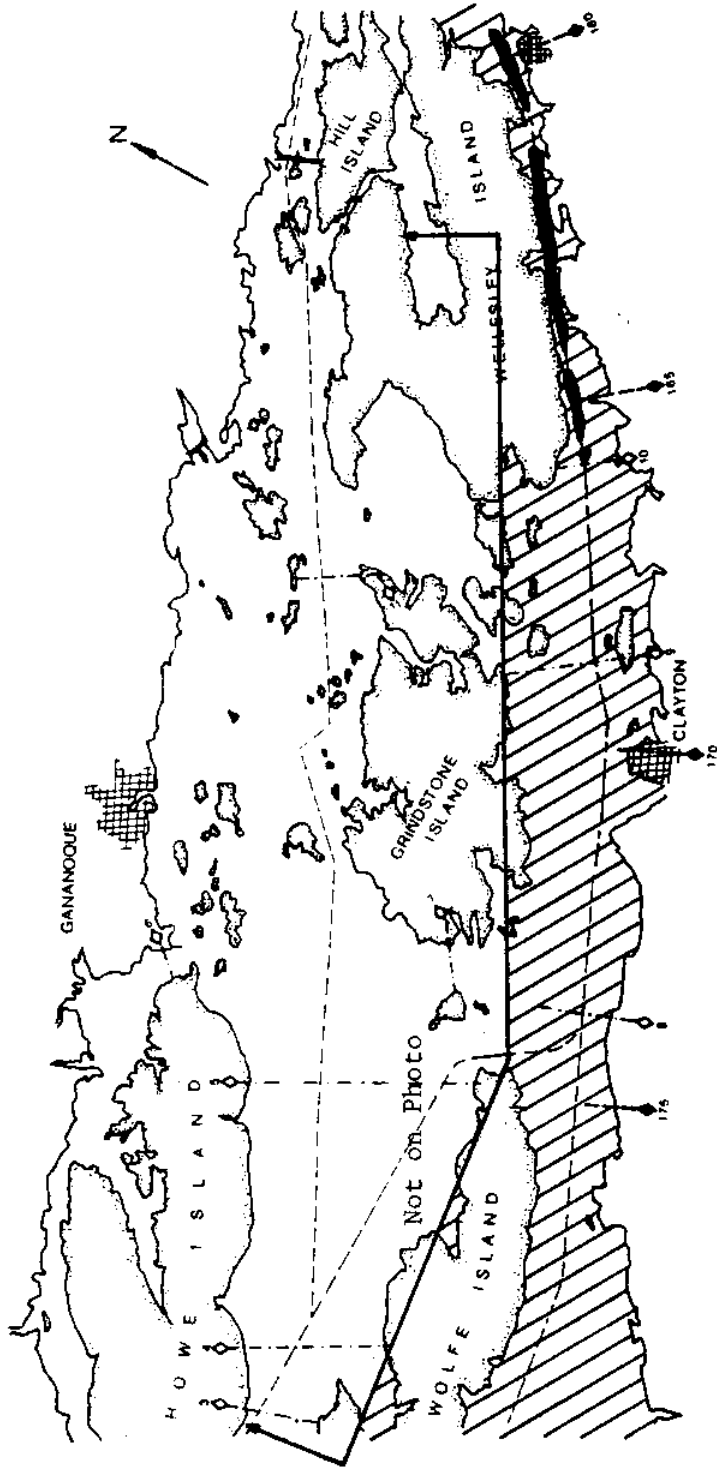
0 Scale of Miles 5

DATE Feb. 14, 1974



0 Scale of Miles 5

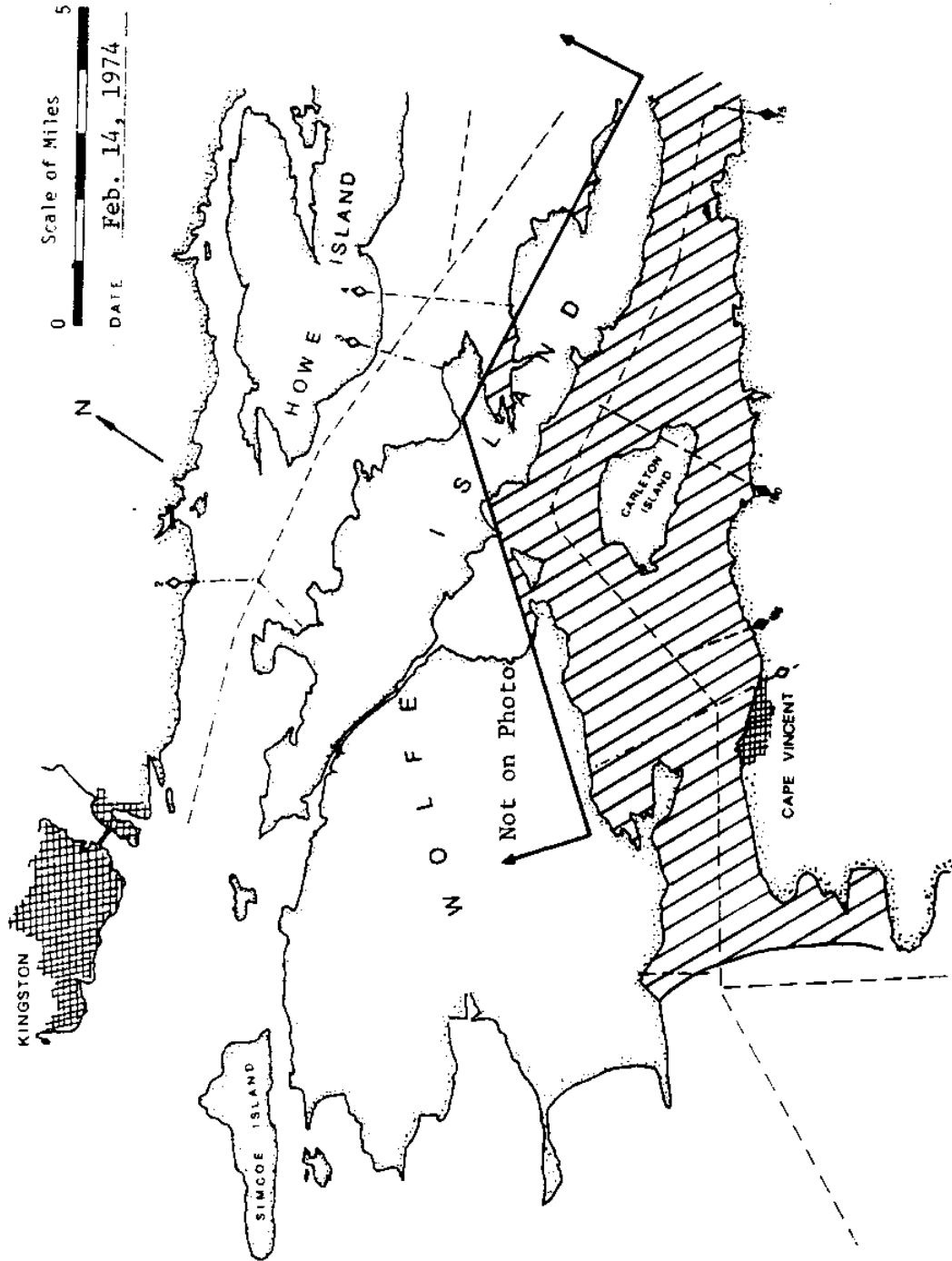
DATE Feb. 14, 1974

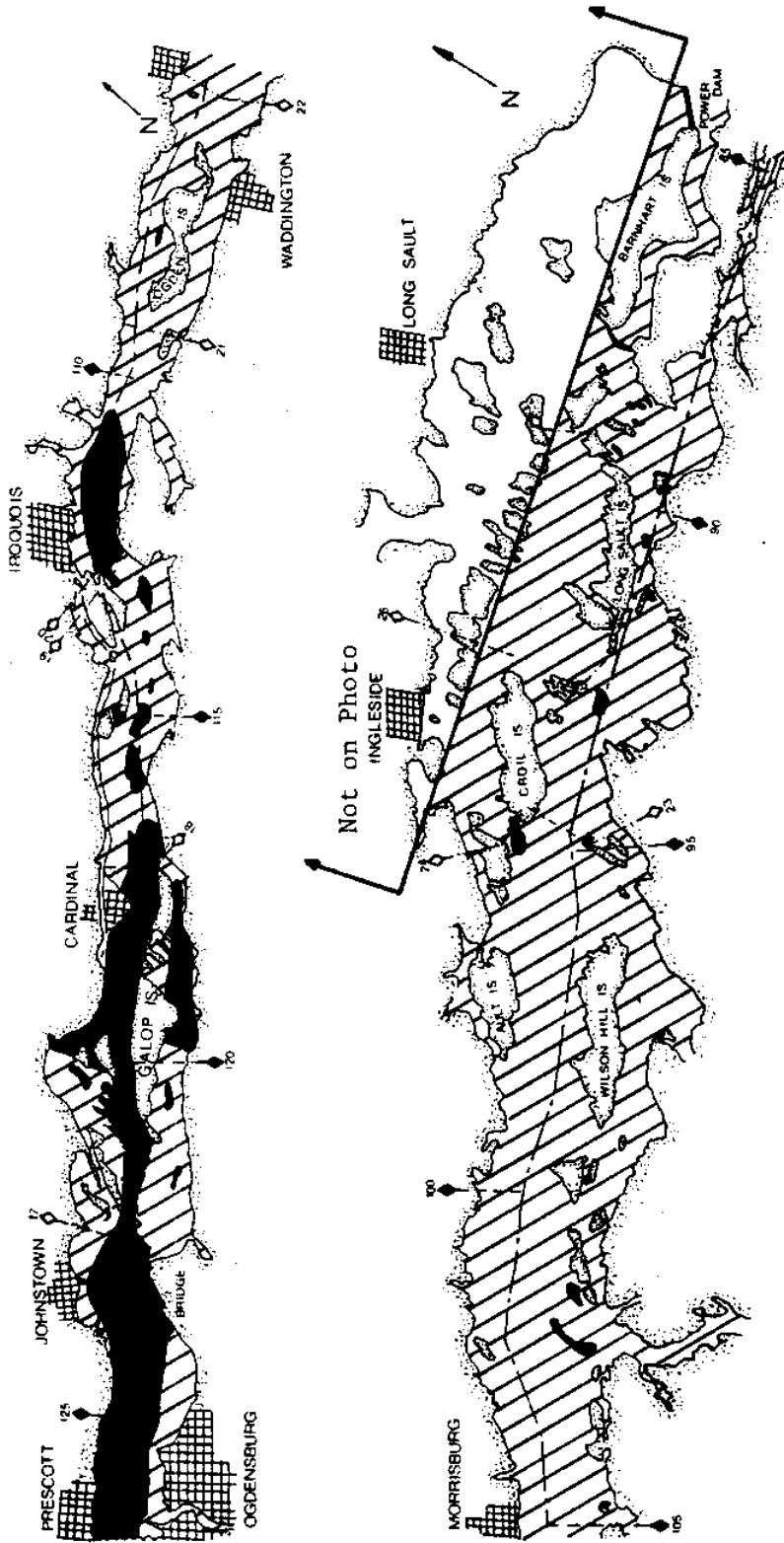


0 Scale of Miles 5

DATE Feb. 14, 1974

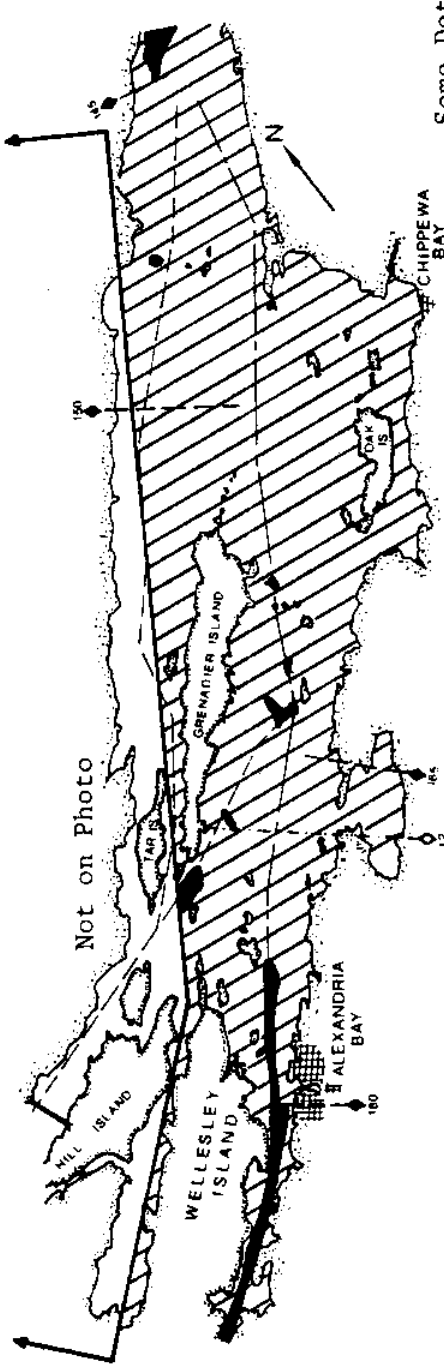
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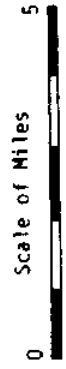
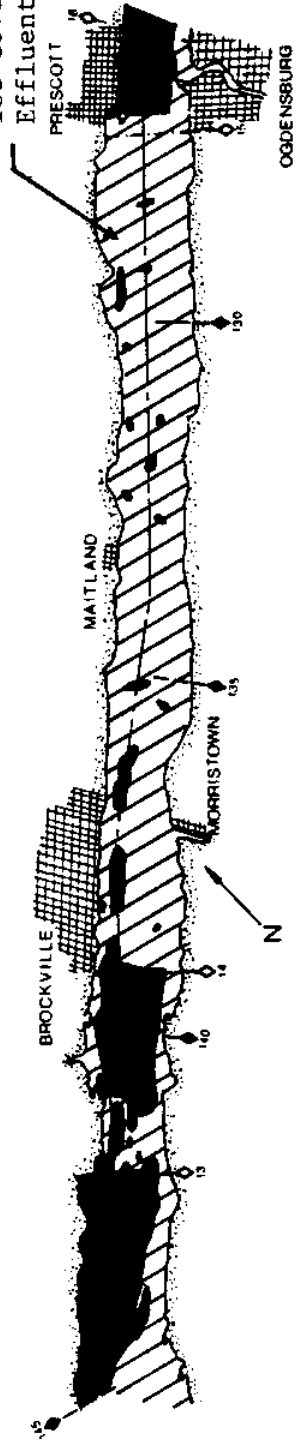


0 Scale of Miles 5

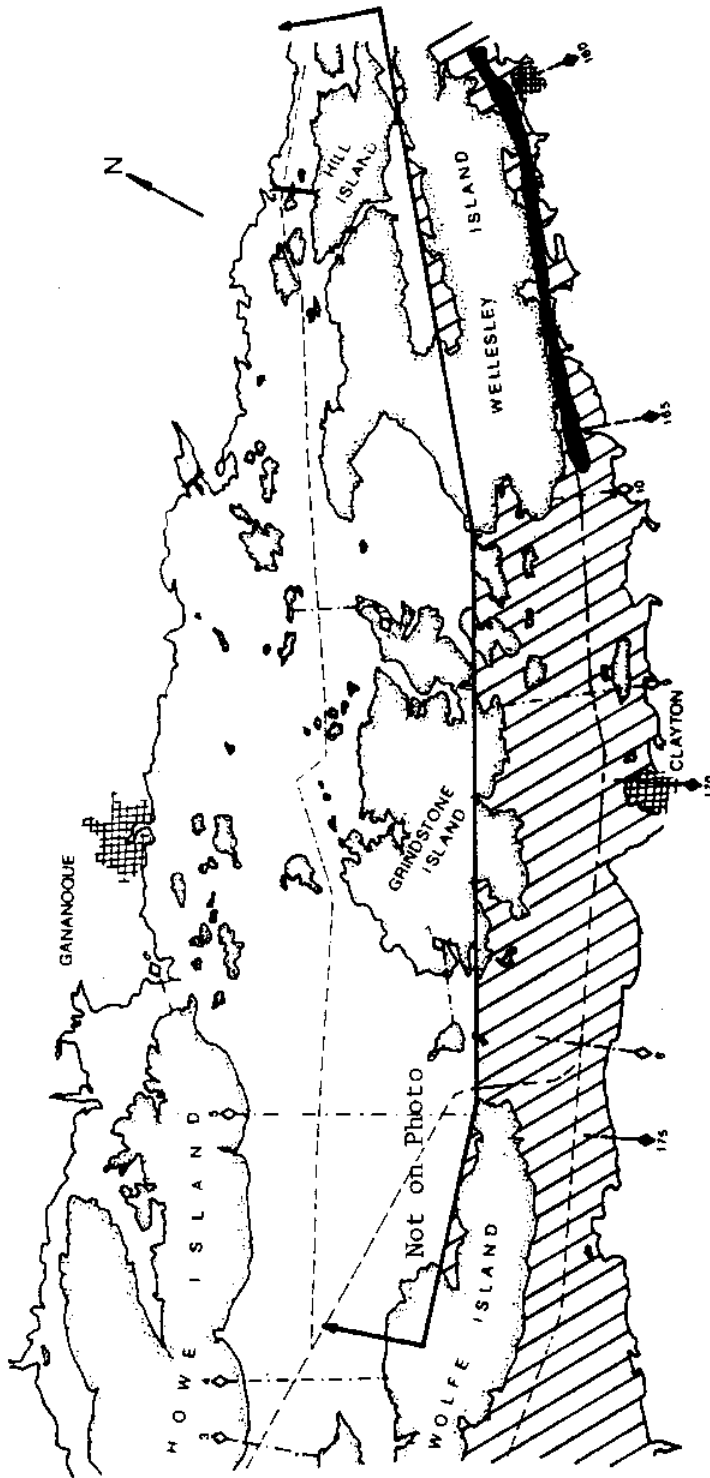
DATE Feb. 21, 1974



Some Deterioration of
Ice Cover Due to Thermal
Effluent Near Maitland

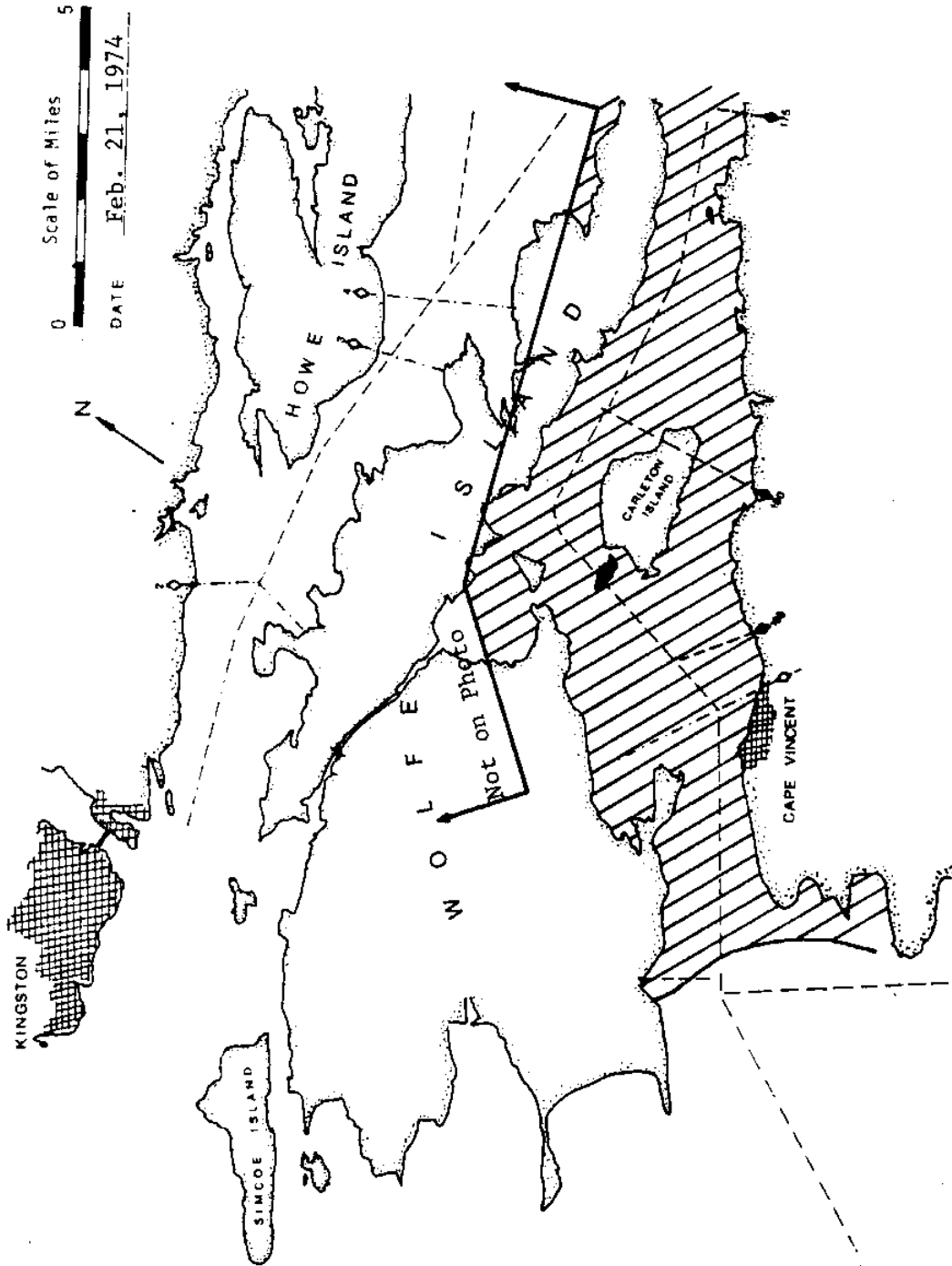


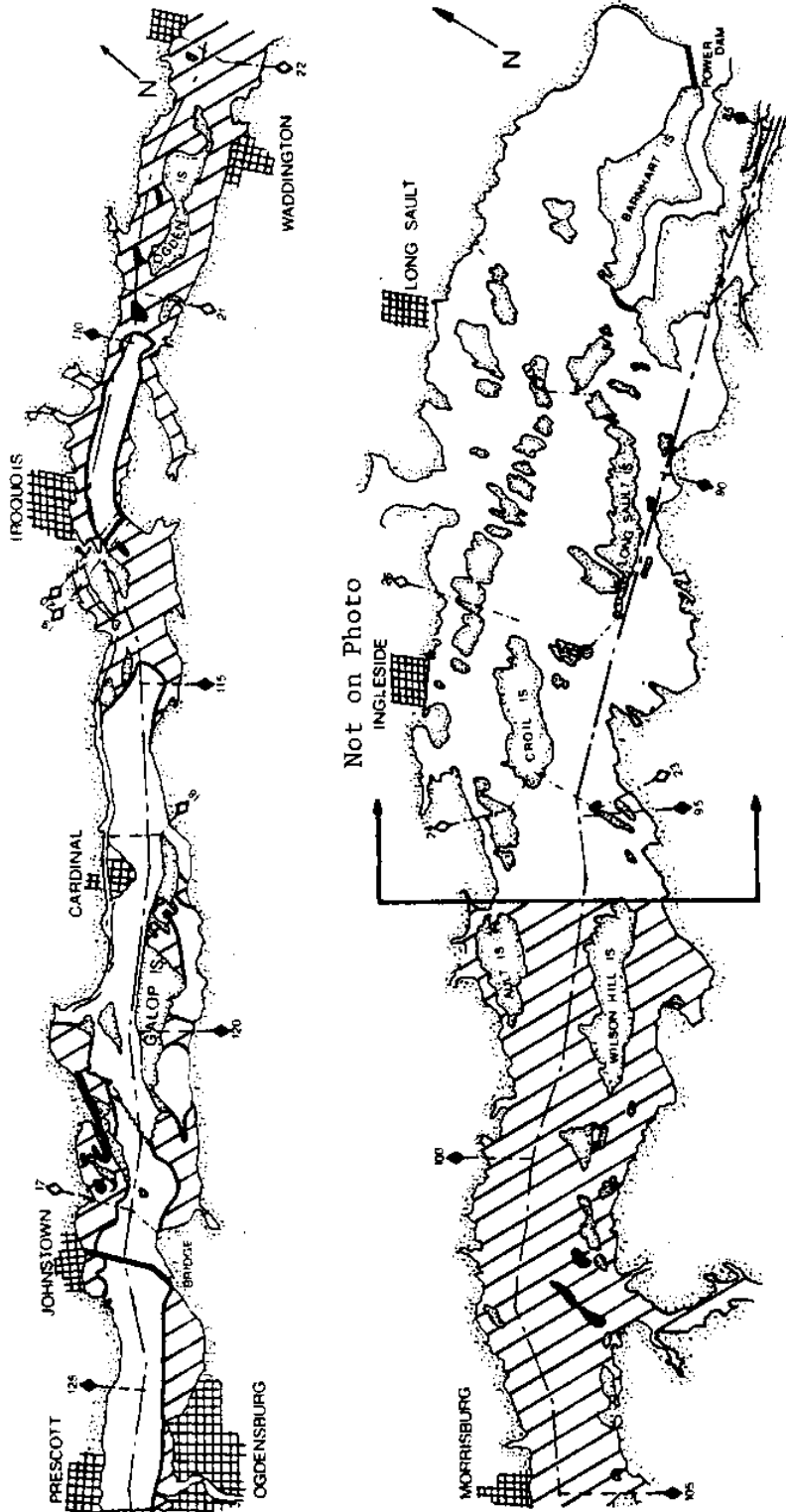
DATE Feb. 21, 1974



0 Scale of Miles 5

DATE Feb. 21, 1974

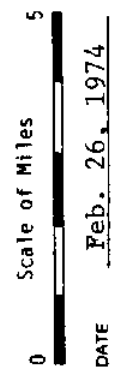
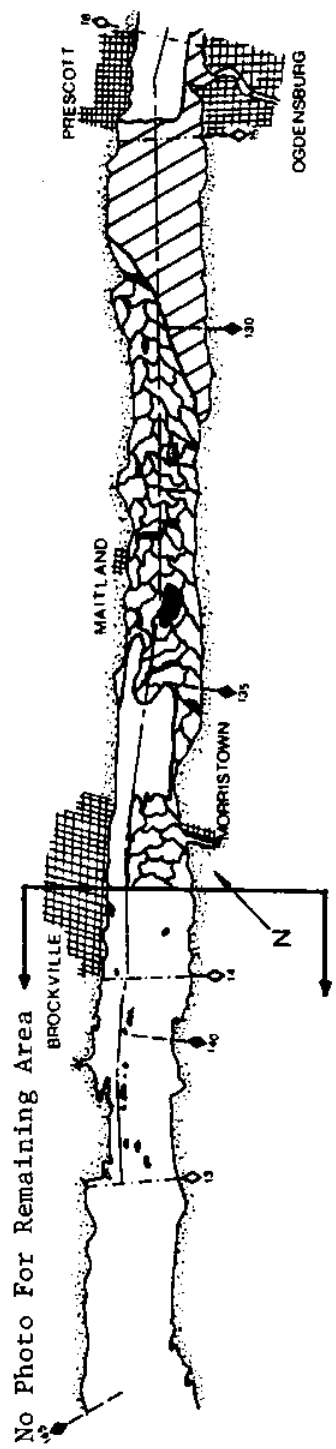
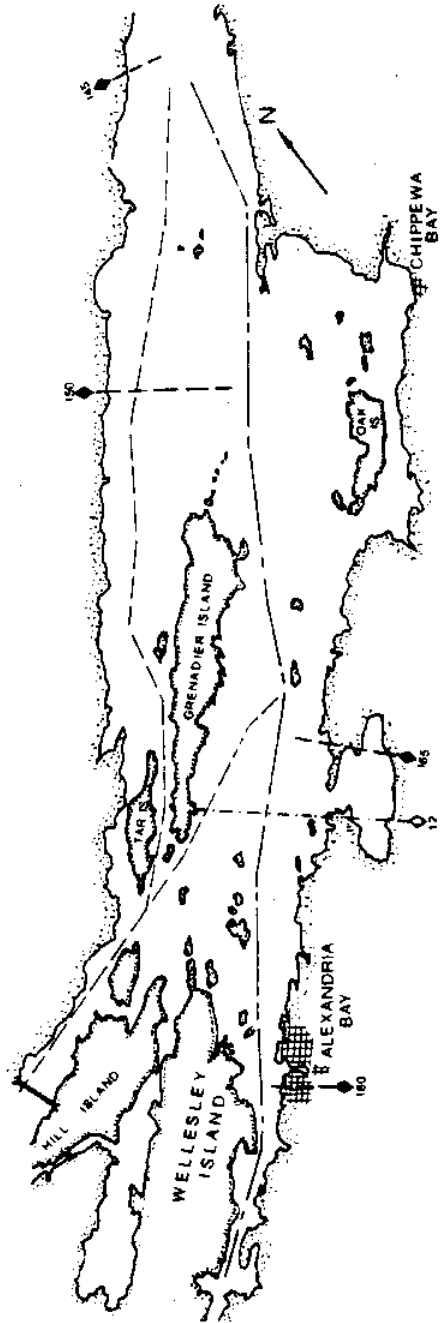


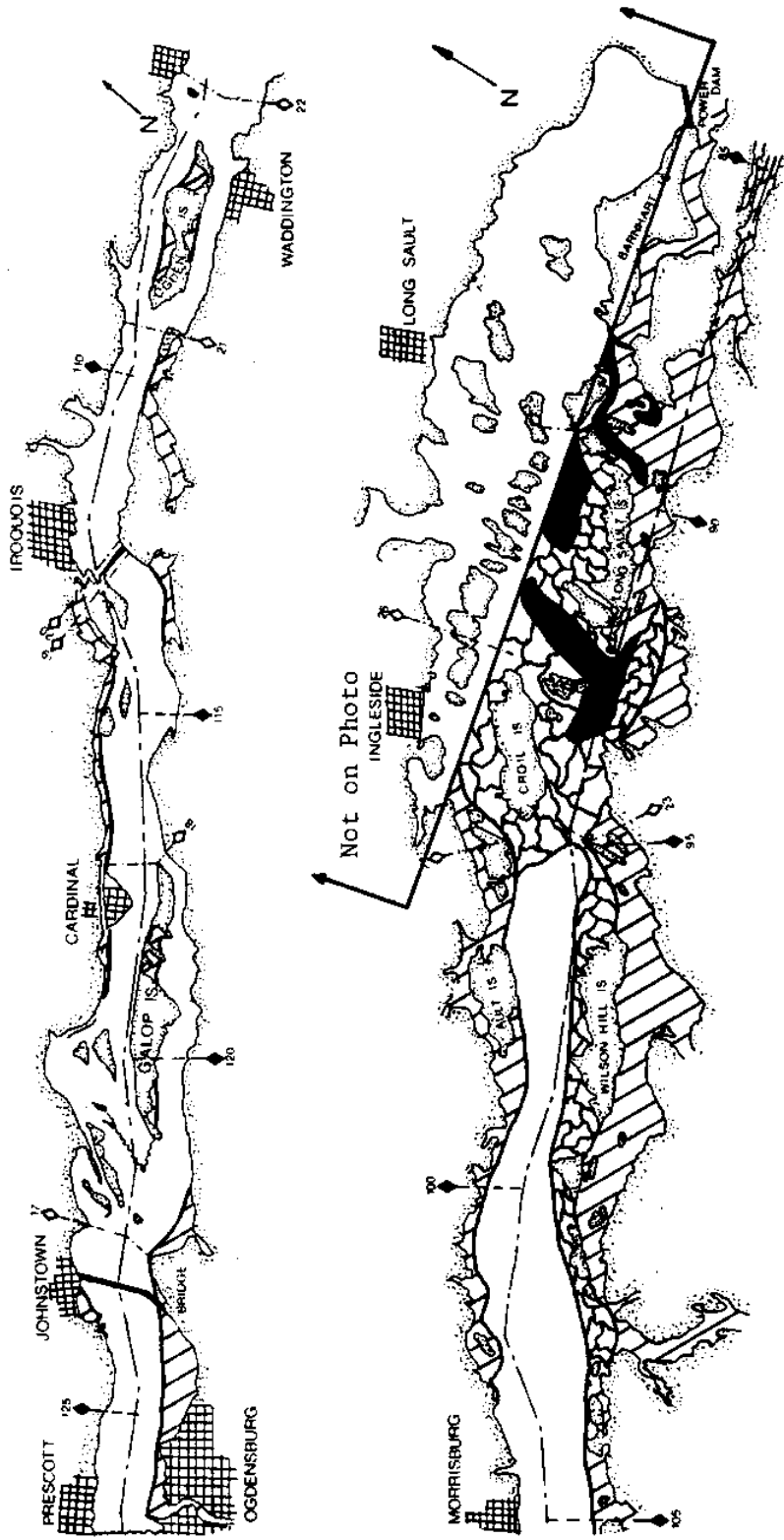


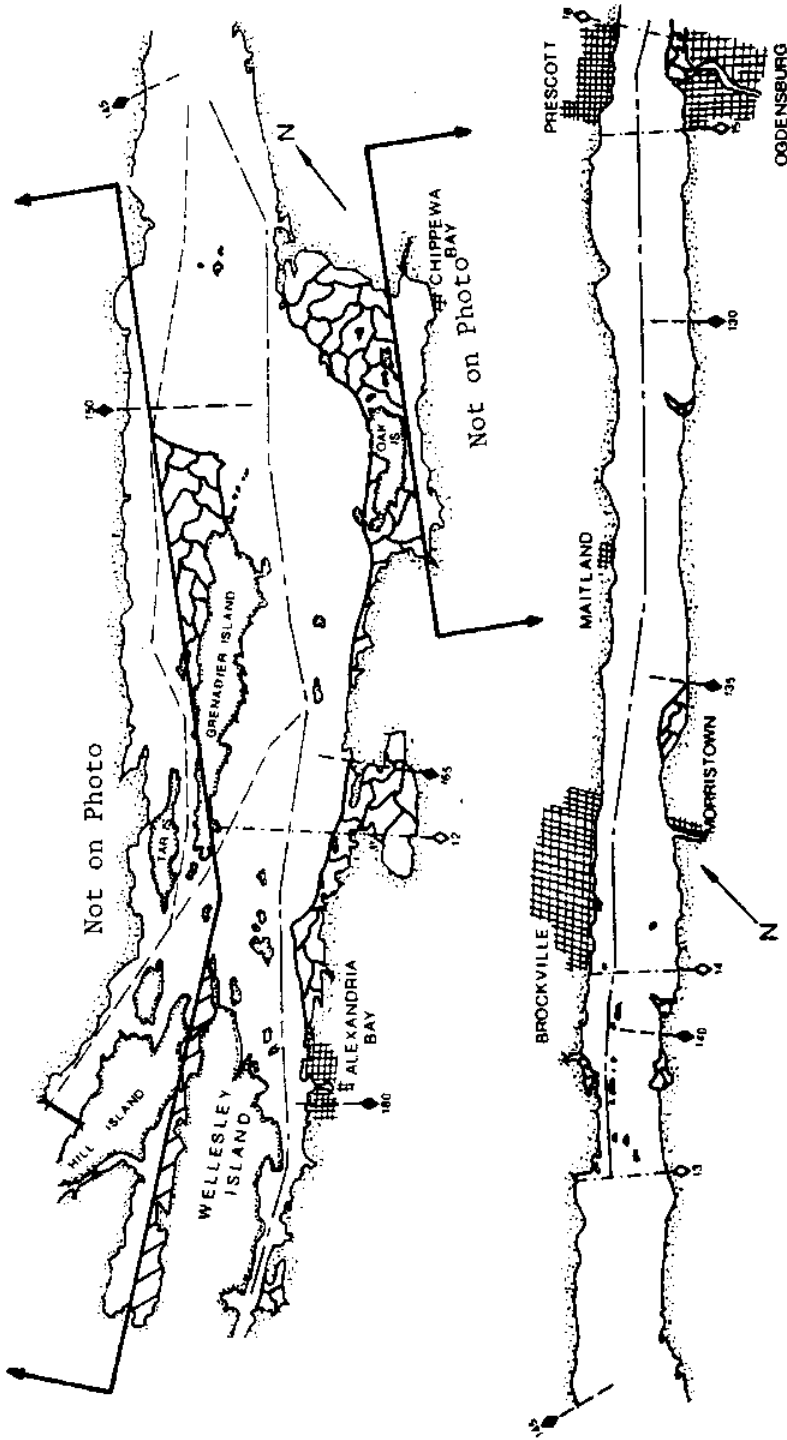
Not on Photo

0 Scale of Miles 5

DATE Feb. 26, 1974

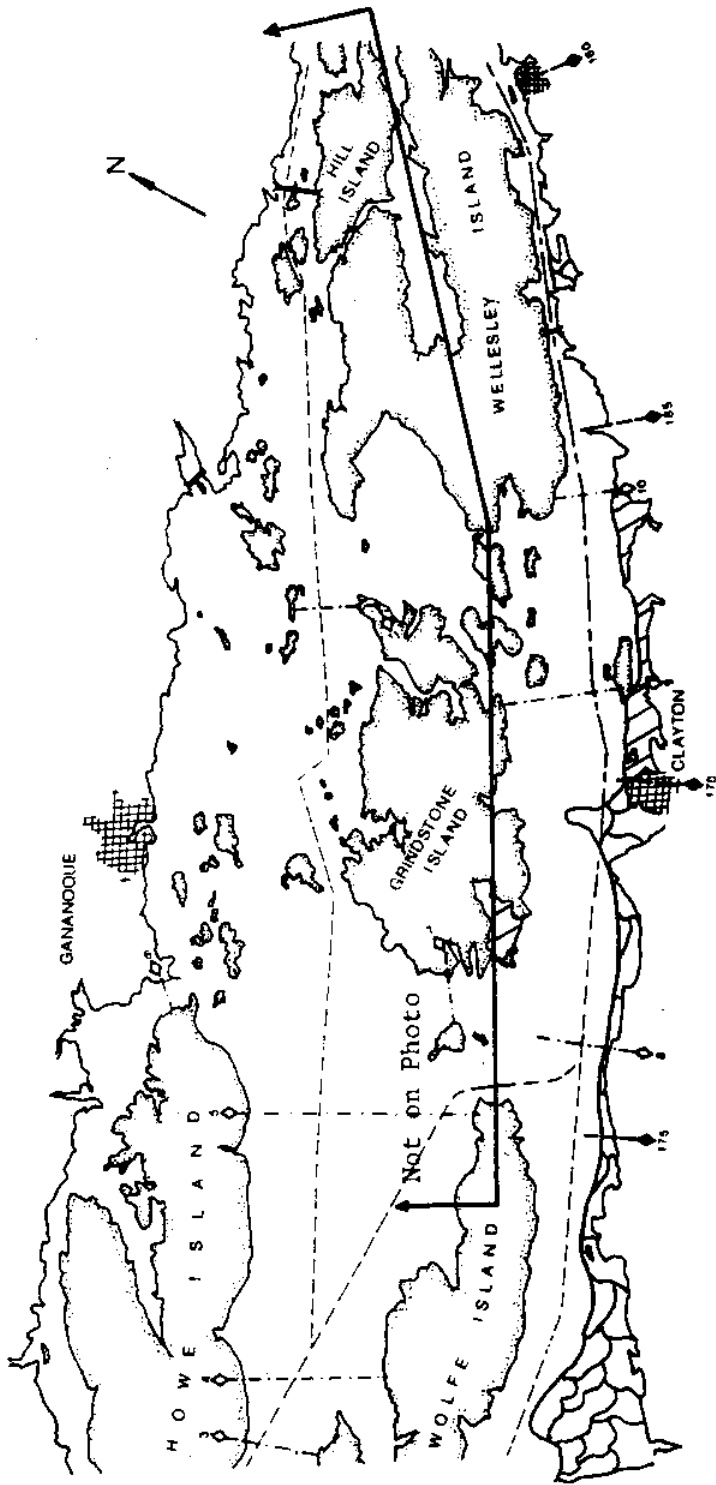






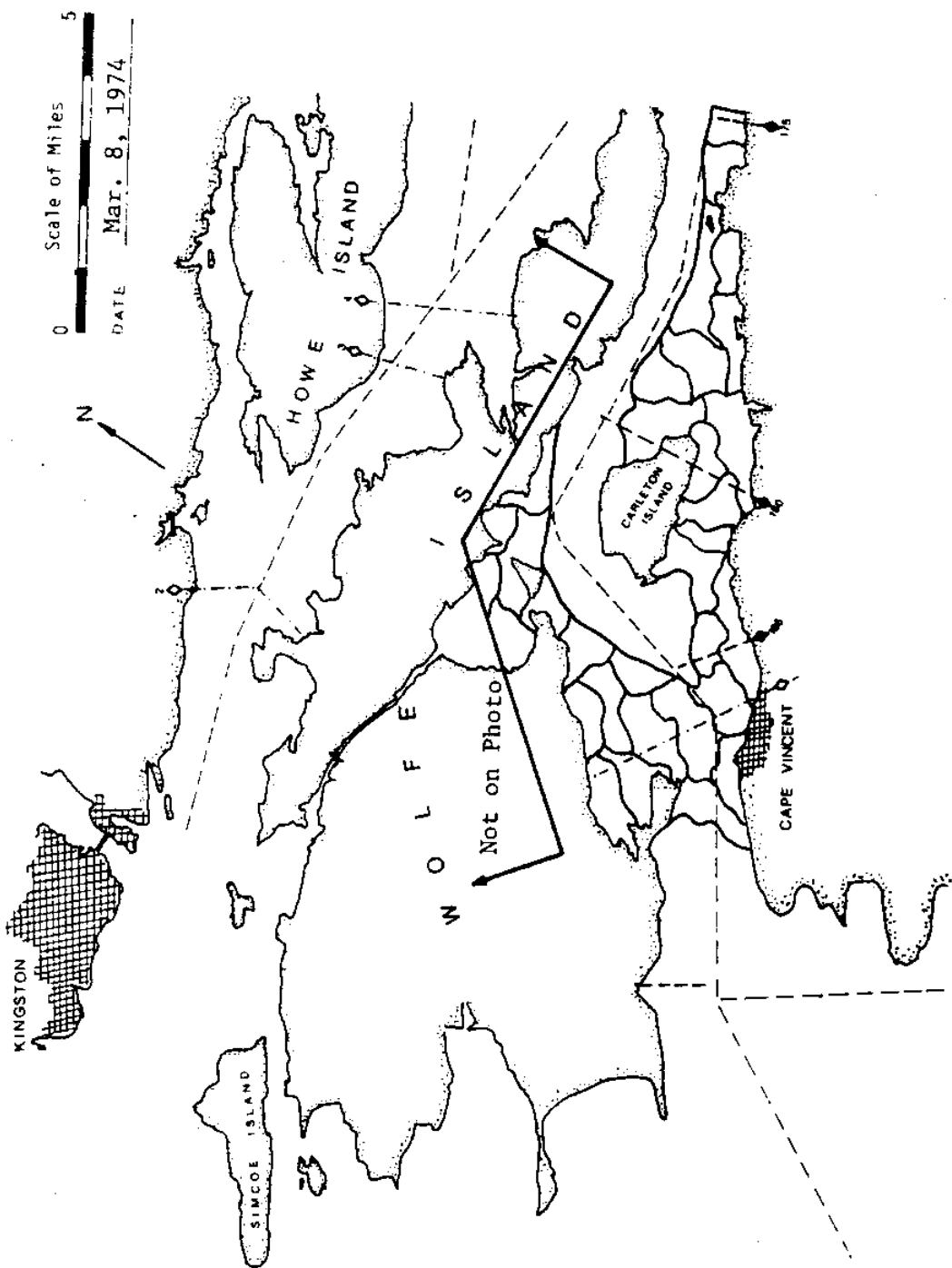
0 Scale of Miles 5

DATE Mar. 8, 1974

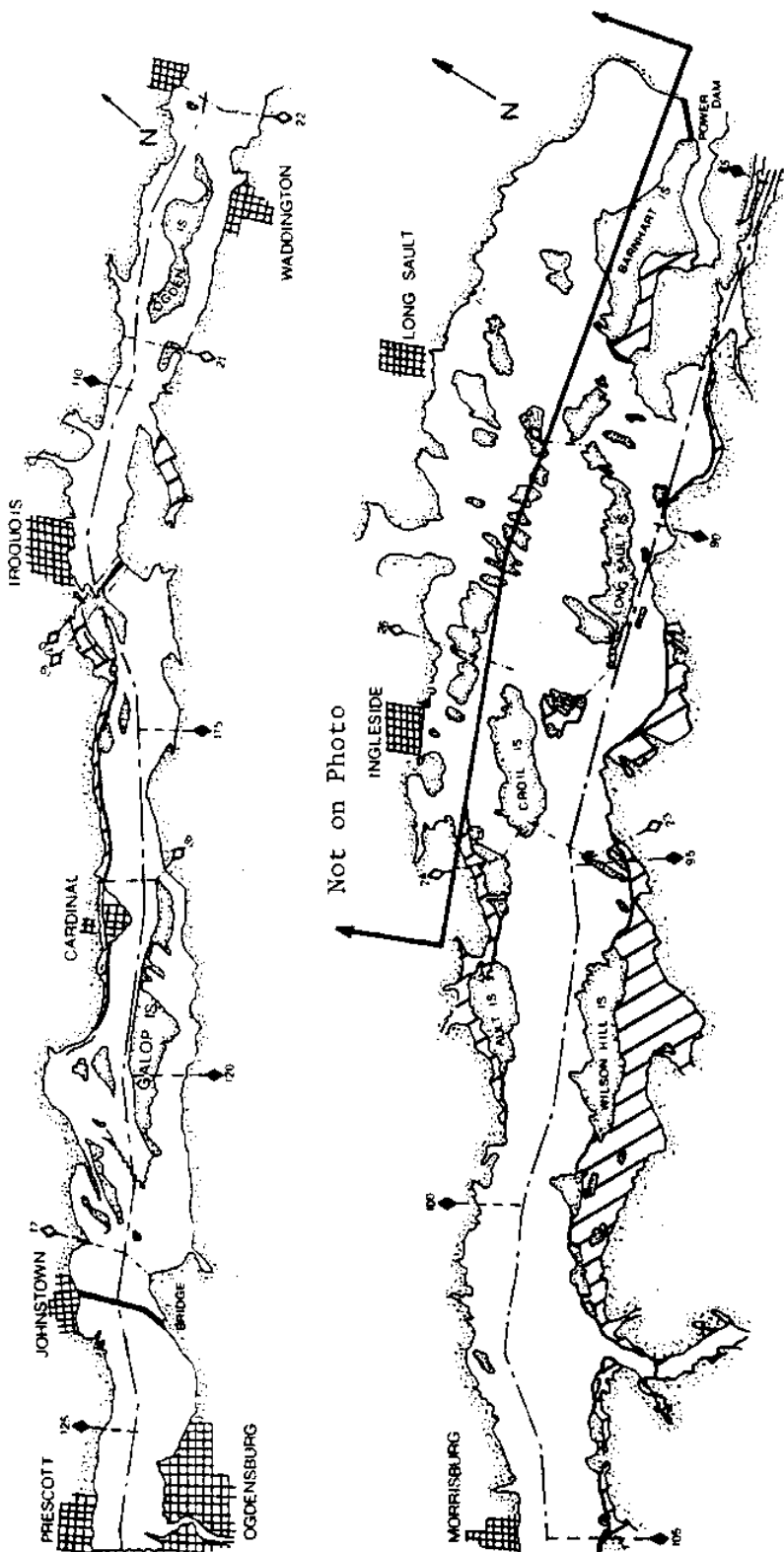


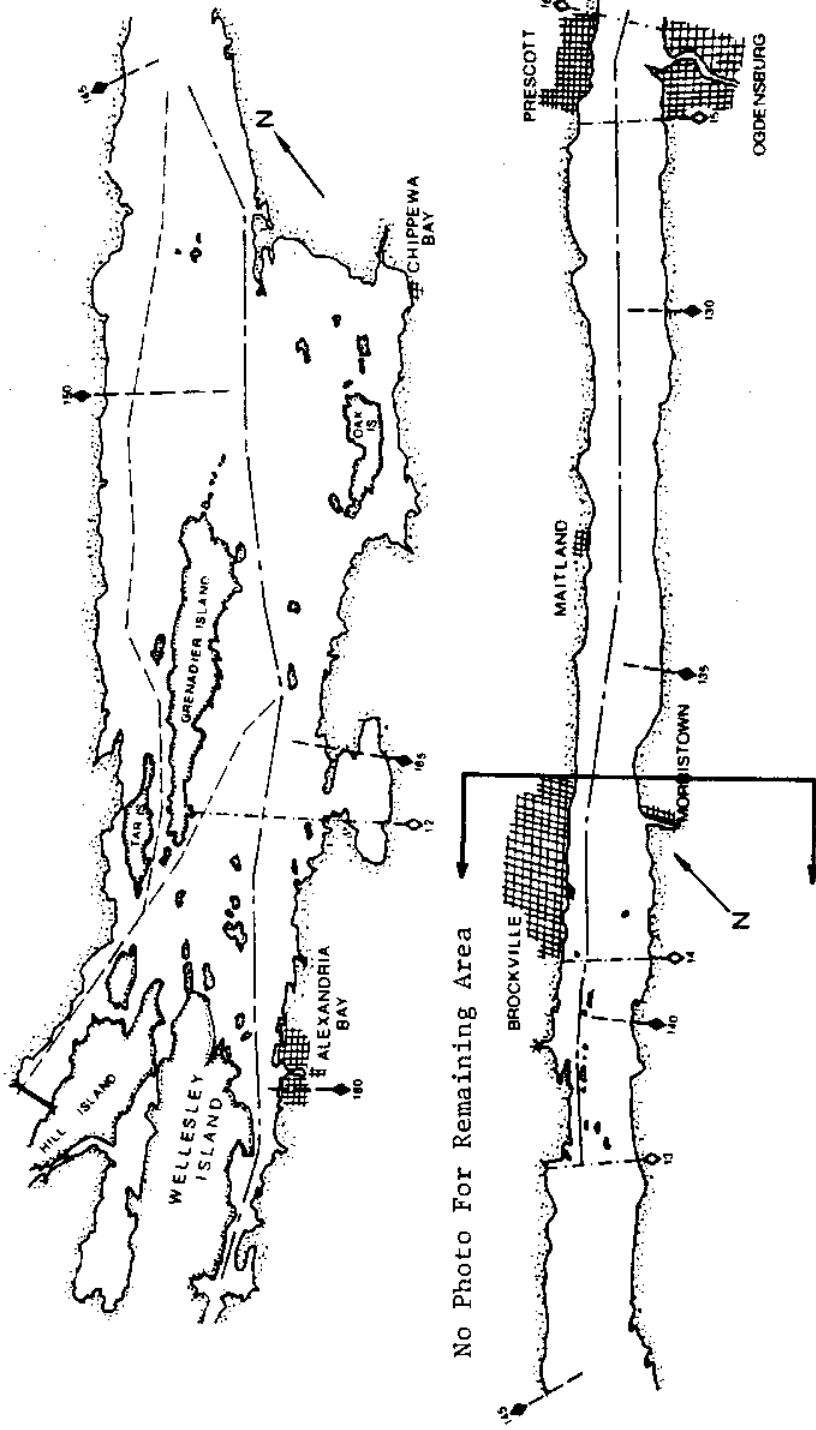
0 Scale of Miles 5

DATE Mar. 8, 1974



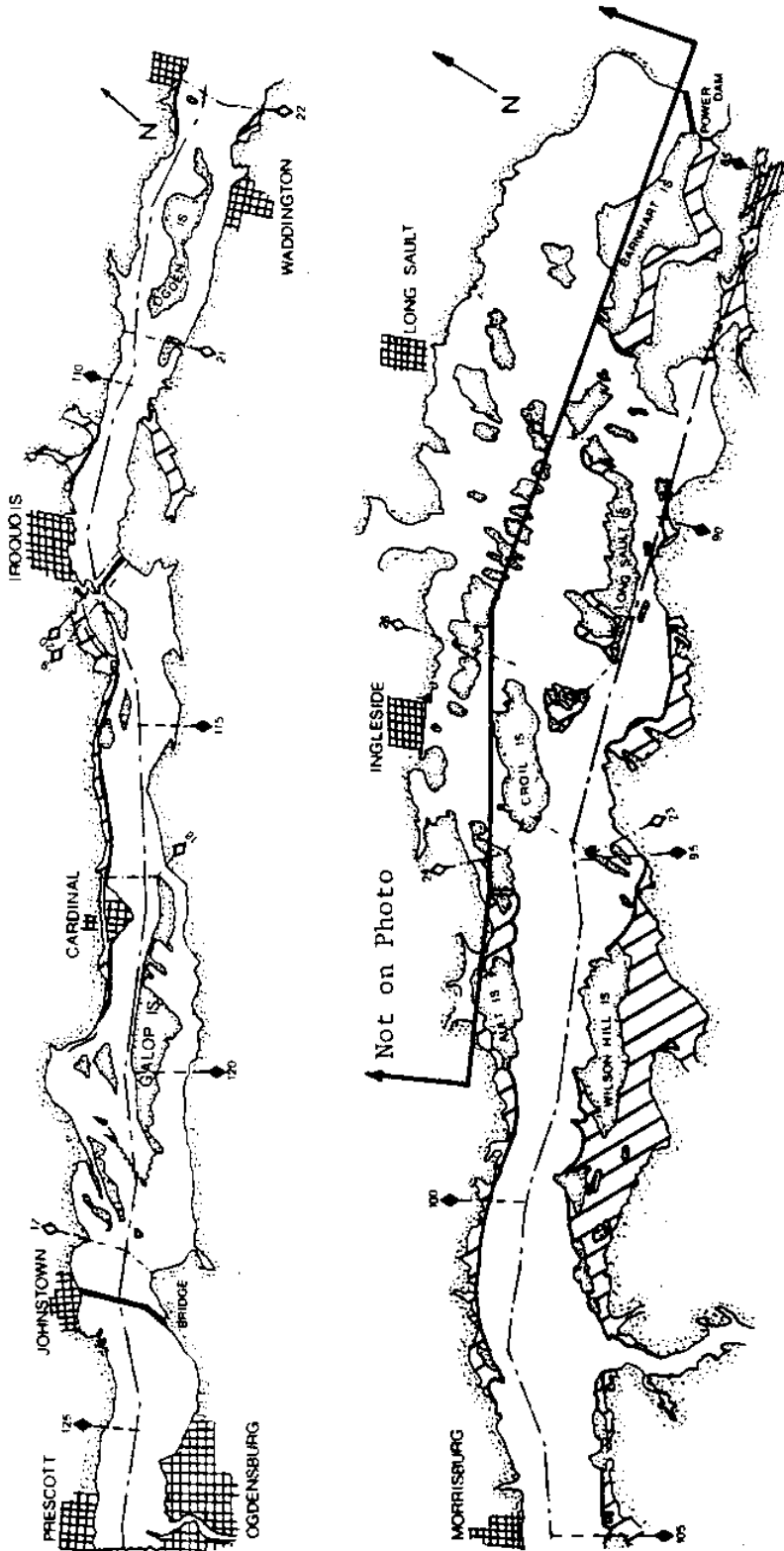
Winter of 1974-75





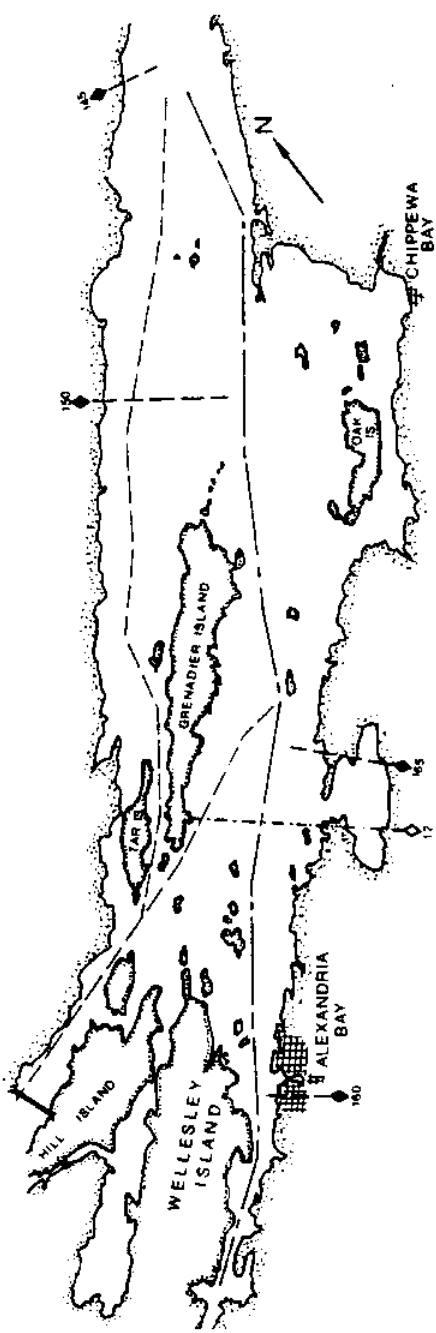
No Photo For Remaining Area

Scale of Miles 5
DATE Dec. 30, 1974

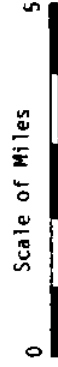
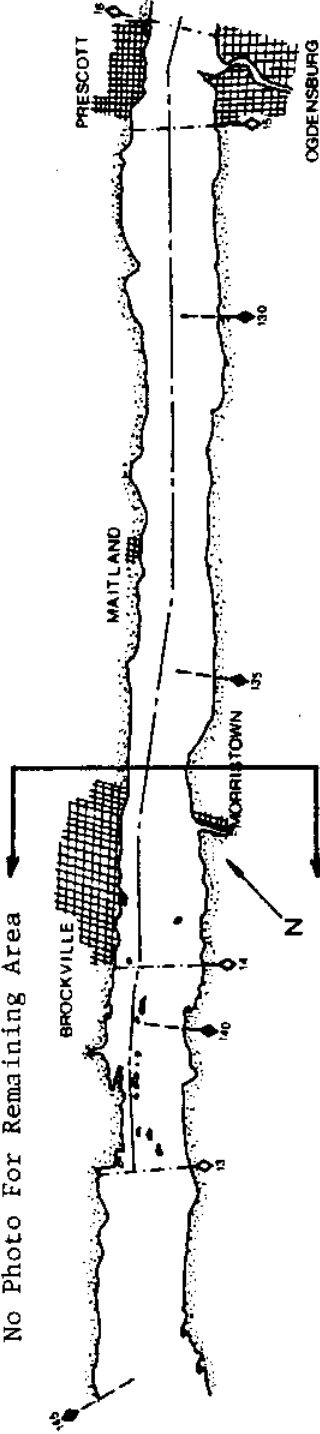


0 Scale of Miles 5

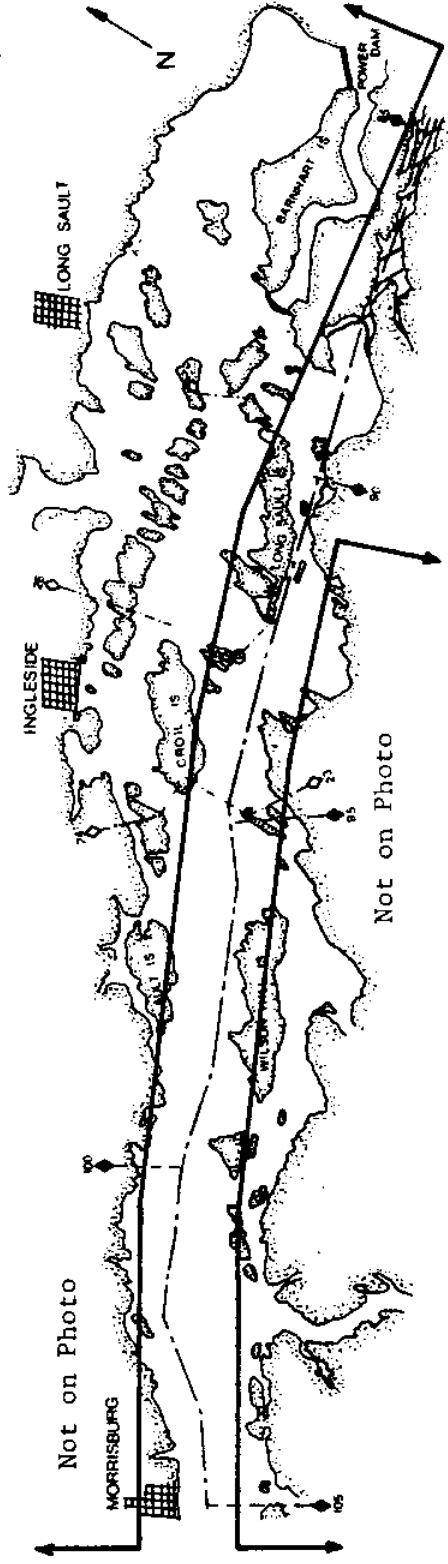
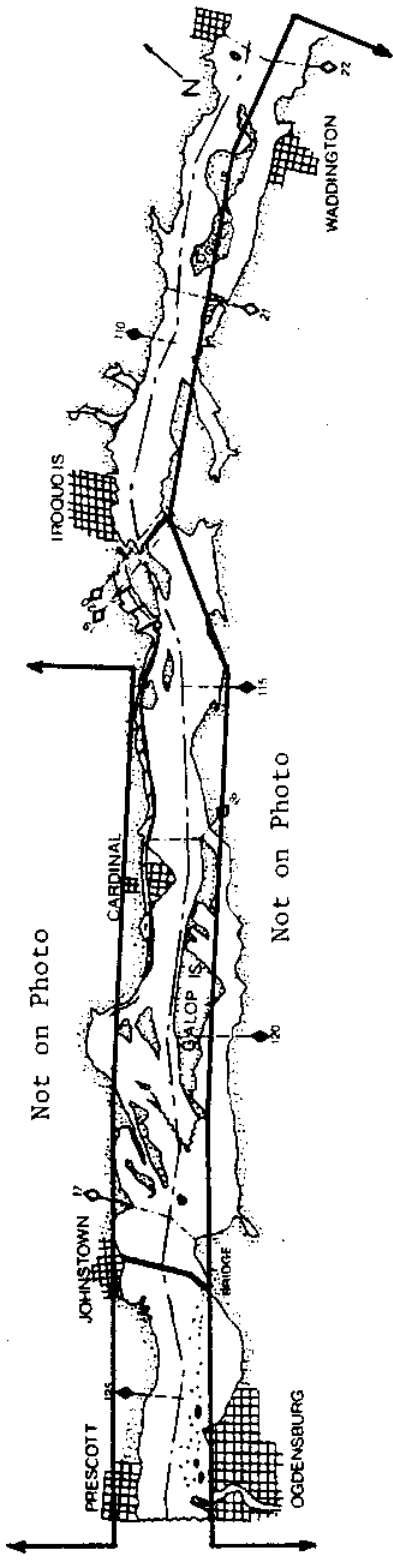
DATE Jan. 2, 1975



No Photo For Remaining Area

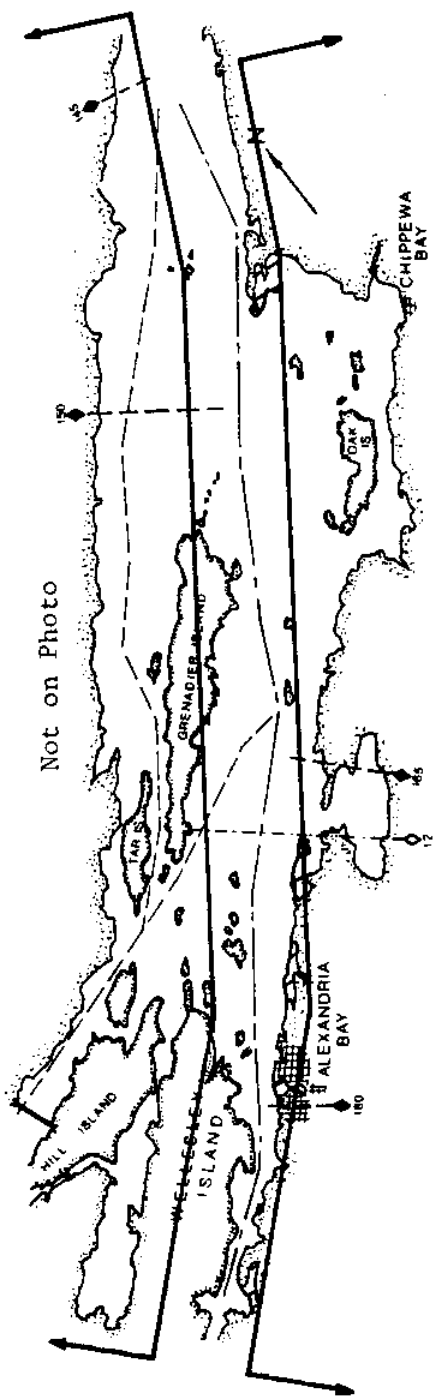


DATE Jan. 2, 1975

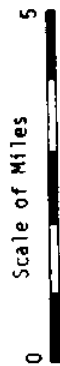
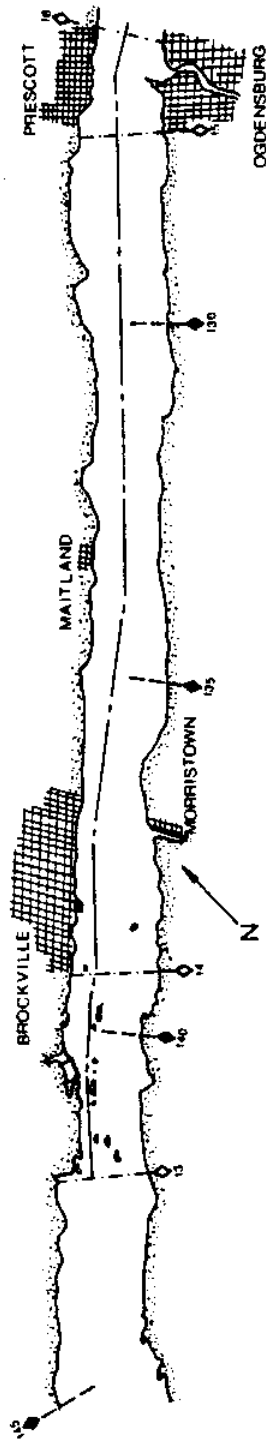


0 Scale of Miles 5

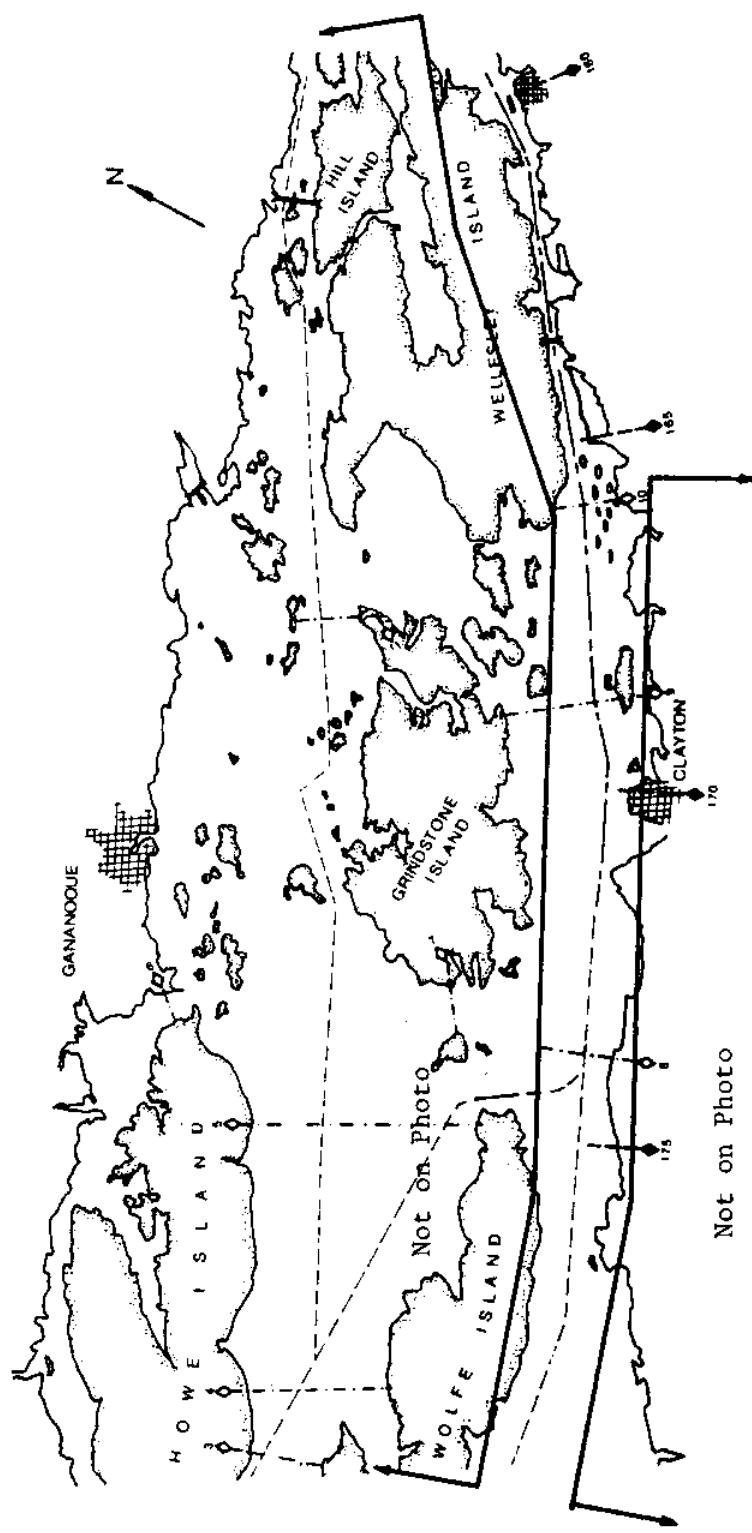
DATE Jan. 15, 1975



Not on Photo



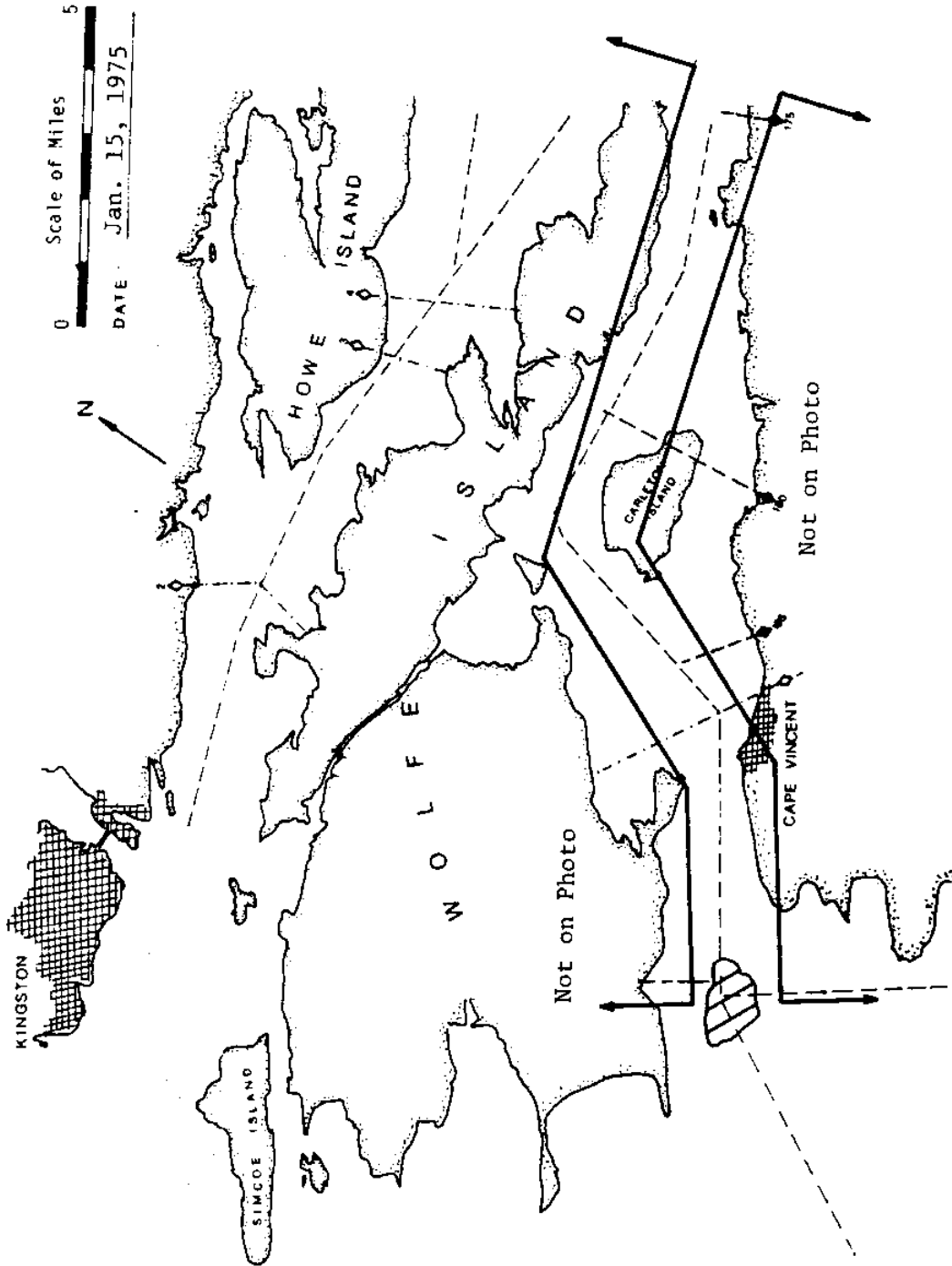
DATE Jan. 15, 1975

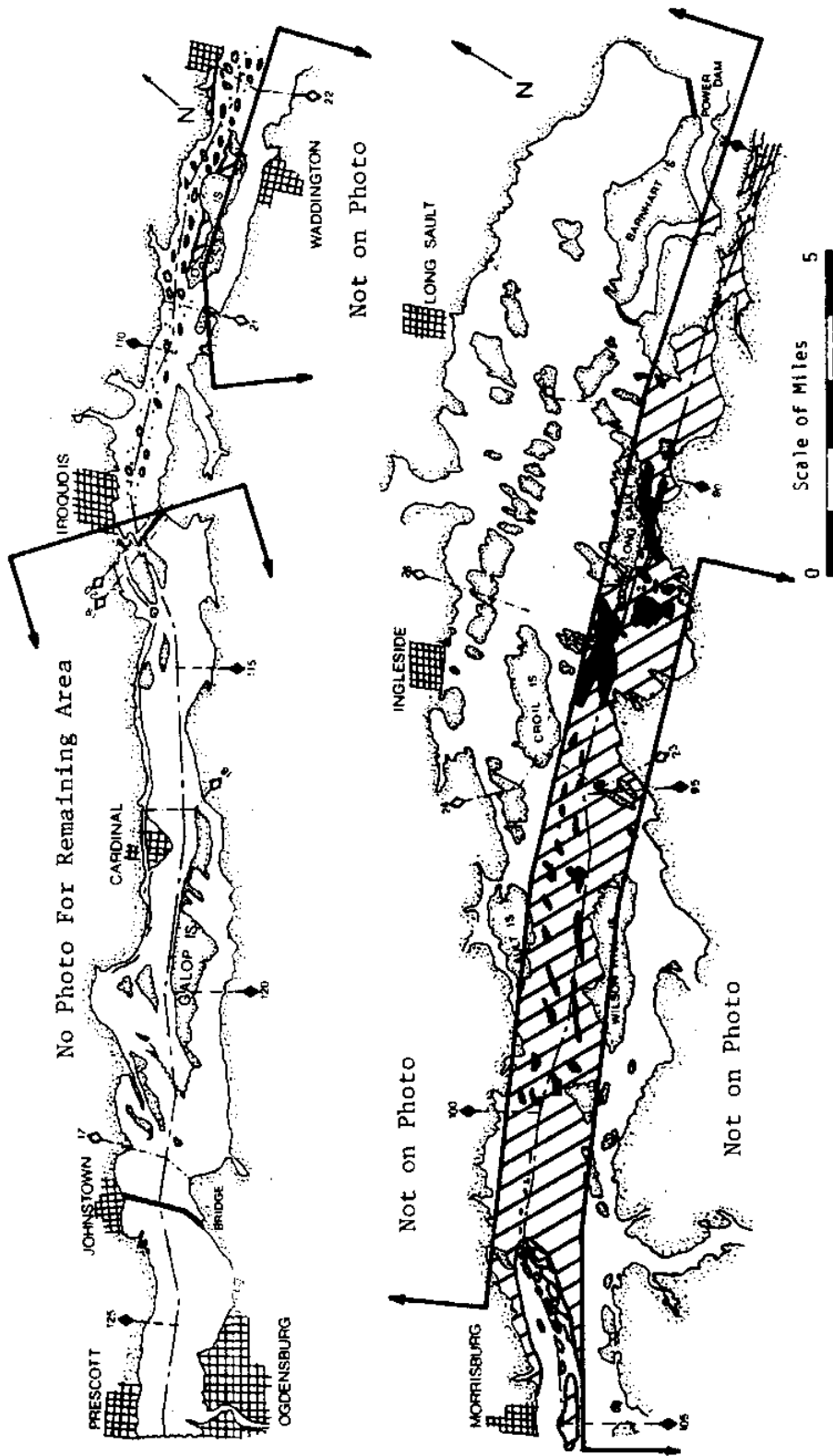


Scale of Miles 5

DATE Jan. 15, 1975

Not on Photo





No Photo For Remaining Area

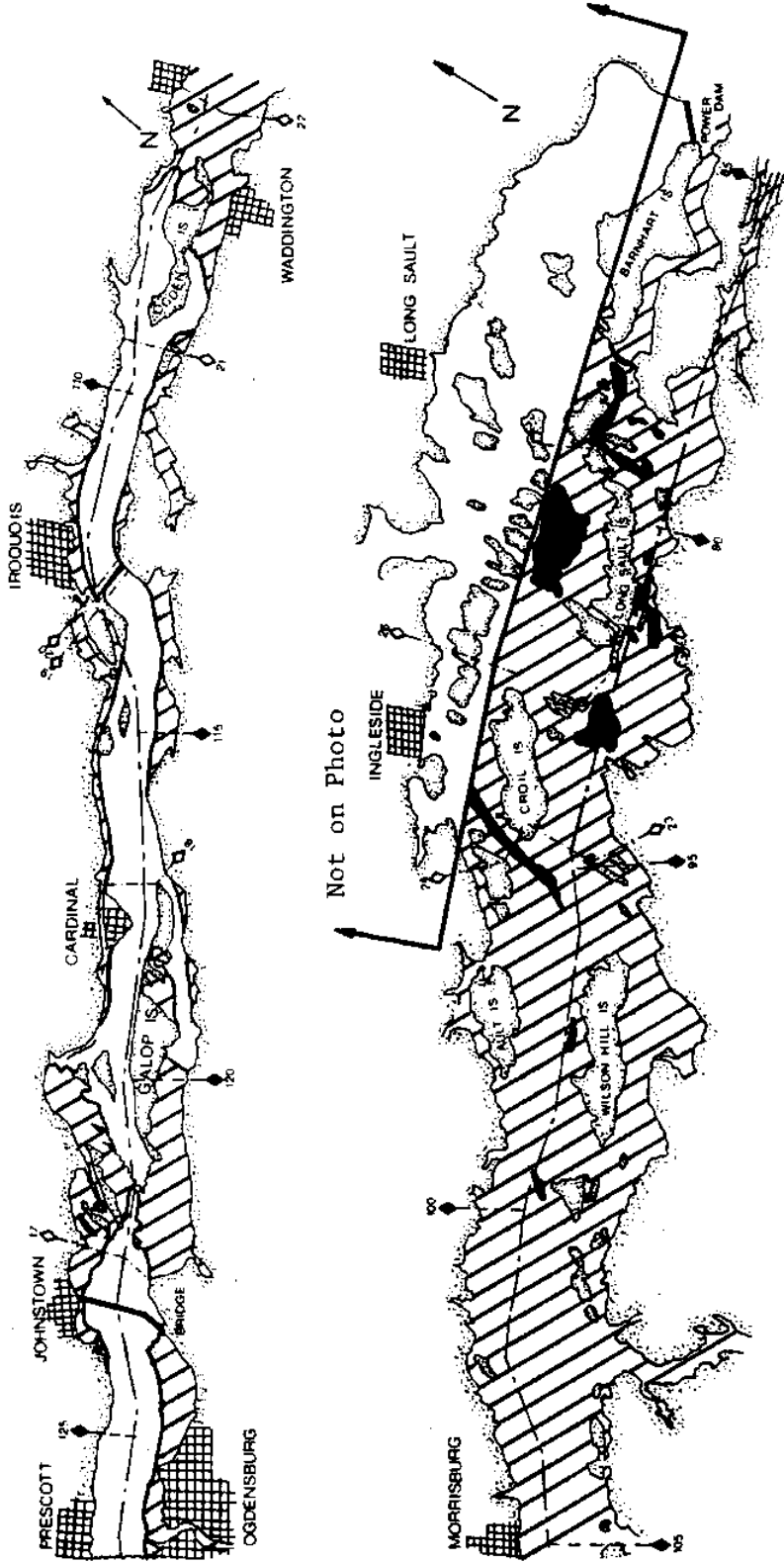
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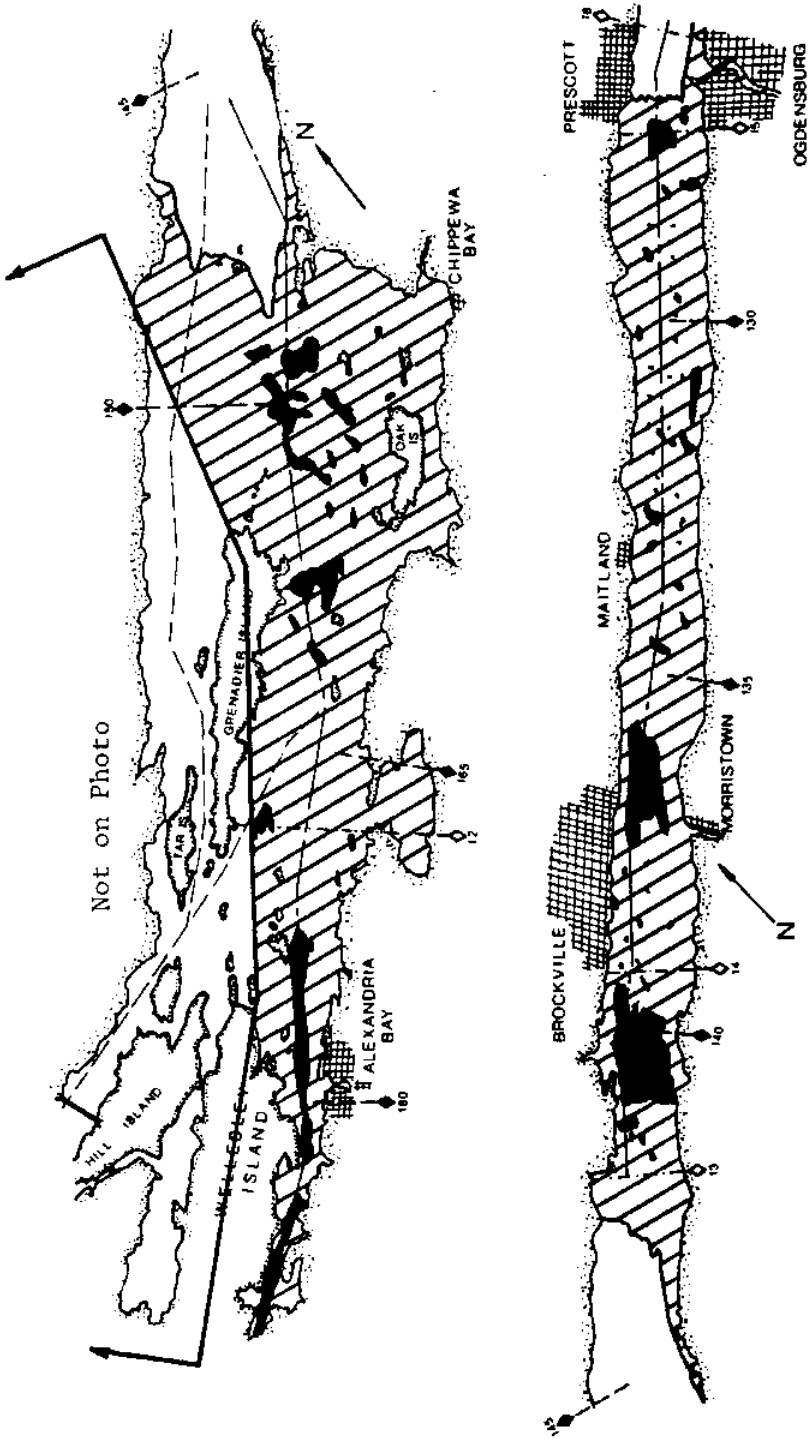
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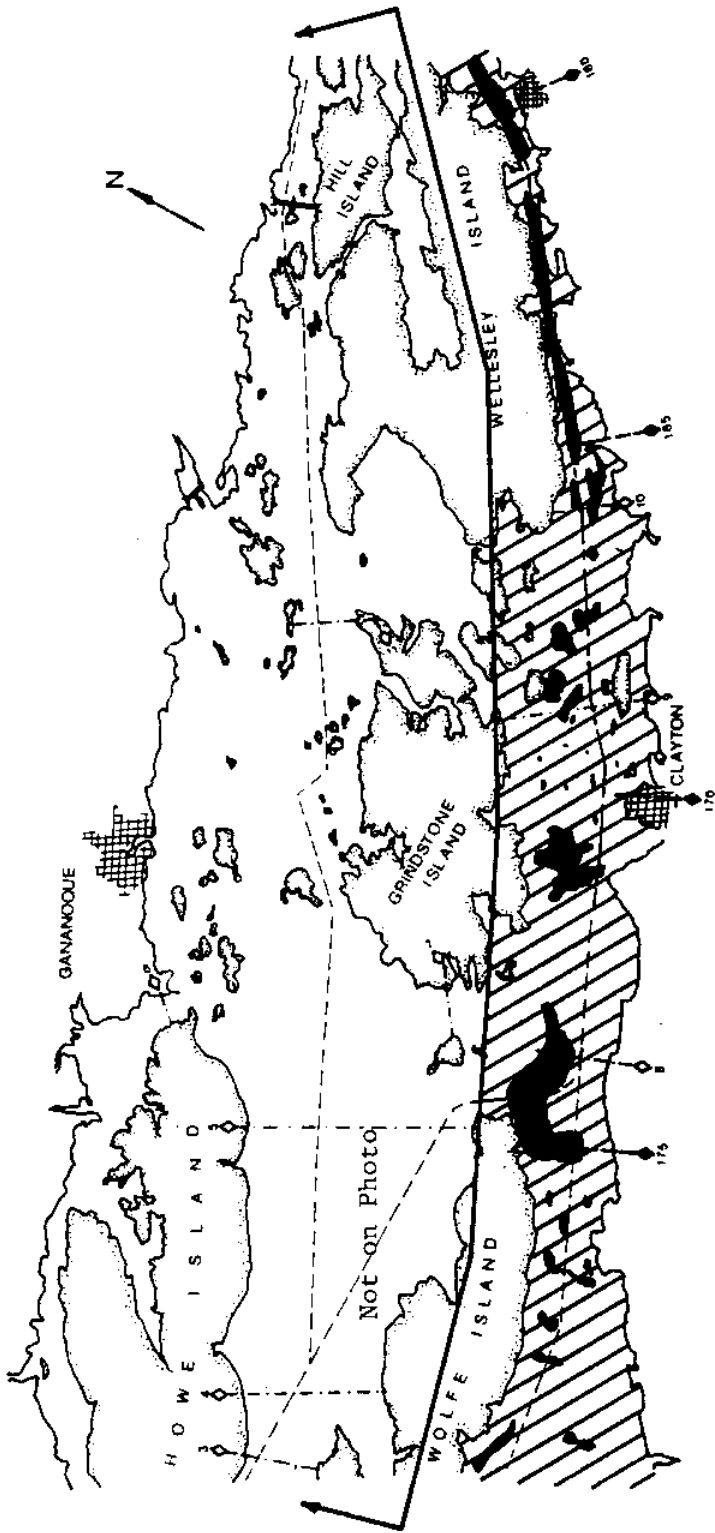
Not on Photo

Scale of Miles
0 5

DATE Jan. 23, 1975

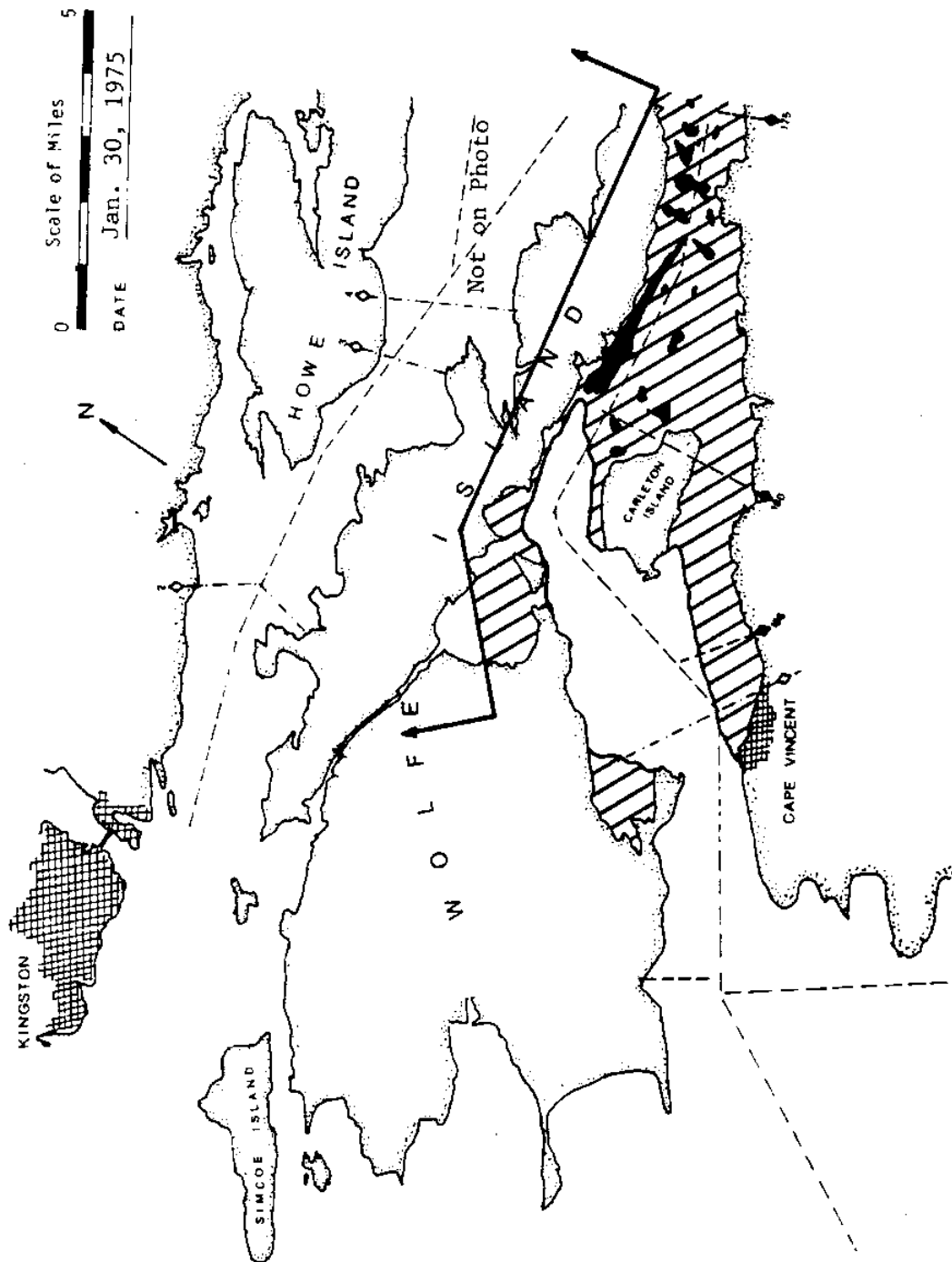


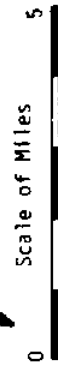
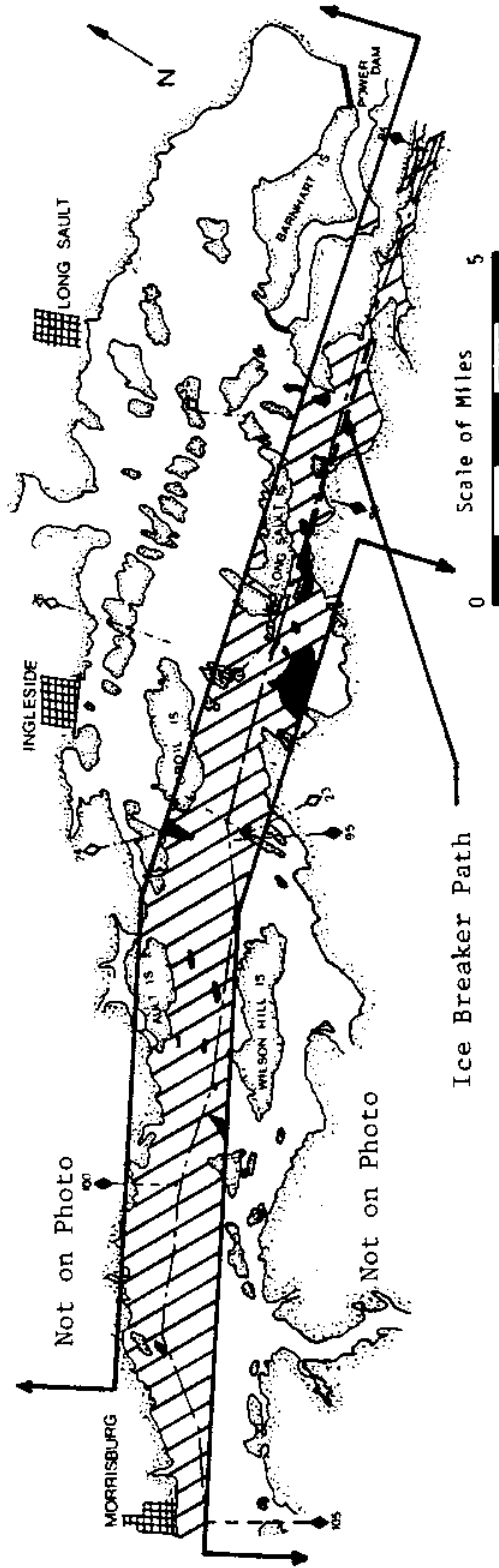
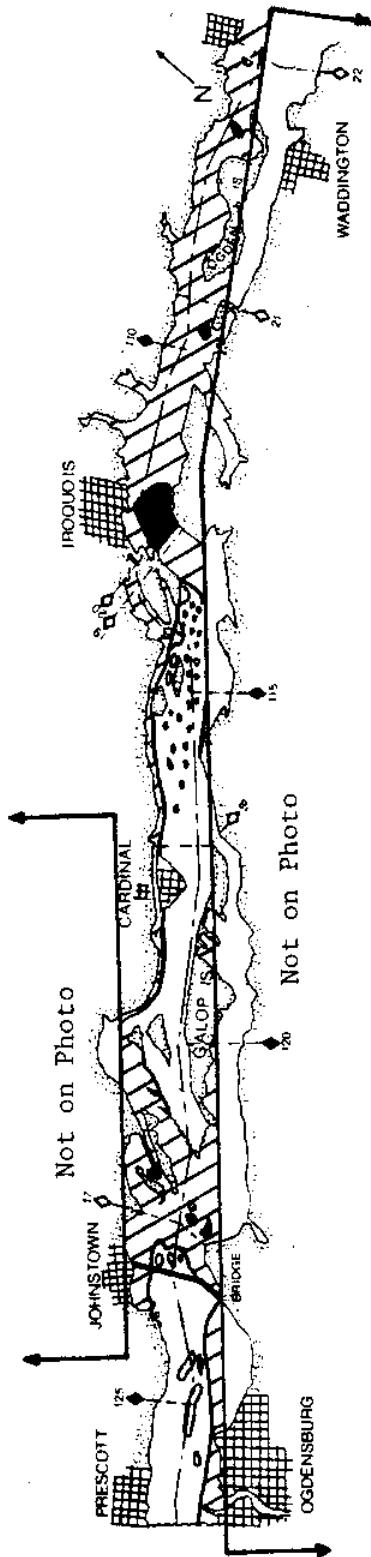




0 Scale of Miles 5

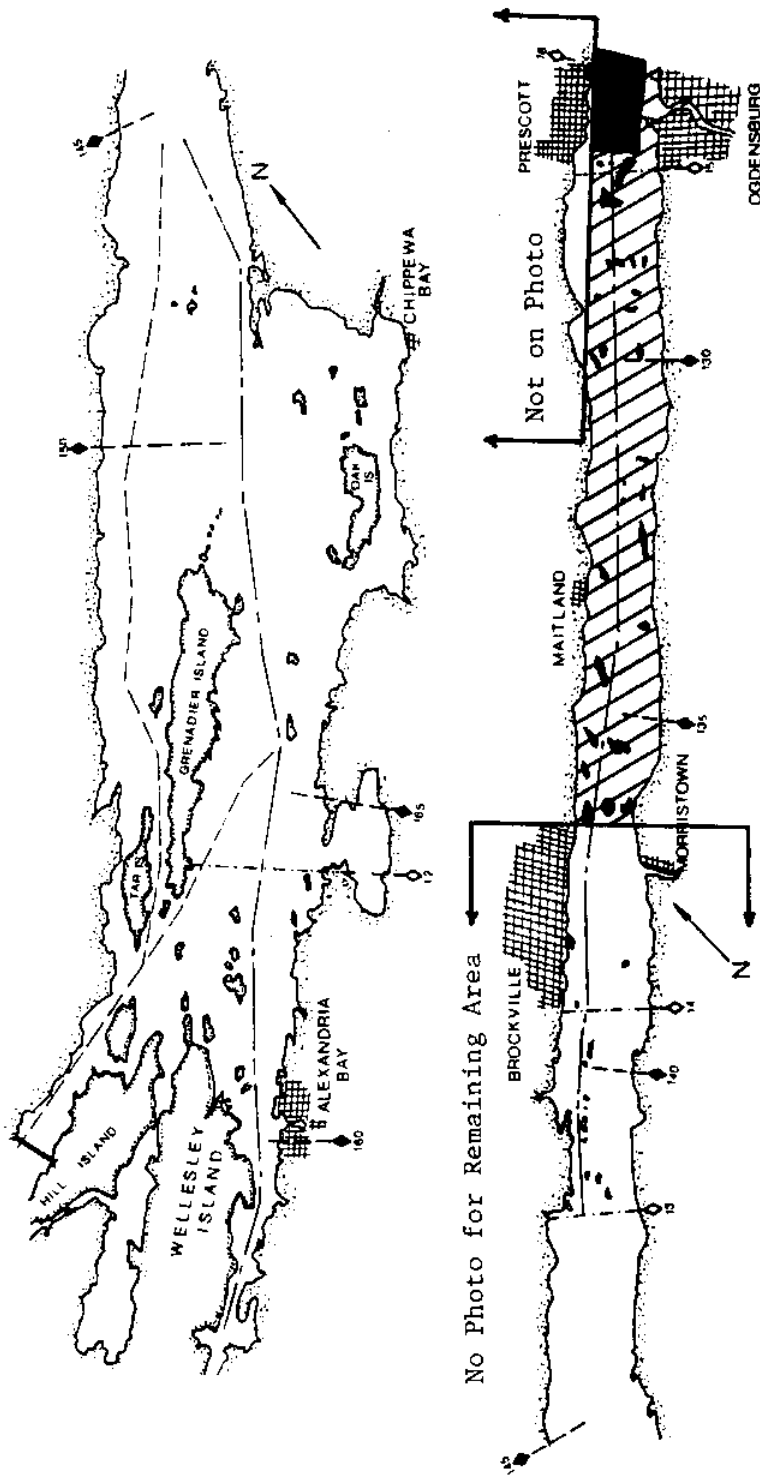
DATE Jan. 30, 1975



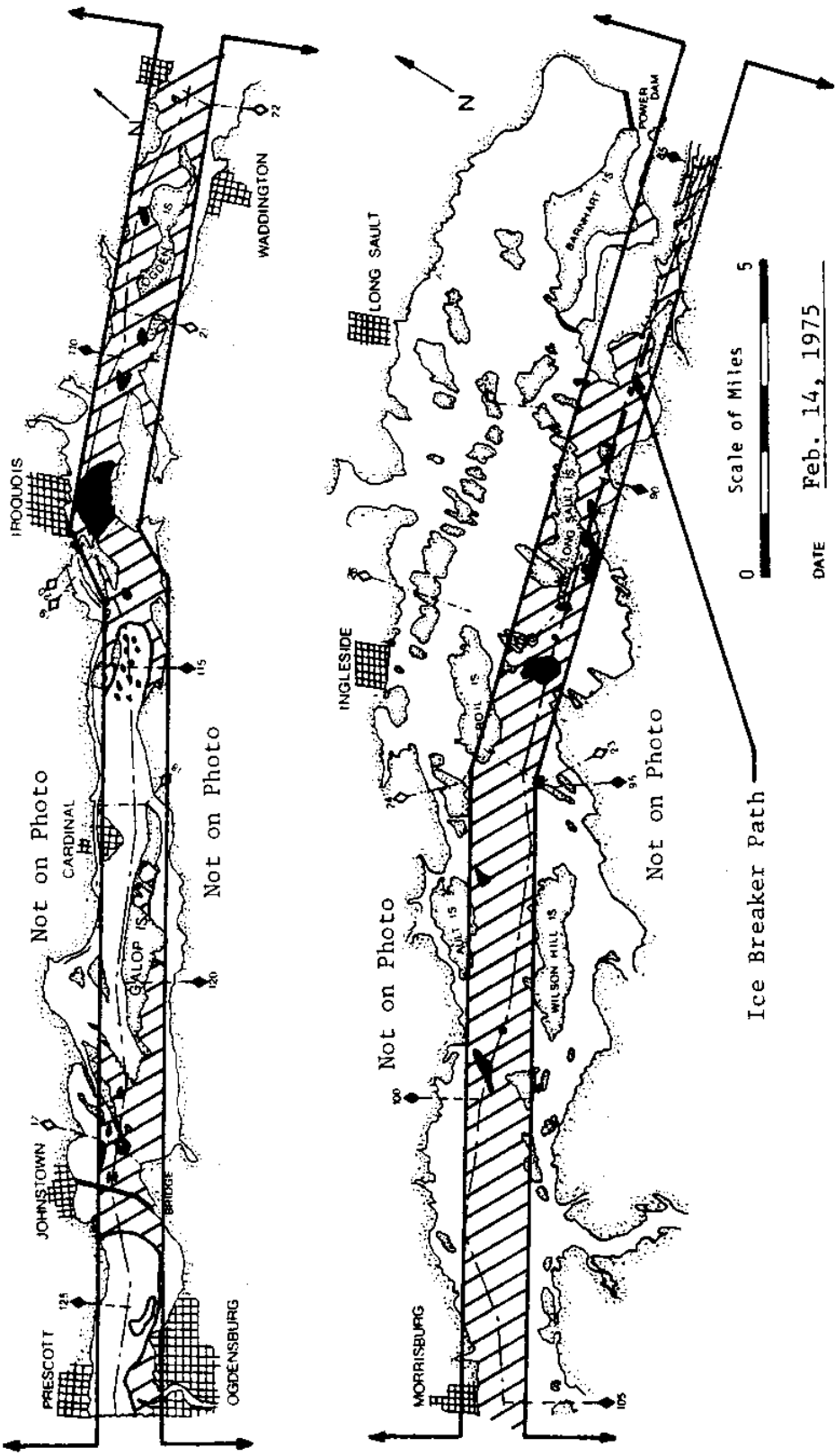


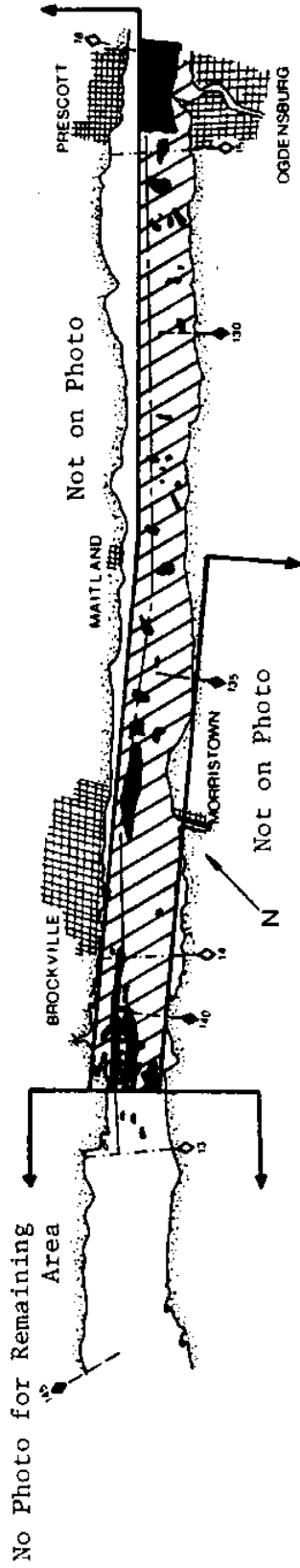
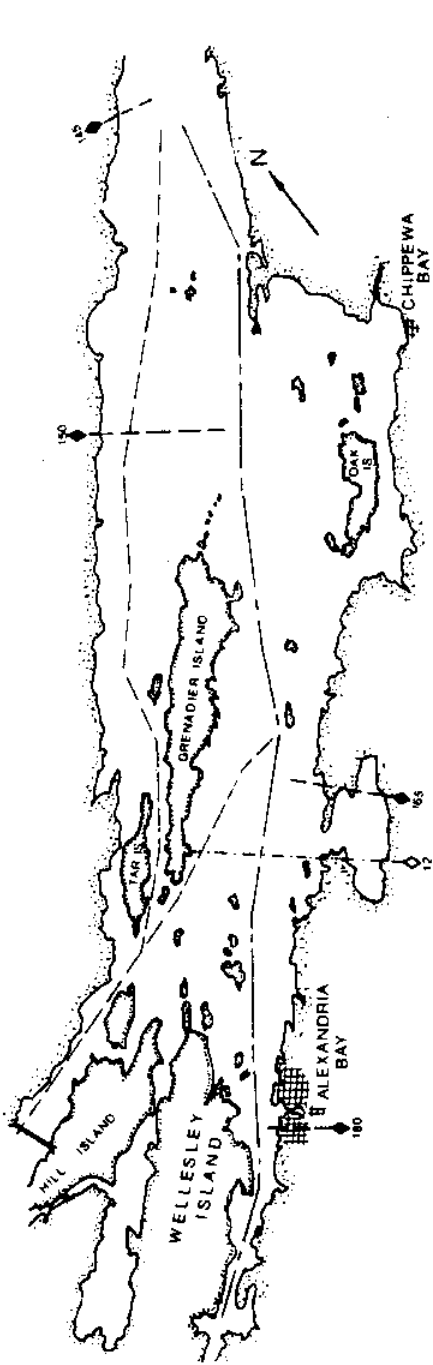
DATE Feb. 10, 1975

Ice Breaker Path

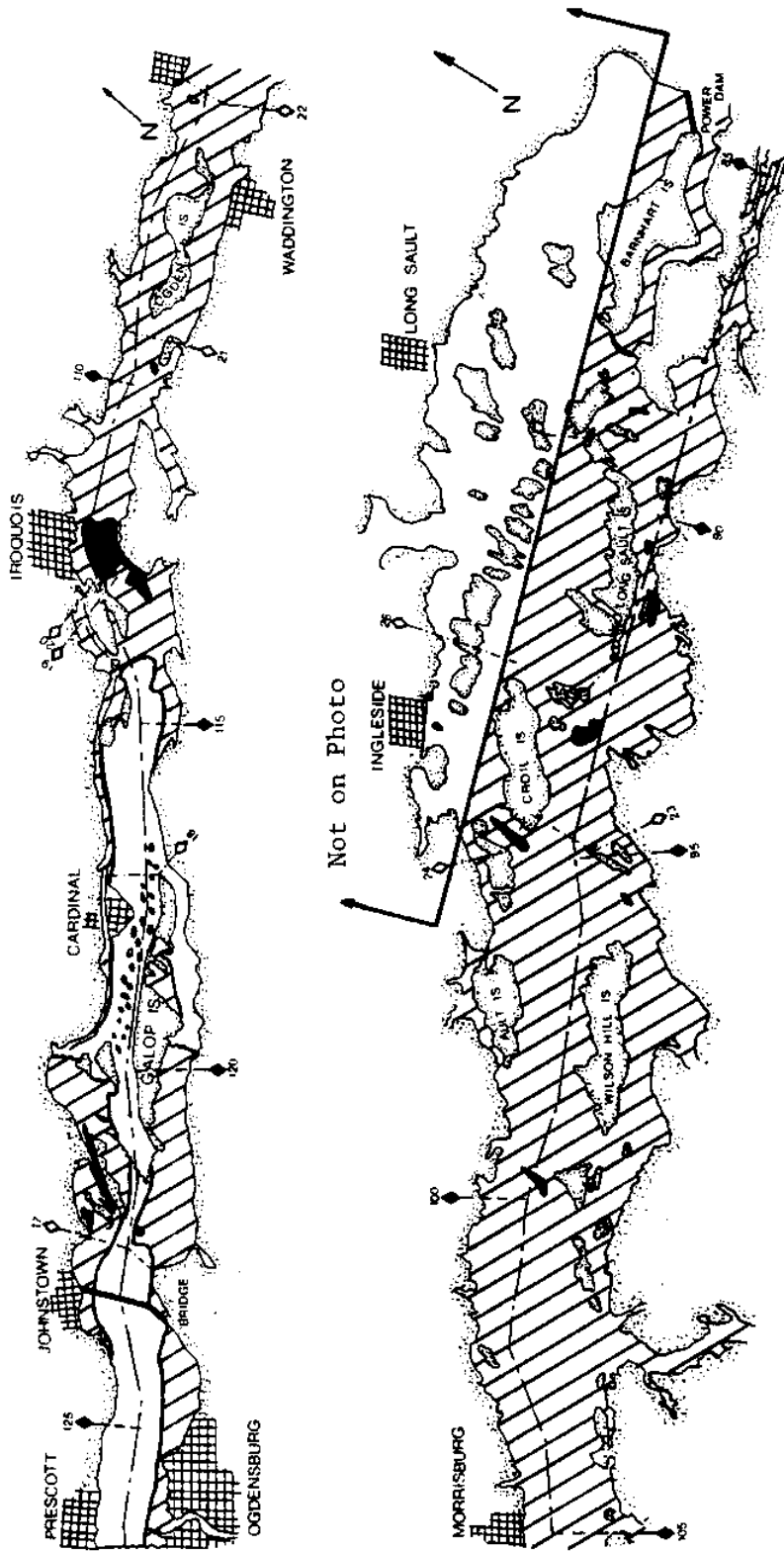


0 Scale of Miles 5
DATE Feb. 10, 1975





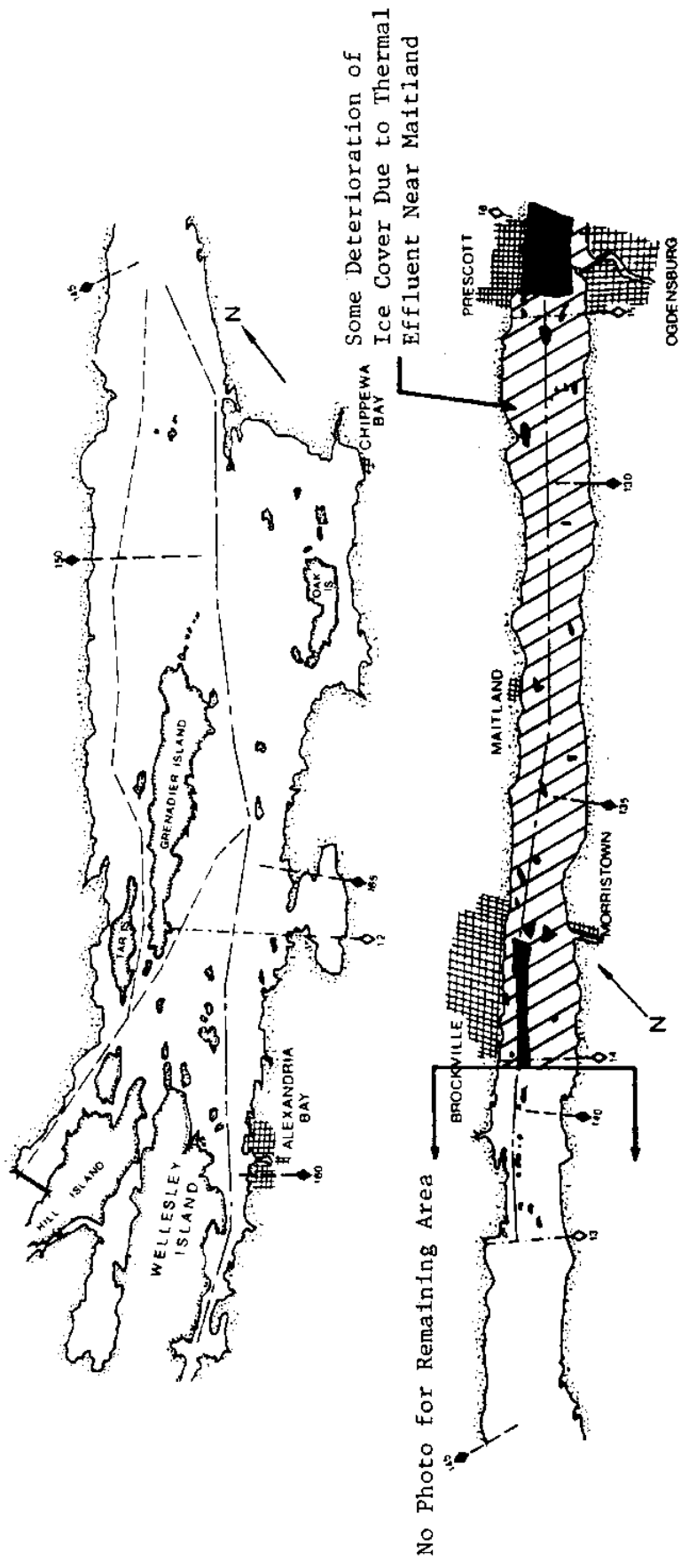
DATE Feb. 14, 1975



Not on Photo

0 Scale of Miles 5

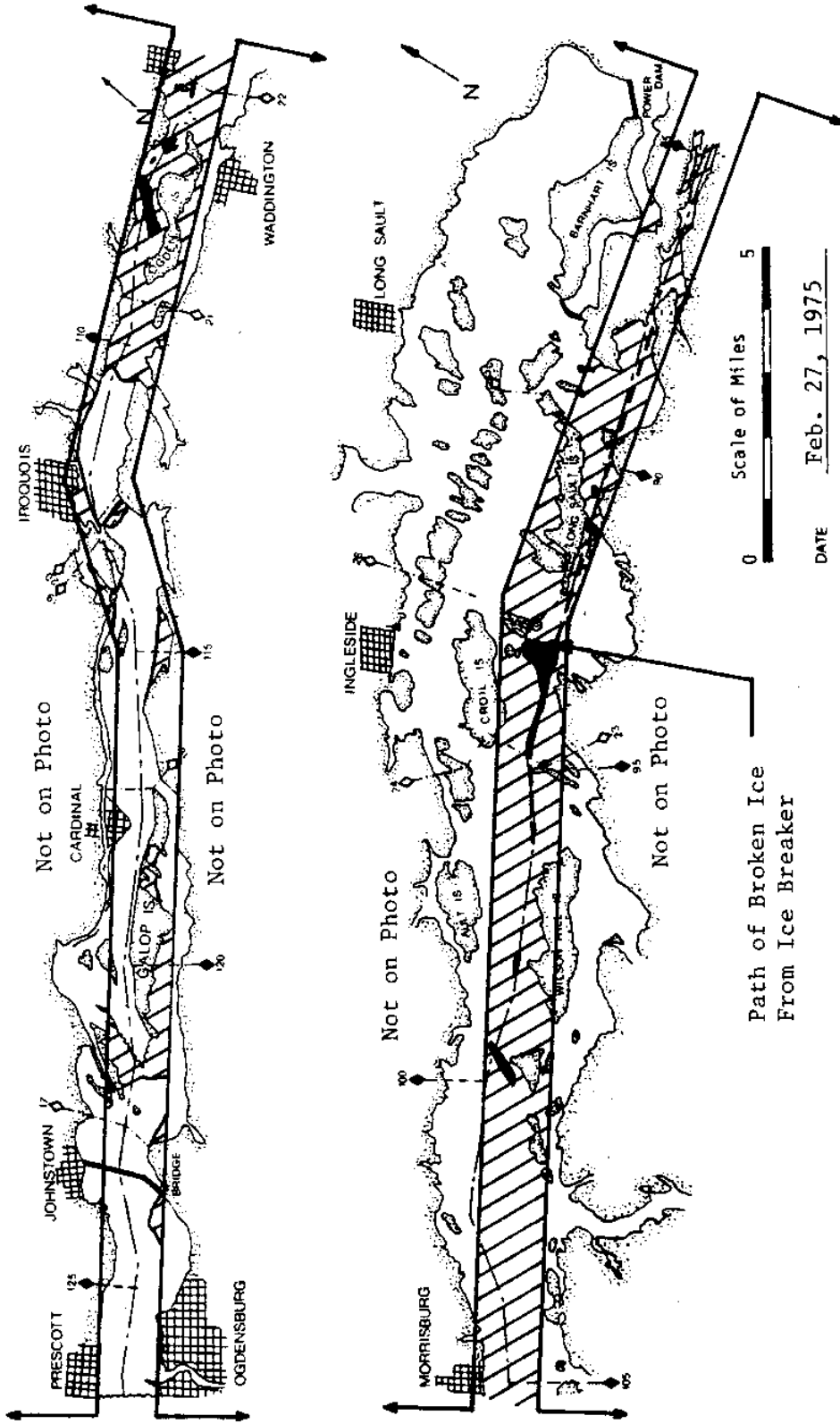
DATE Feb. 21, 1975

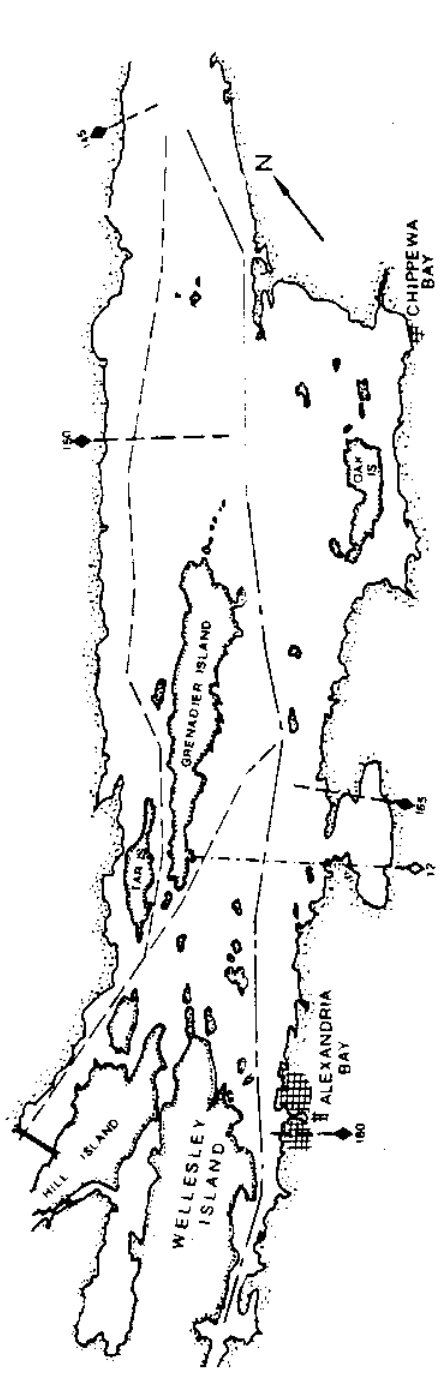


Some Deterioration of
Ice Cover Due to Thermal
Effluent Near Maitland

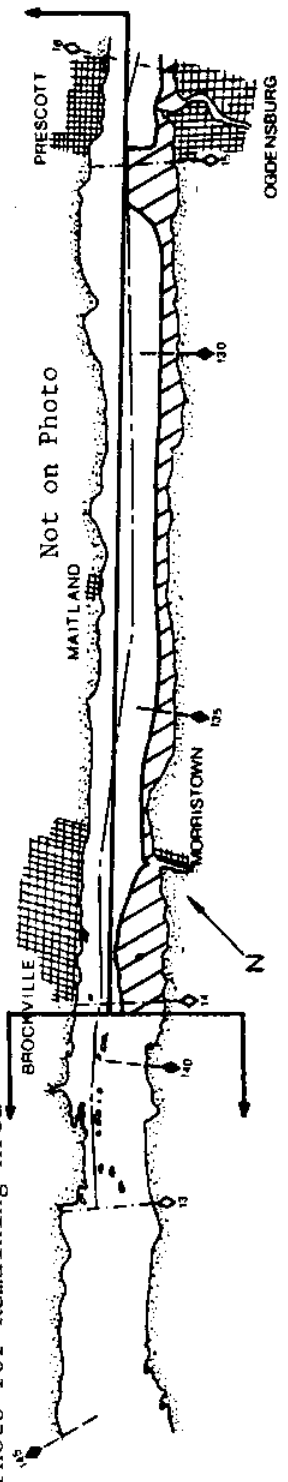
No Photo for Remaining Area

0 Scale of Miles 5
DATE Feb. 21, 1975



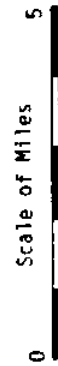
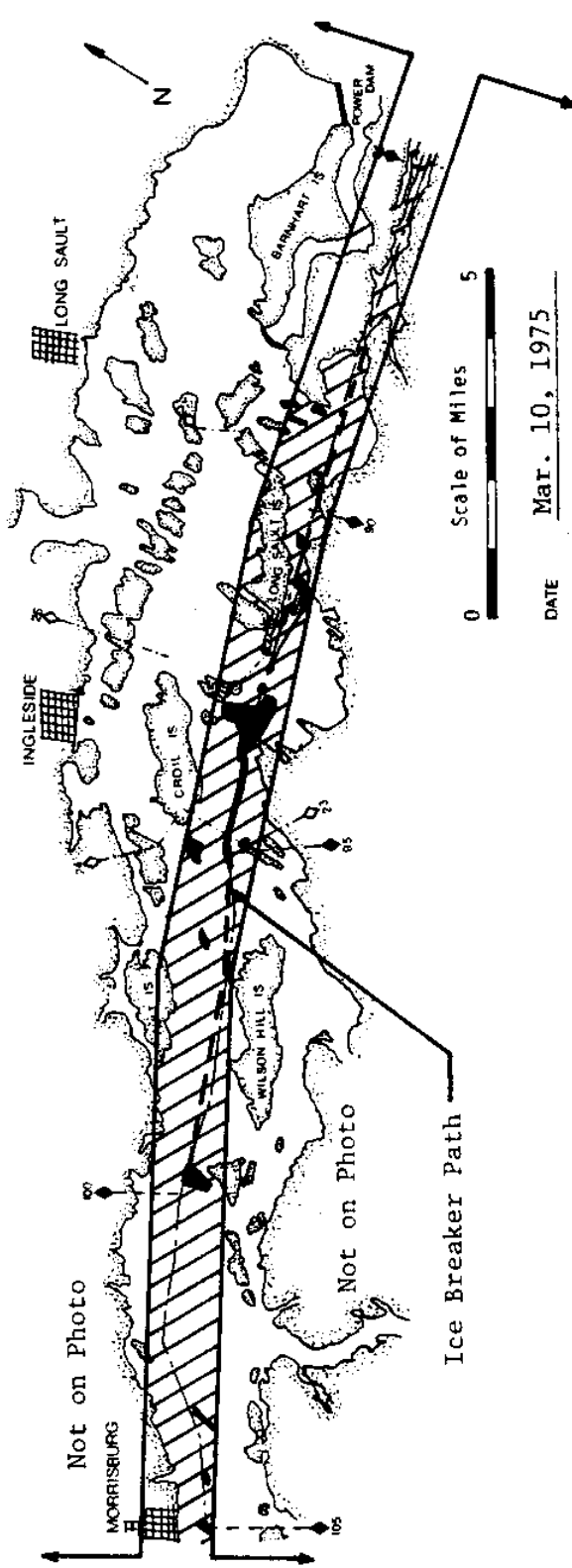
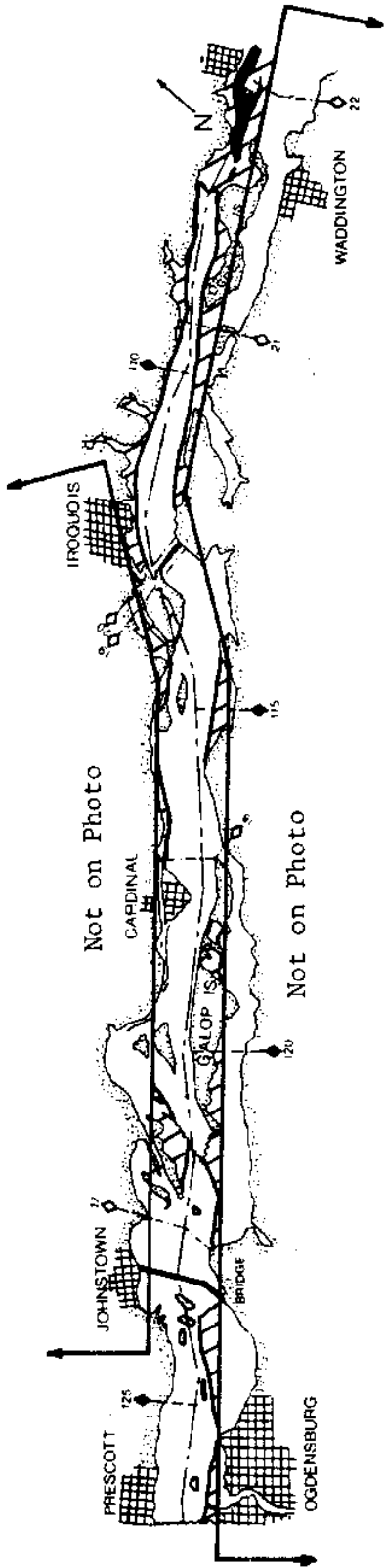


No Photo for Remaining Area

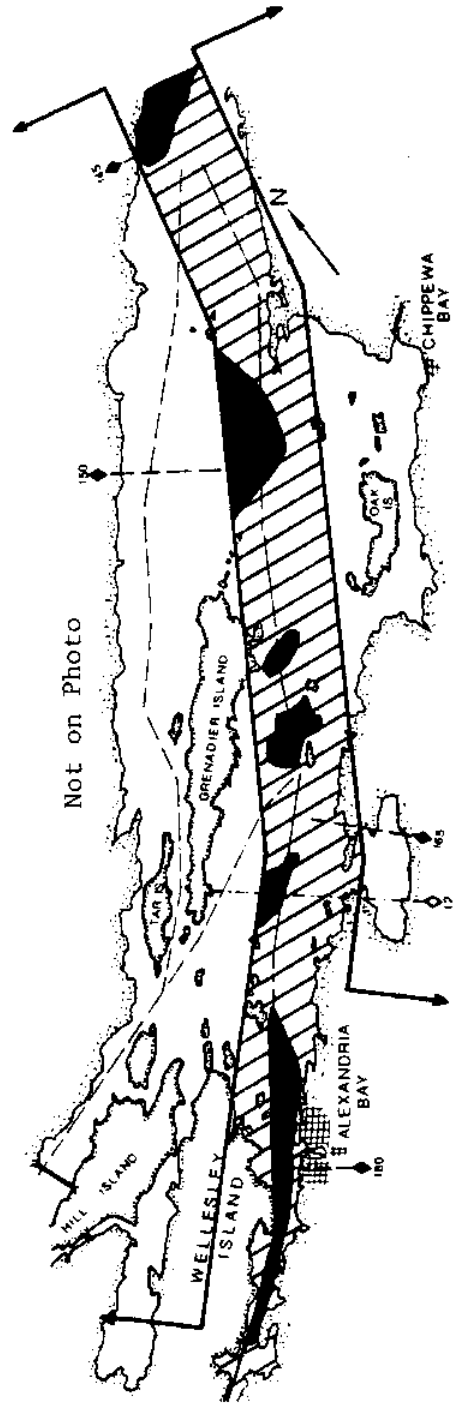


0 Scale of Miles 5

DATE Feb. 27, 1975

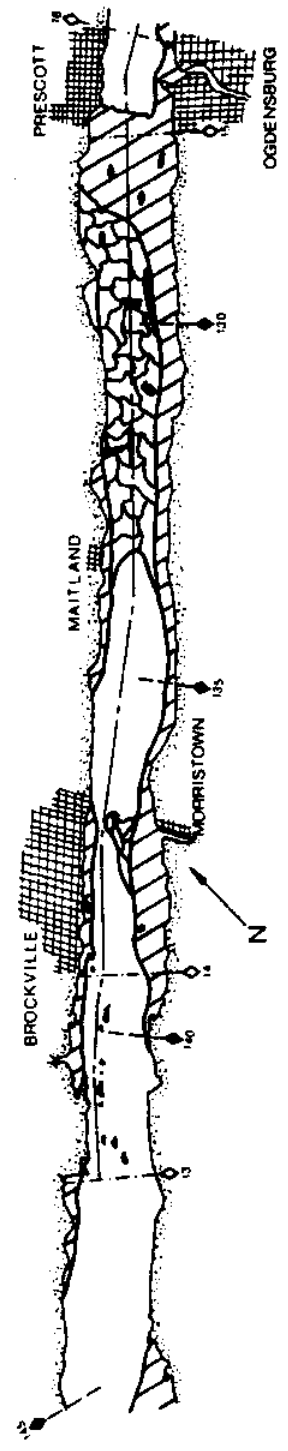


DATE Mar. 10, 1975



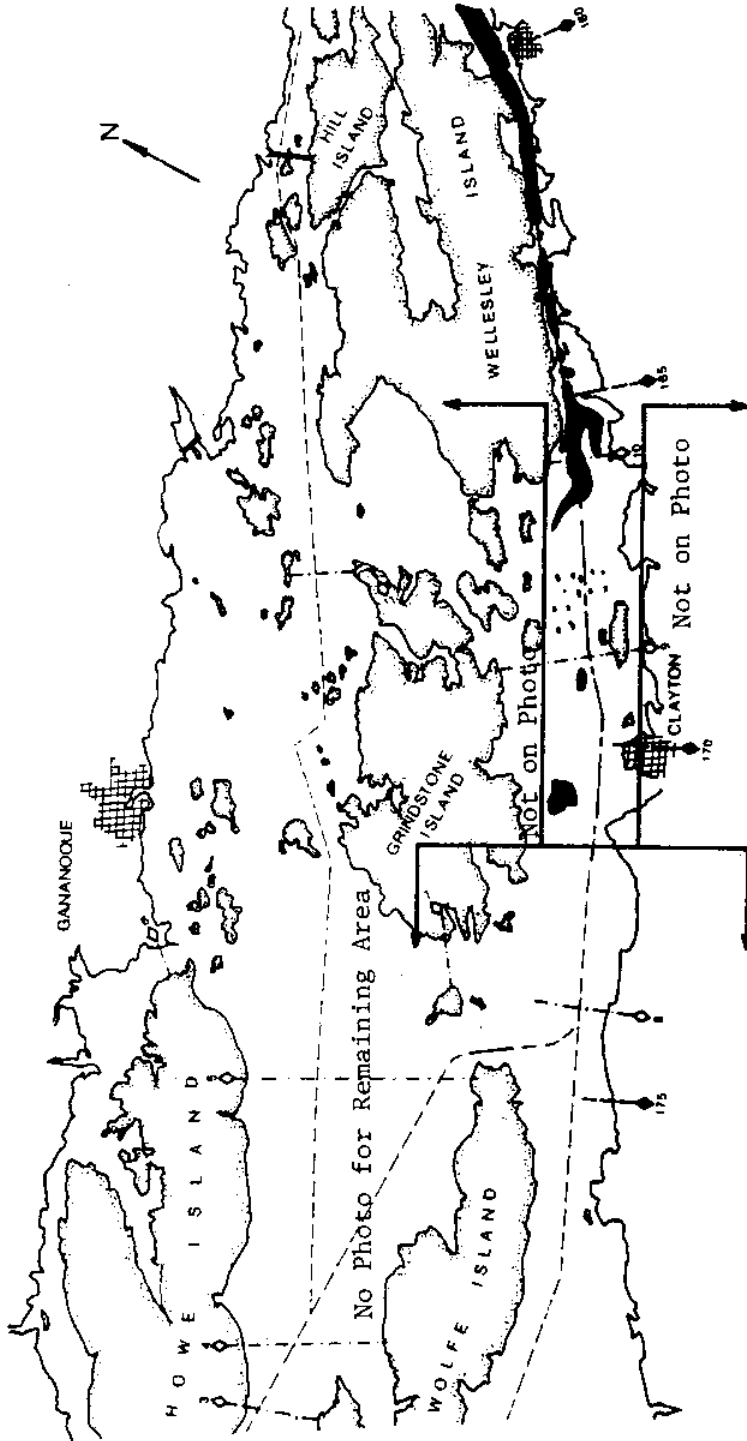
Not on Photo

Not on Photo



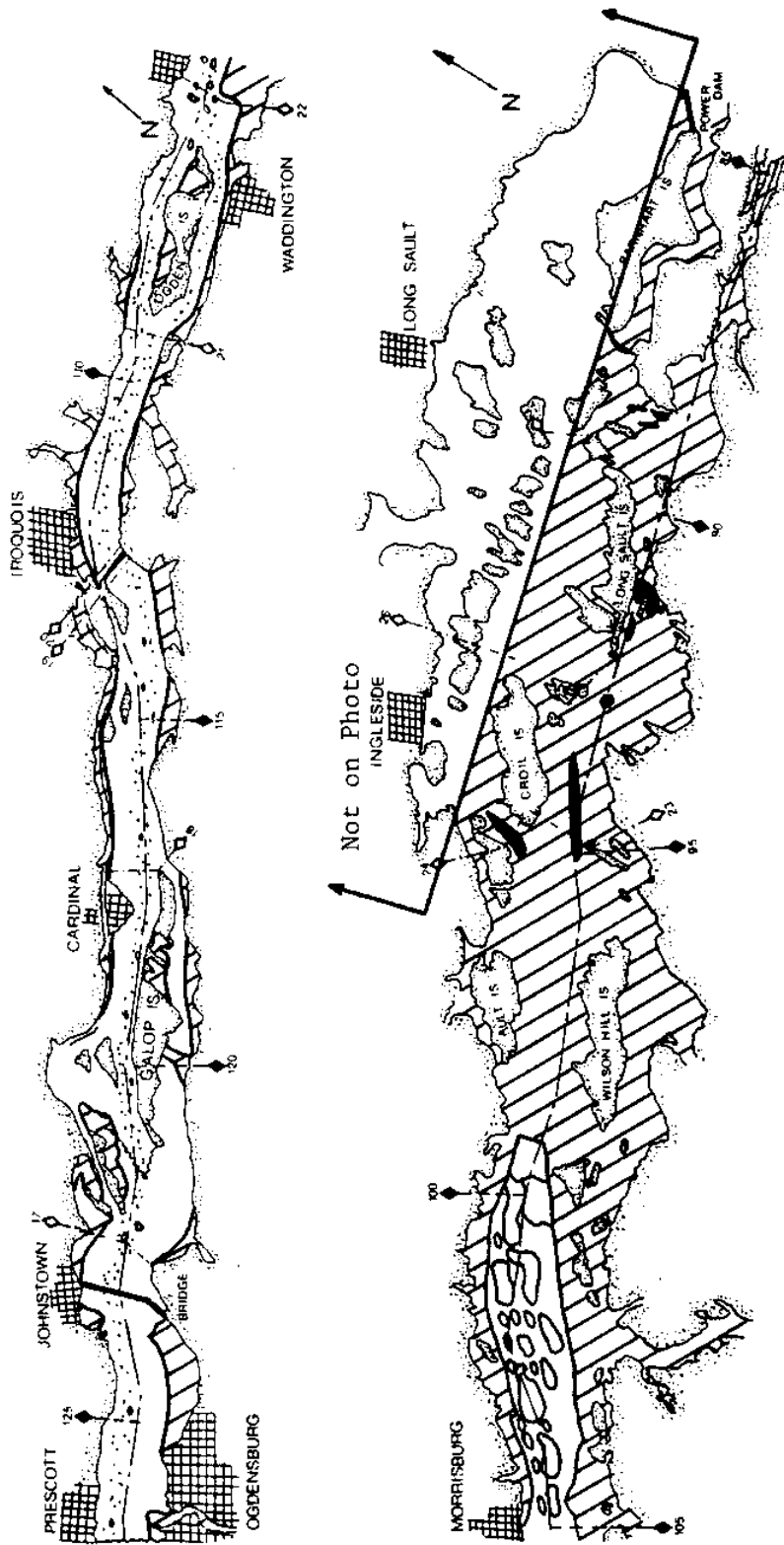
0 Scale of Miles 5

DATE Mar. 10, 1975



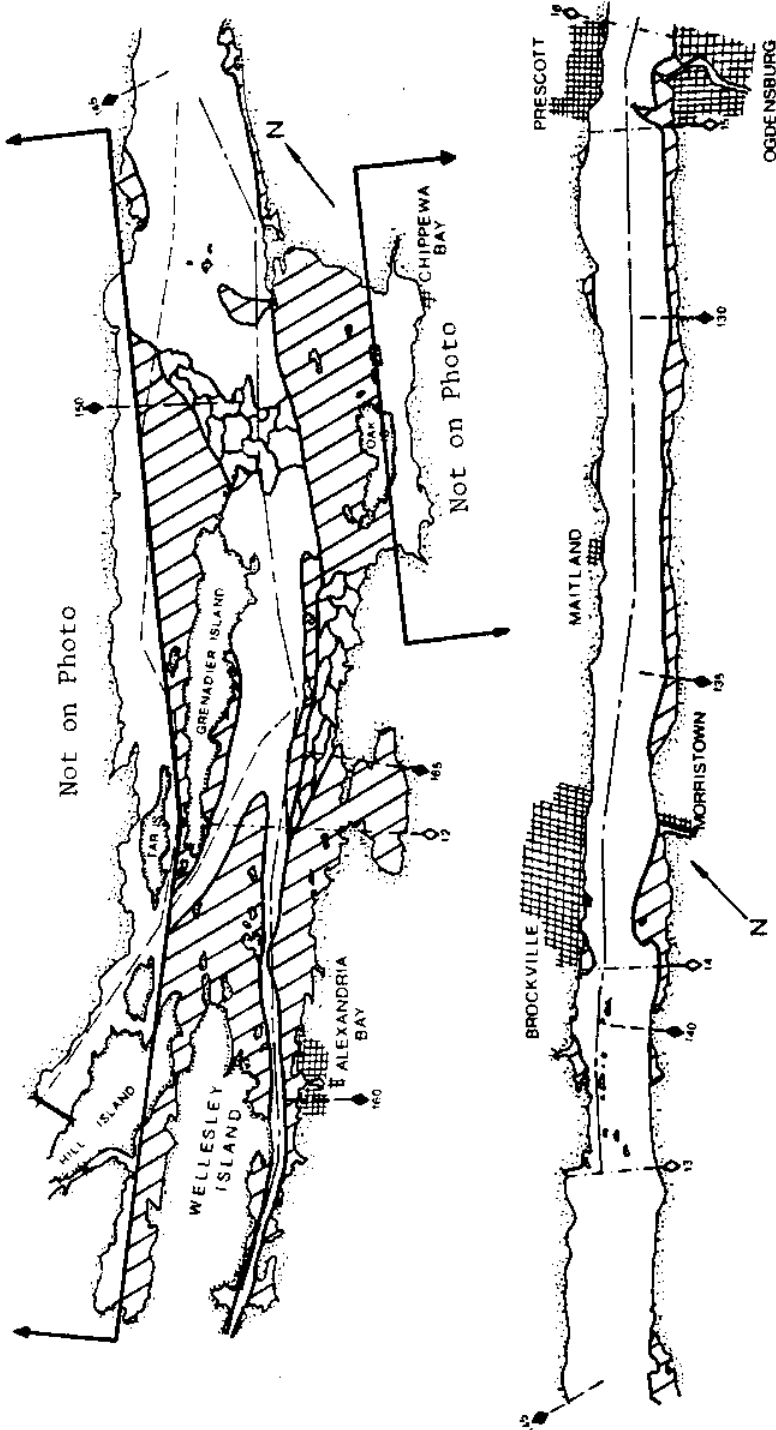
Scale of Miles 0 5

DATE Mar. 10, 1975



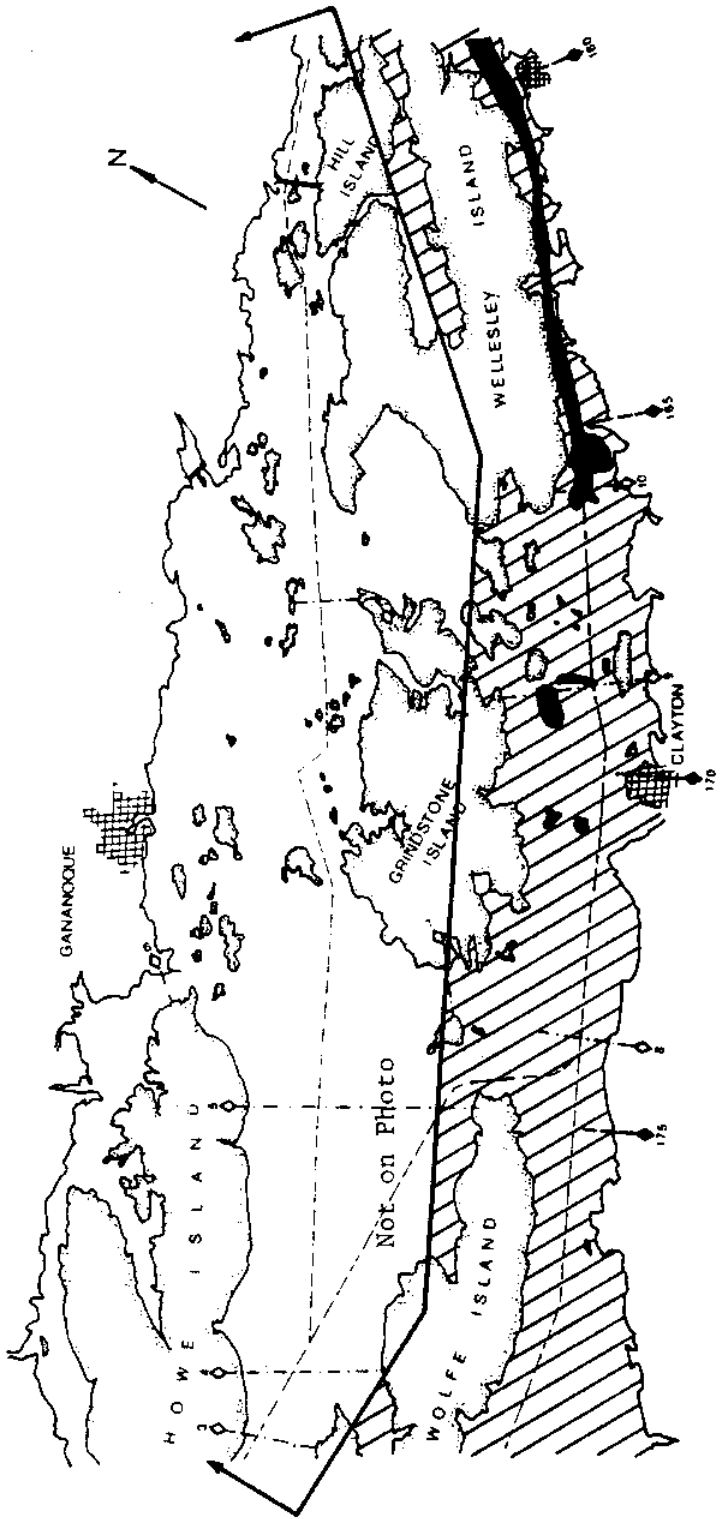
Scale of Miles 0 5

DATE Mar. 17, 1975



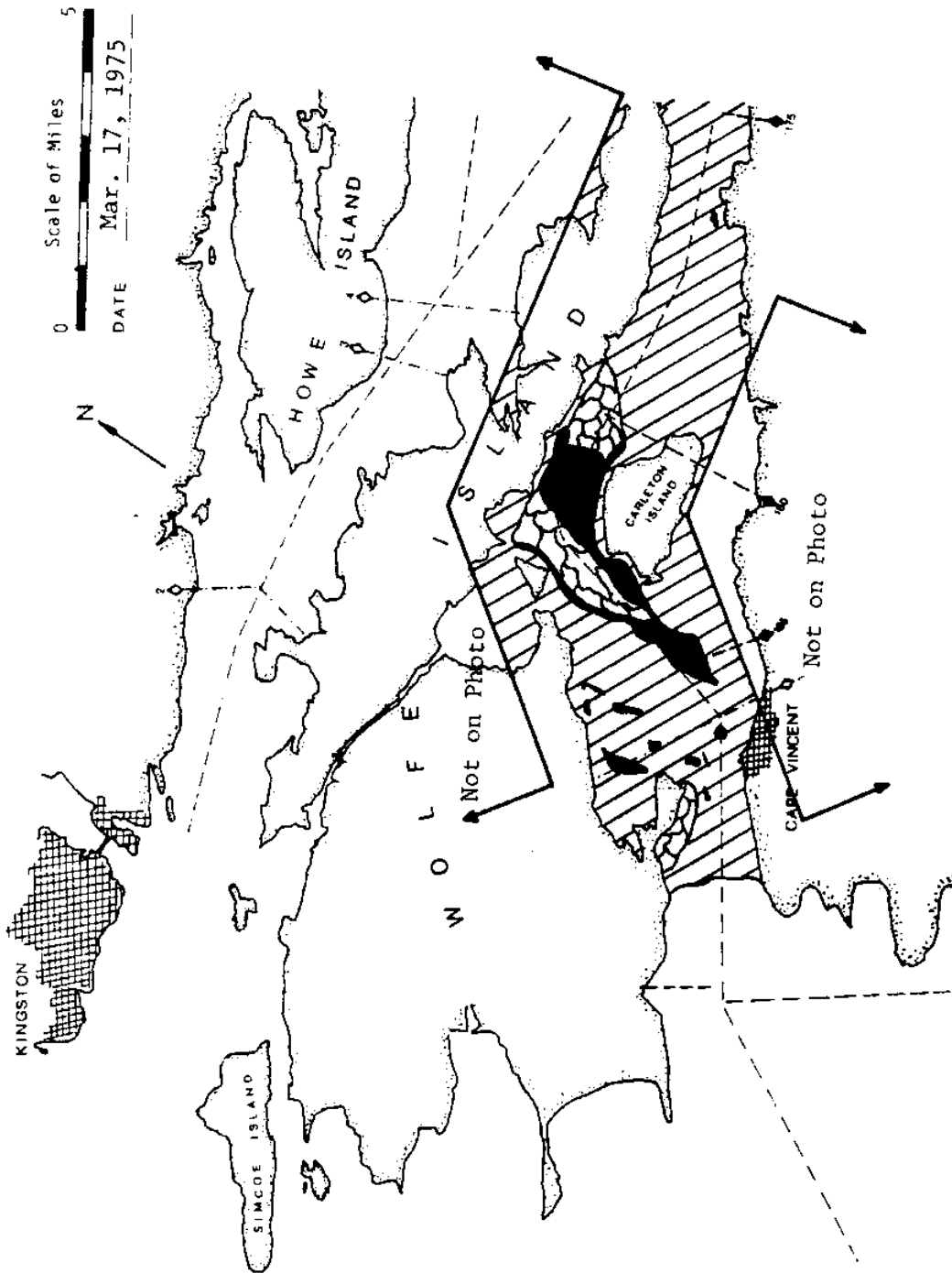
0 Scale of Miles 5

DATE Mar. 17, 1975



0 Scale of Miles 5

DATE Mar. 17, 1975



Scale of Miles 5
DATE Mar. 17, 1975

N

KINGSTON

SIMCOE ISLAND

HOWE ISLAND

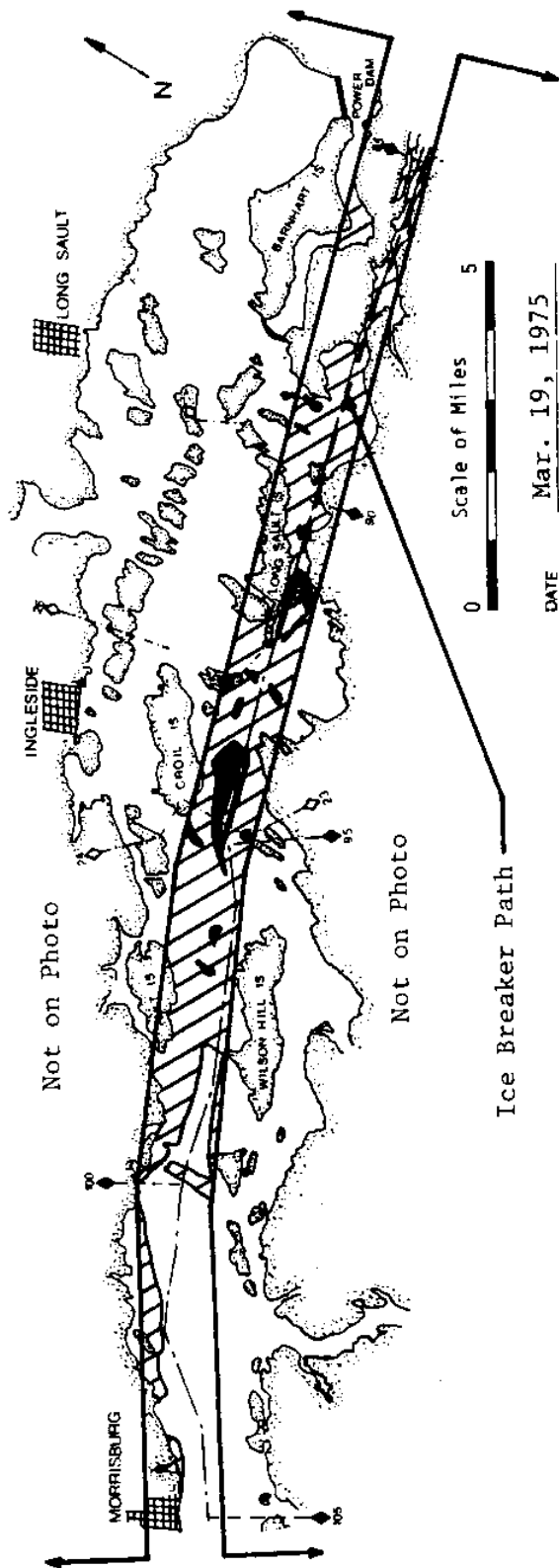
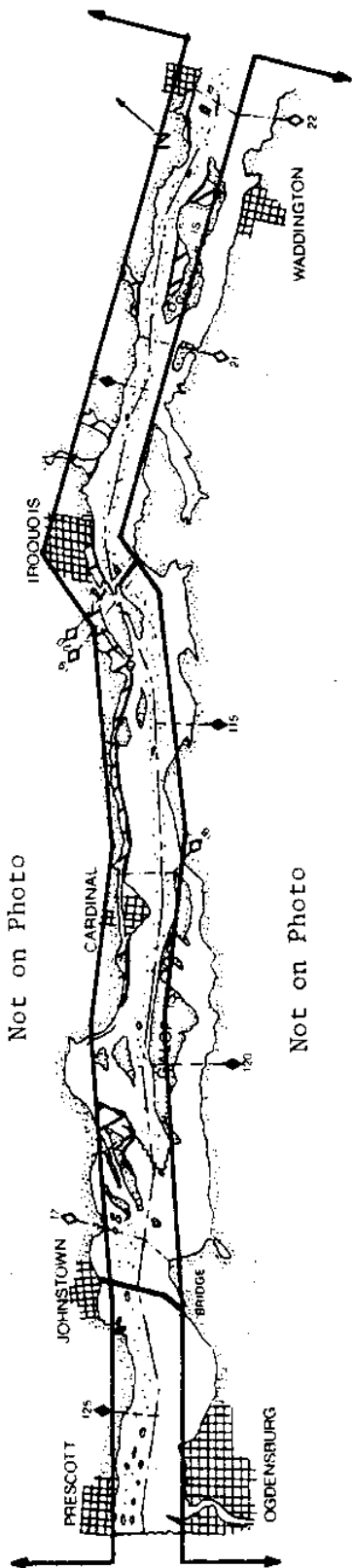
CARLETON ISLAND

CAPT VINCENT

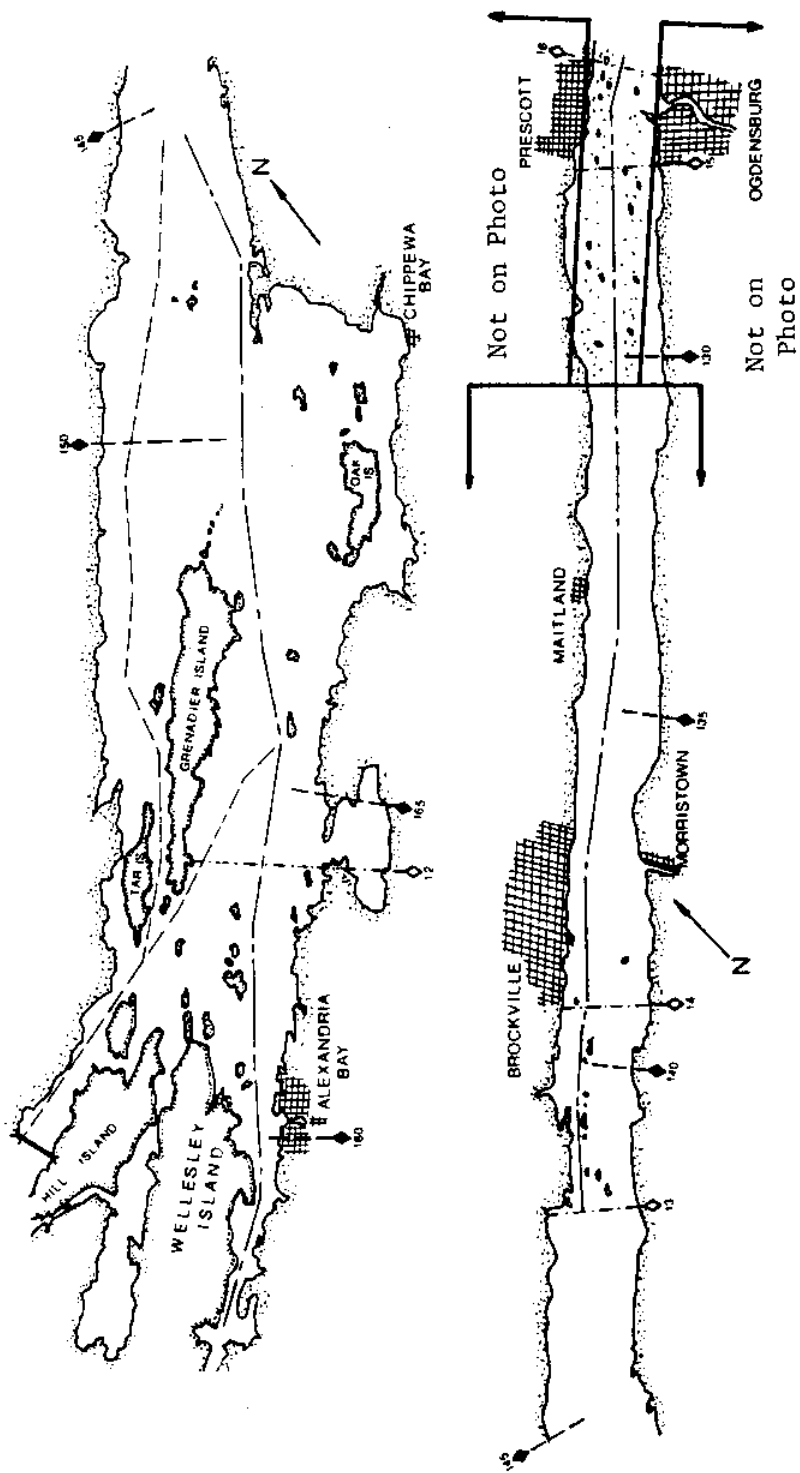
Not on Photo

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S
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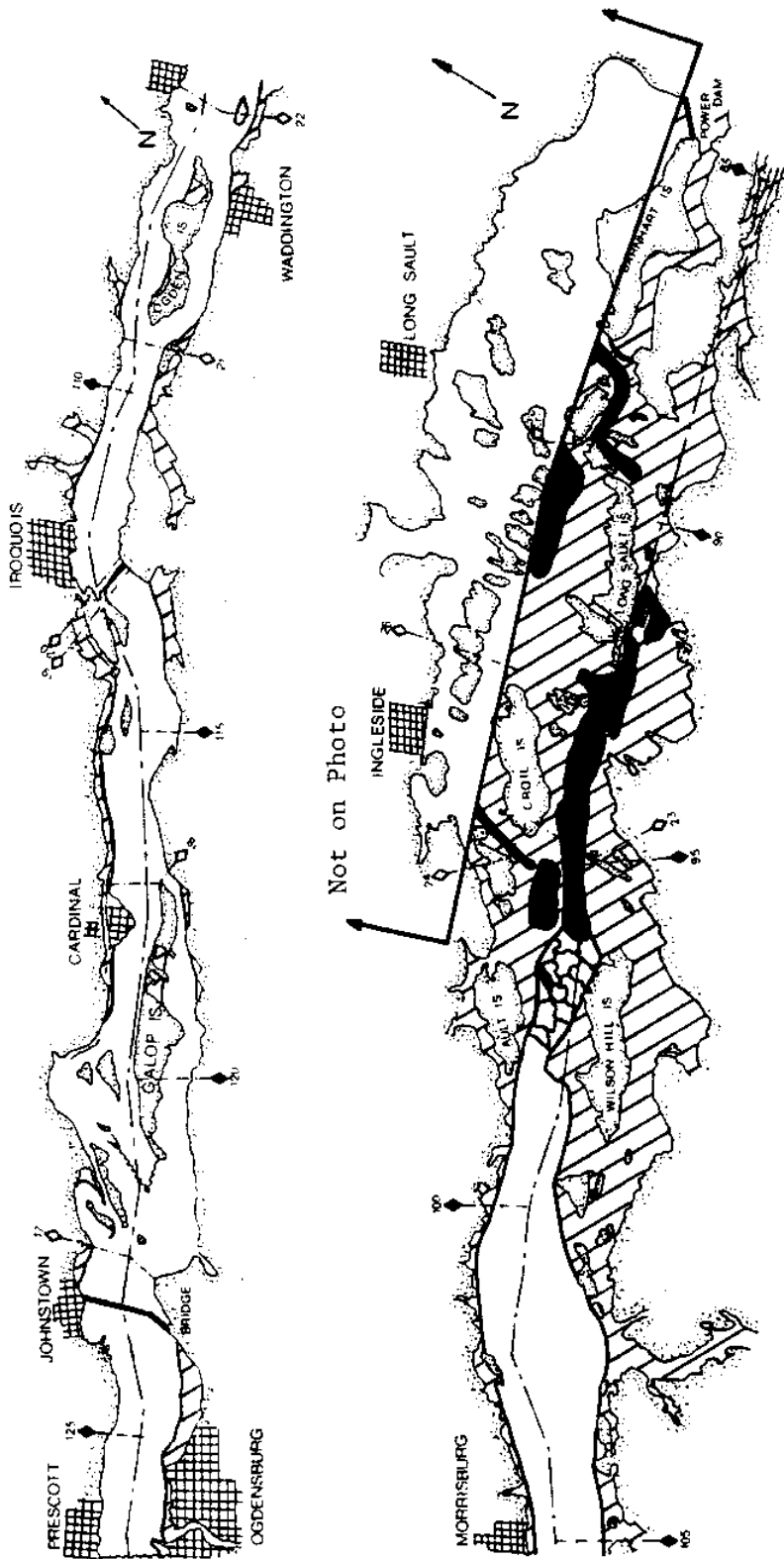


Ice Breaker Path



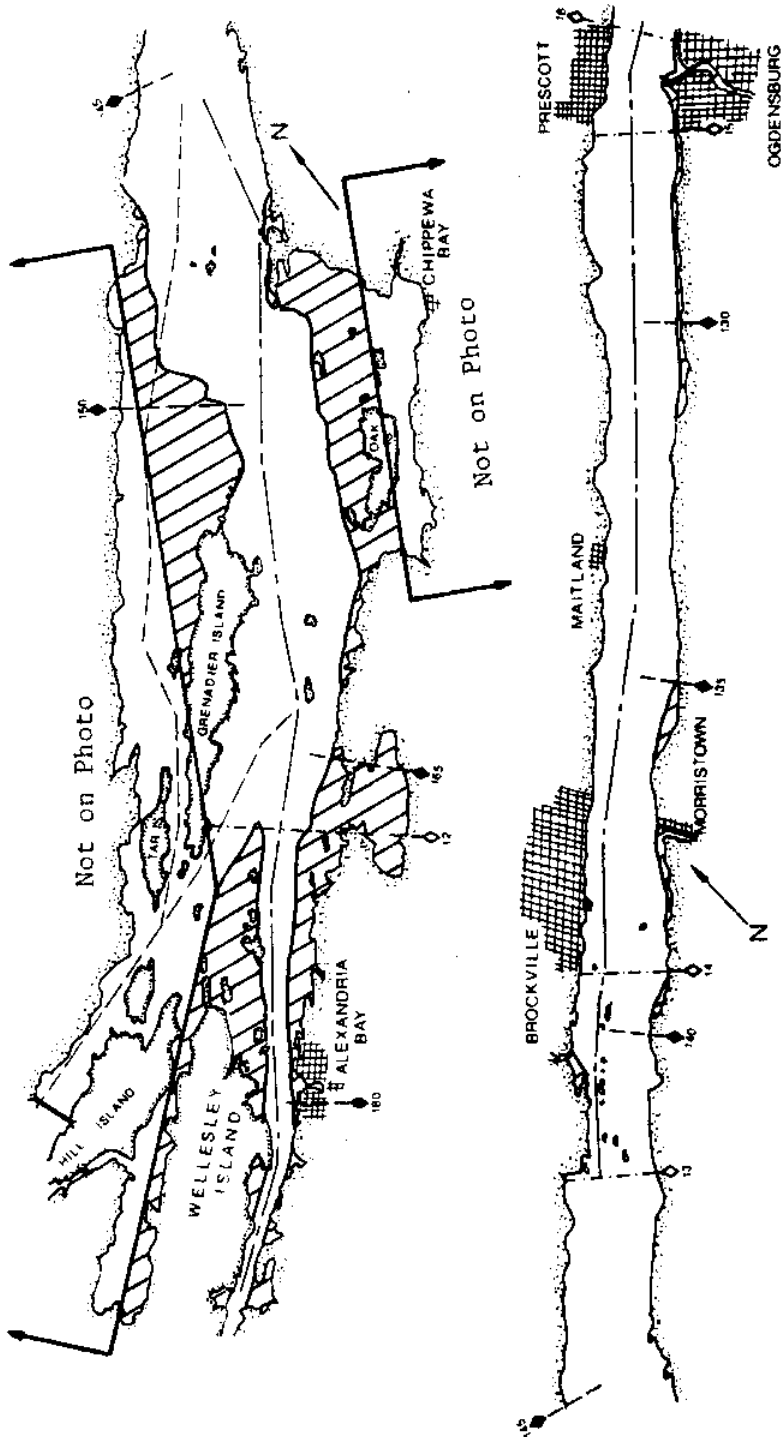
0 Scale of Miles 5

DATE Mar. 19, 1975

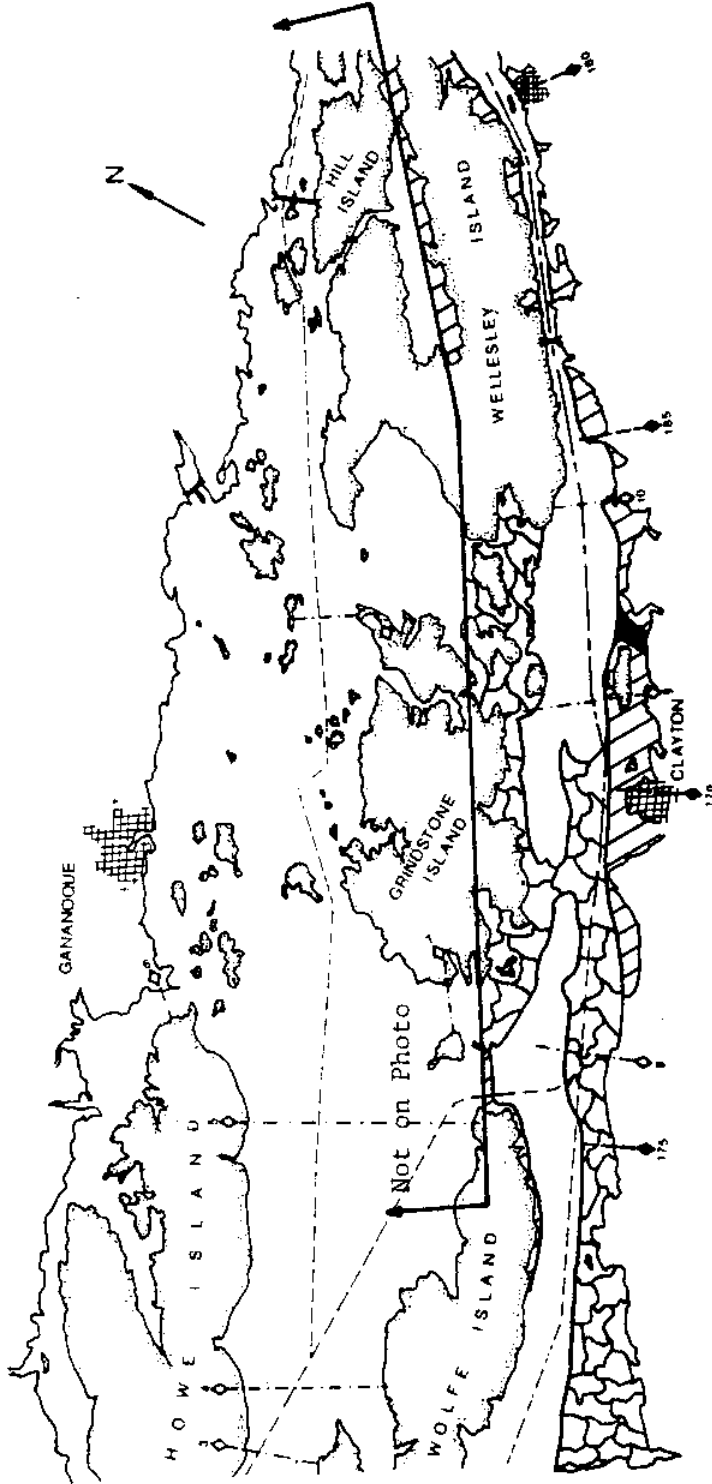


0 Scale of Miles 5

DATE Mar. 21, 1975

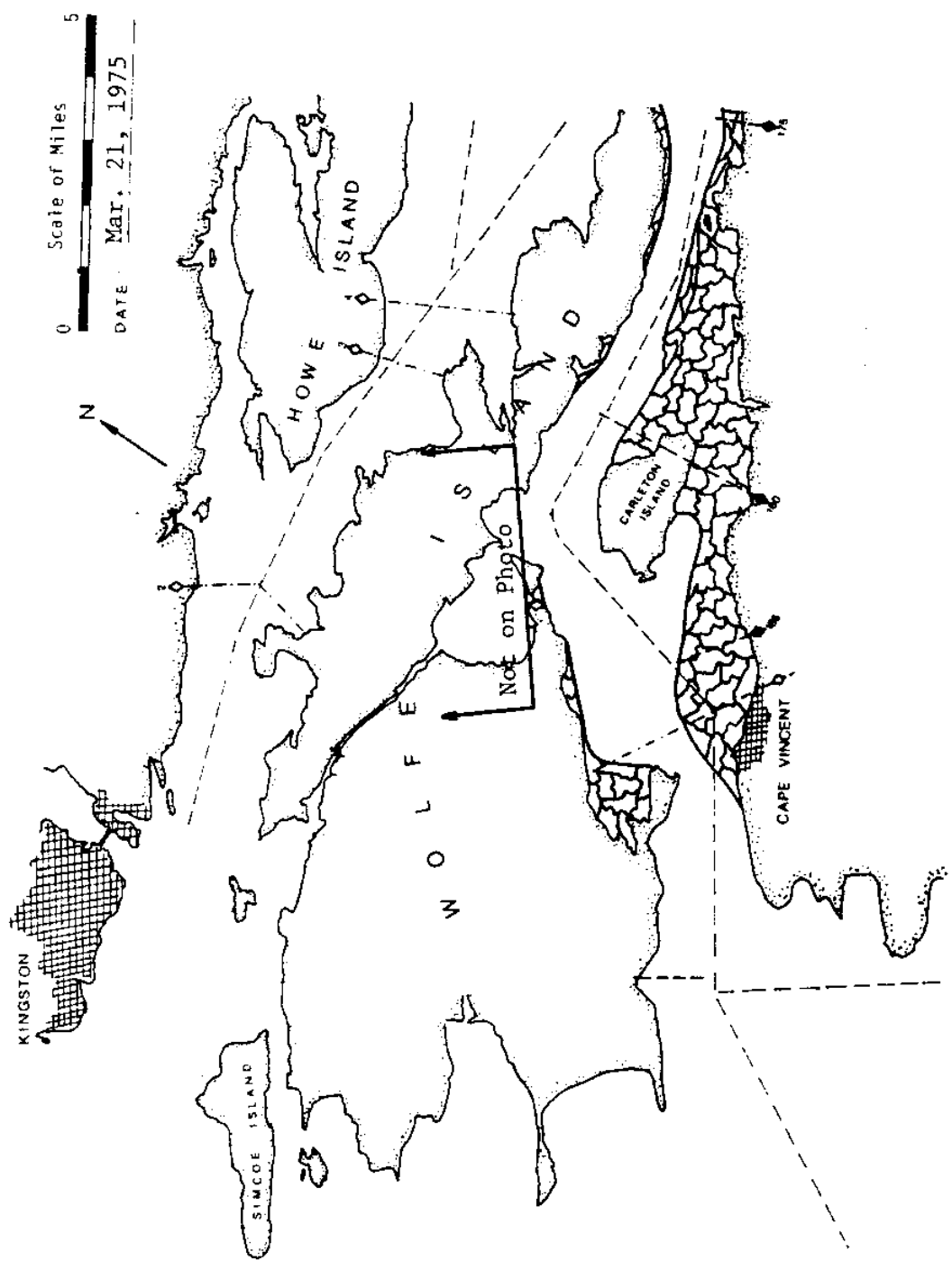


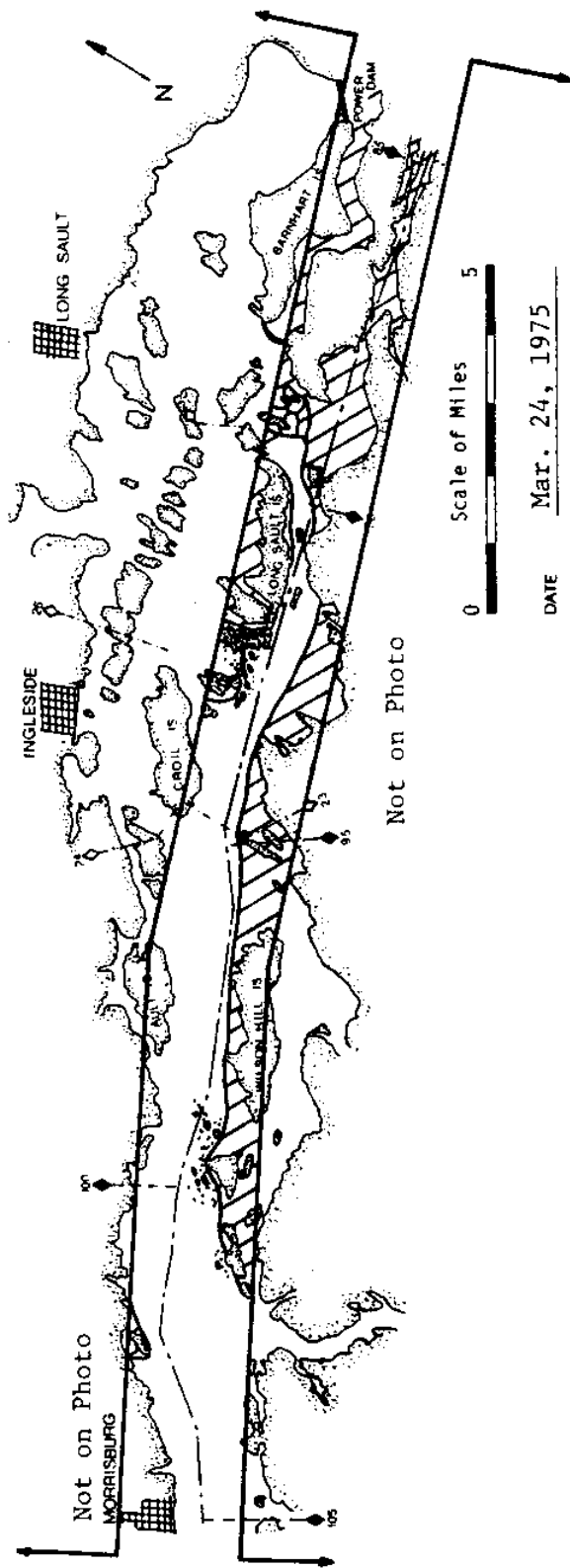
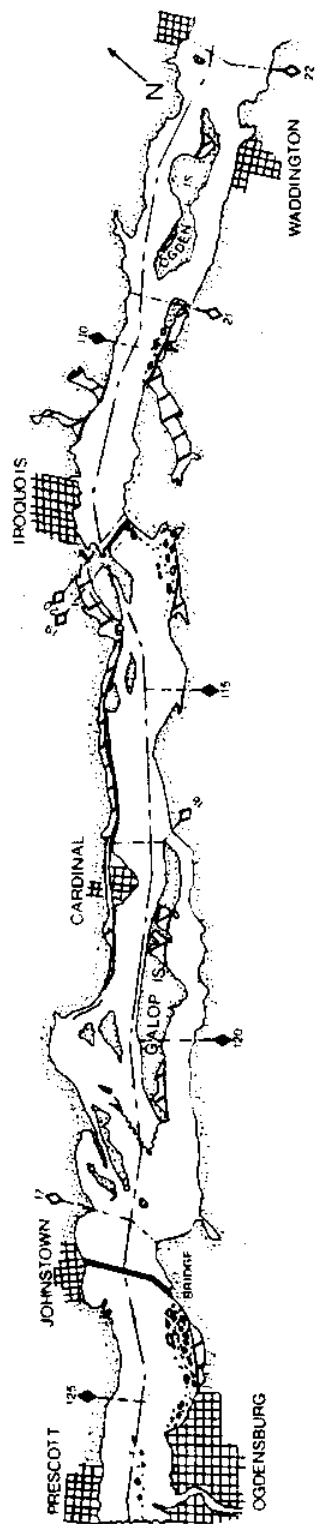
Scale of Miles 0 5
DATE Mar. 21, 1975



0 Scale of Miles 5

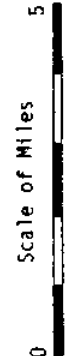
DATE Mar. 21, 1975



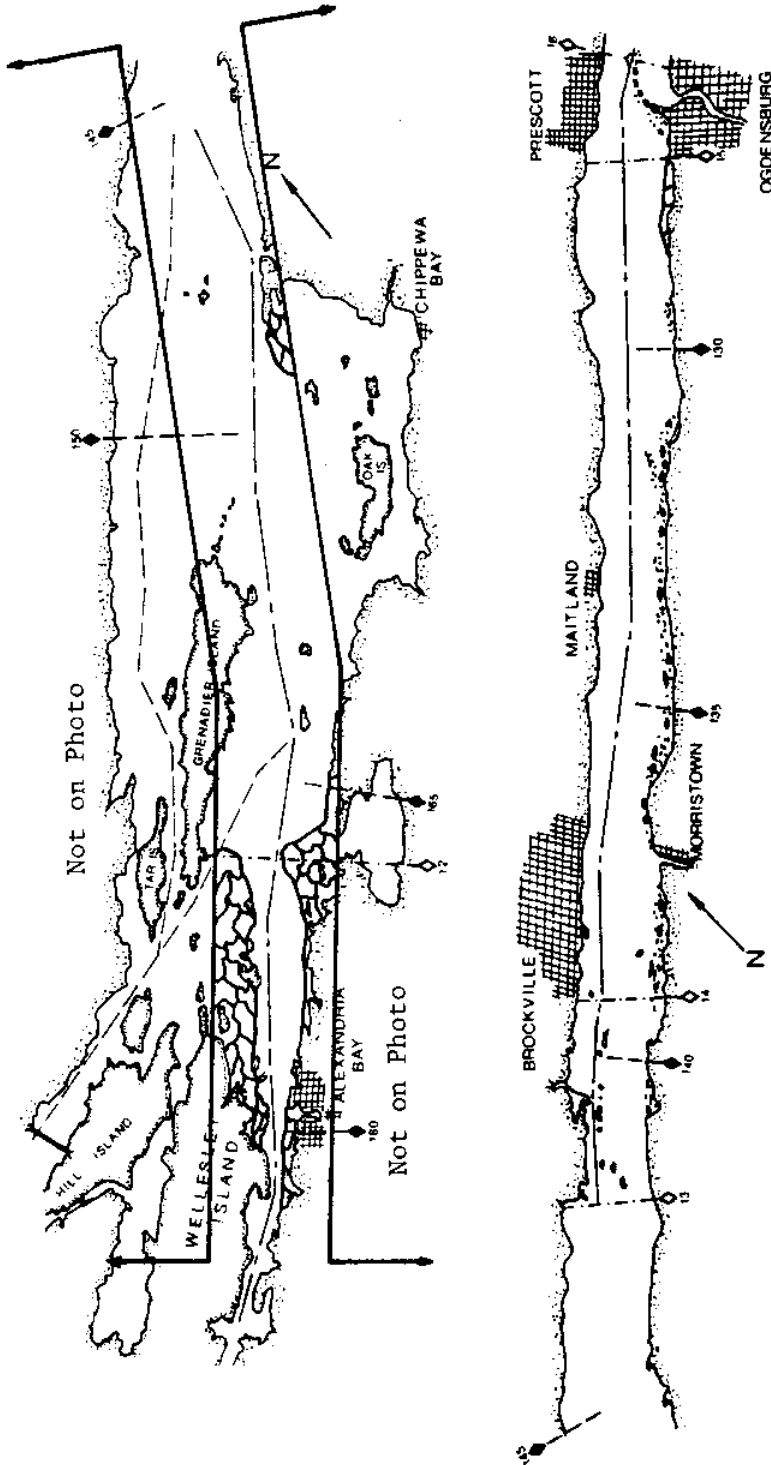


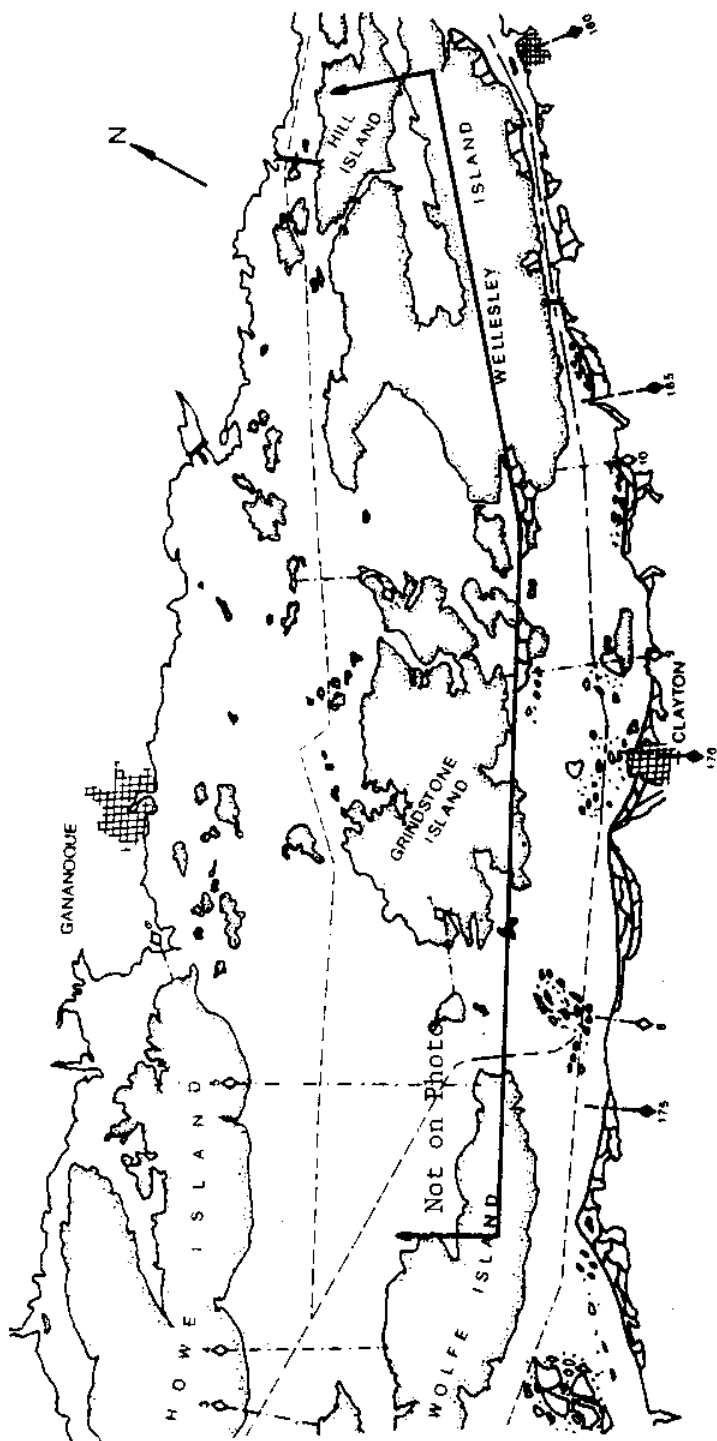
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MORRISBURG

Not on Photo



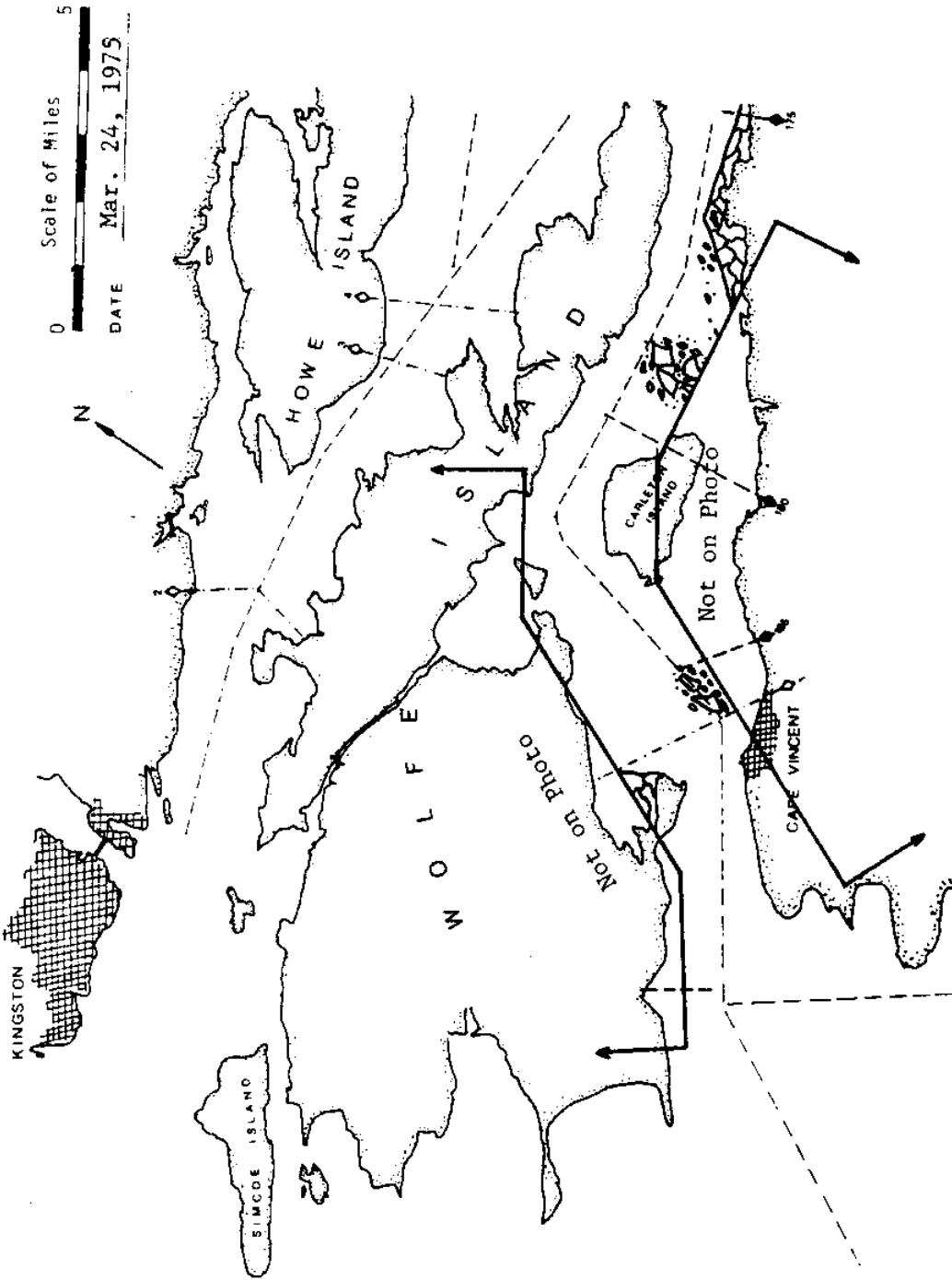
DATE Mar. 24, 1975



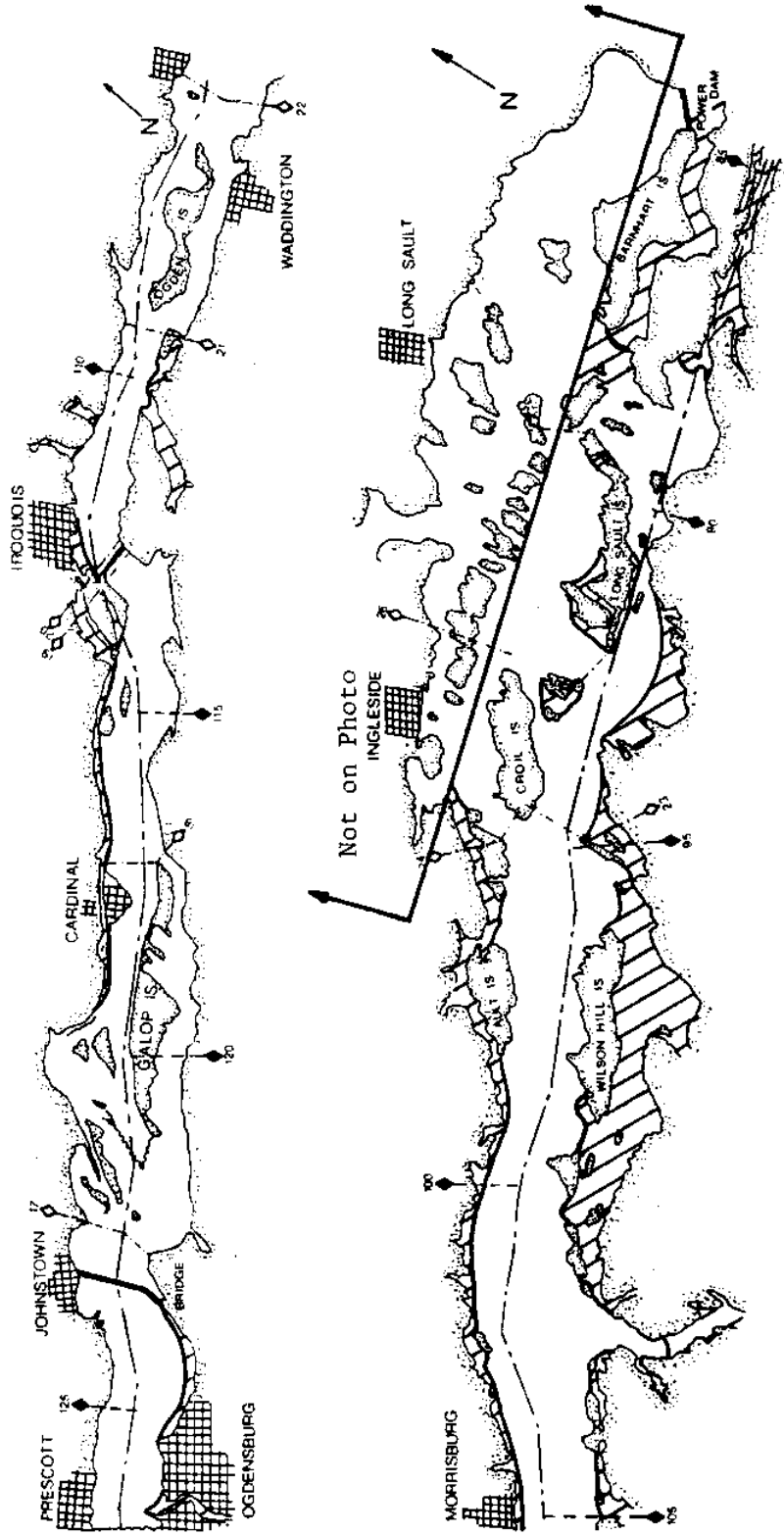


0 Scale of Miles 5

DATE Mar. 24, 1975

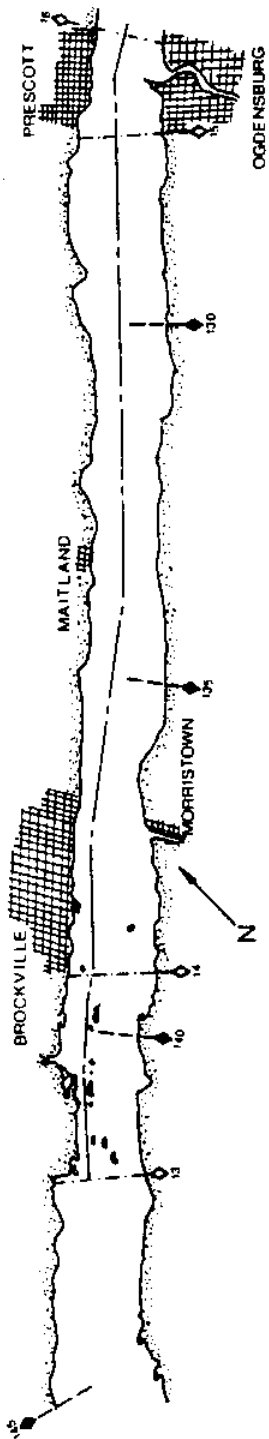
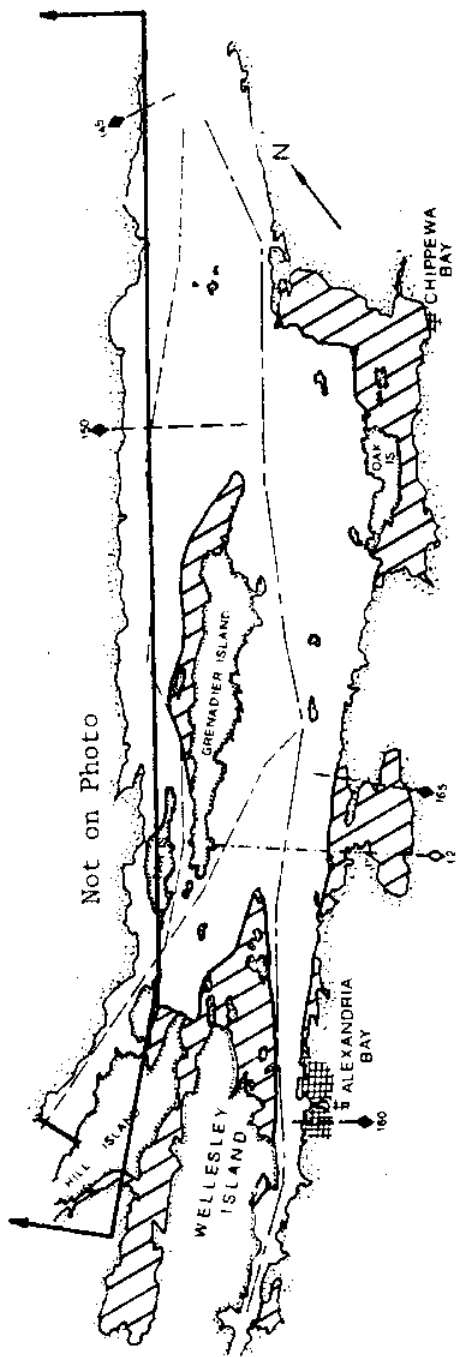


Winter of 1975-76



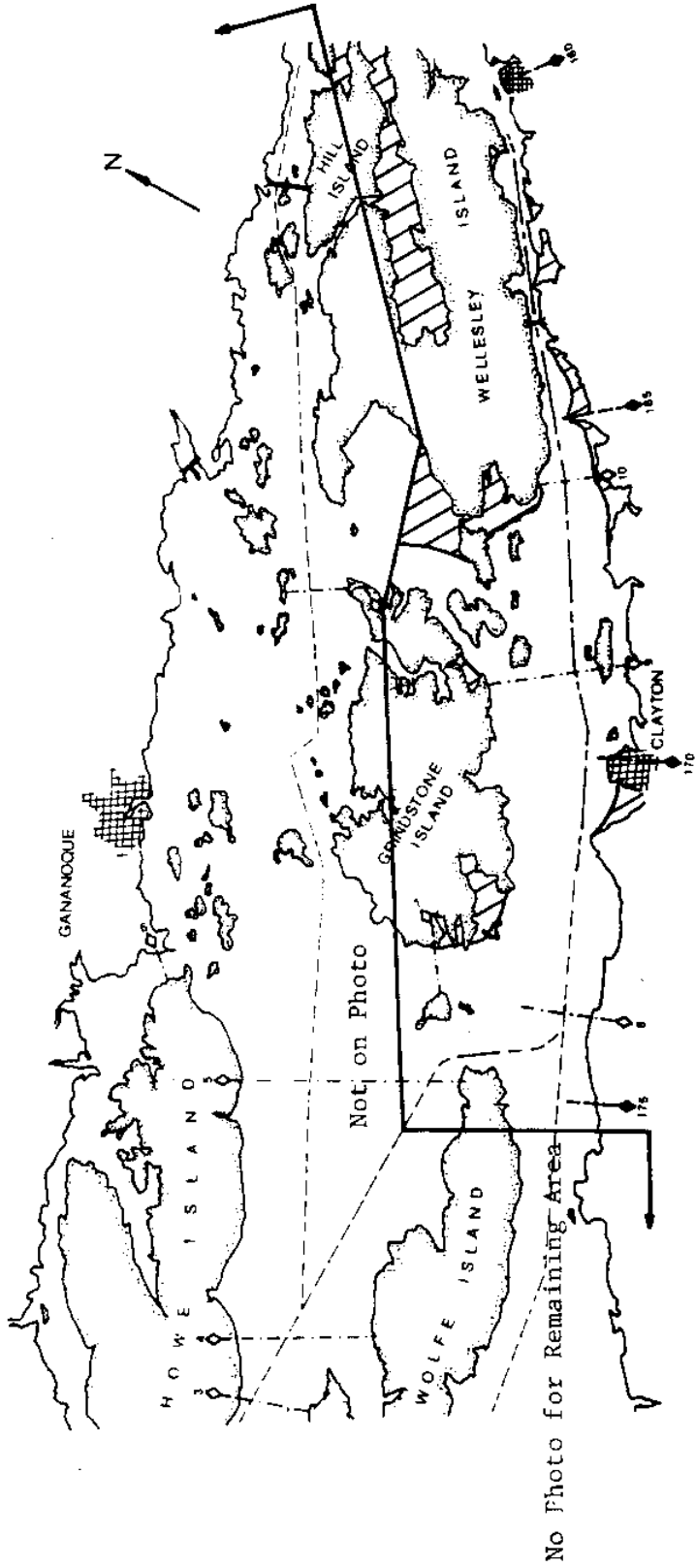
0 Scale of Miles 5

DATE Dec. 19, 1975



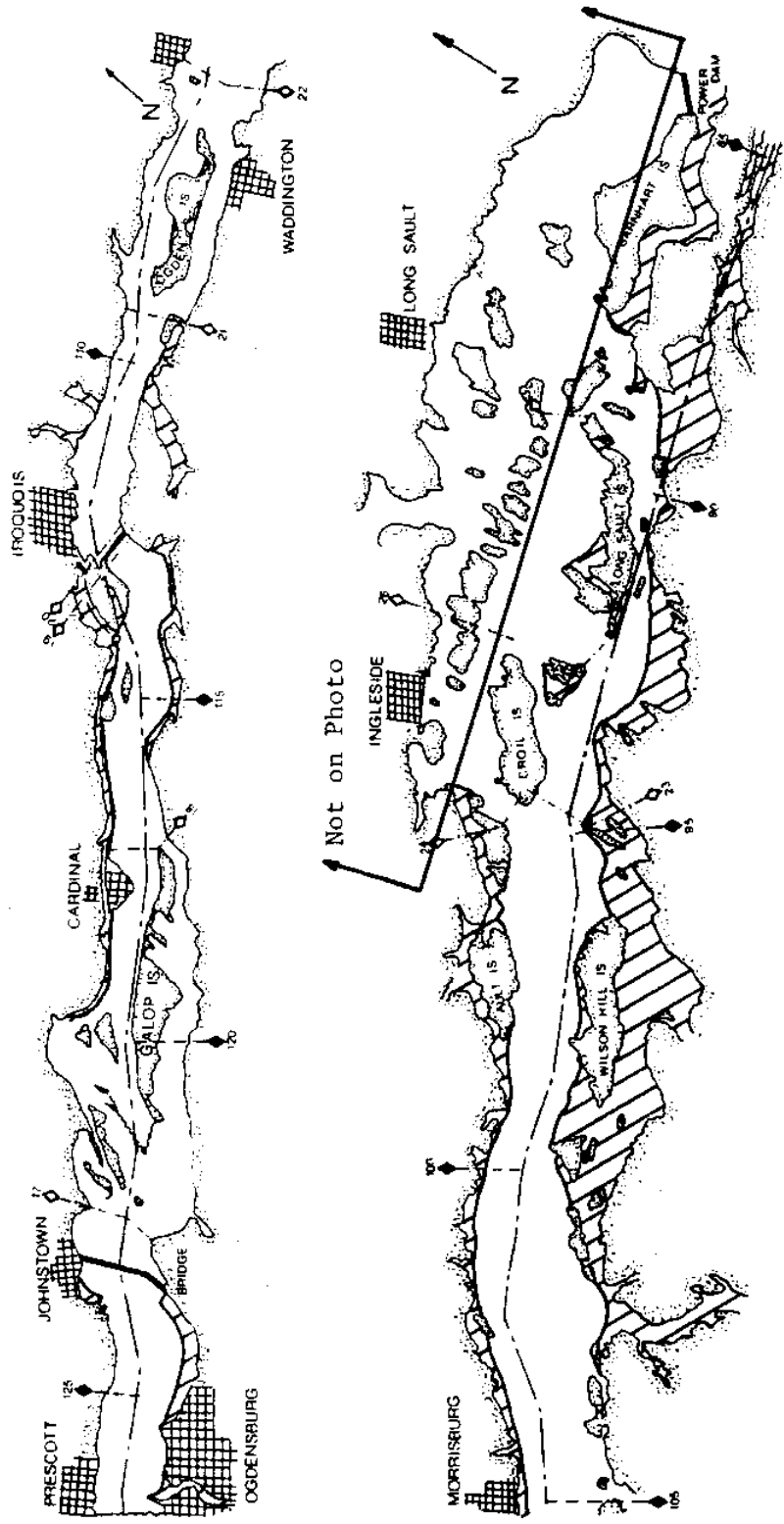
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DATE Dec. 19, 1975



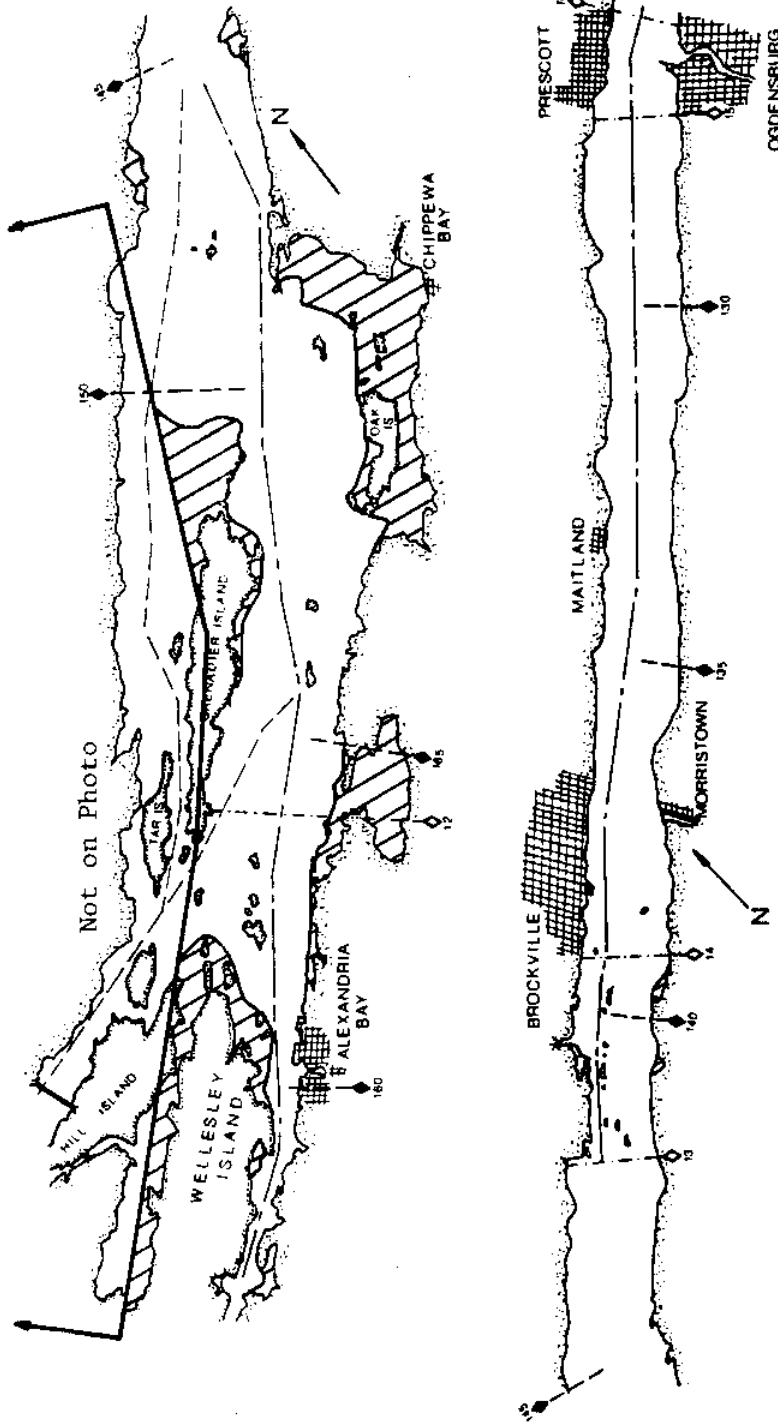
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DATE Dec. 19, 1975

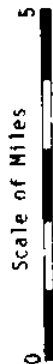
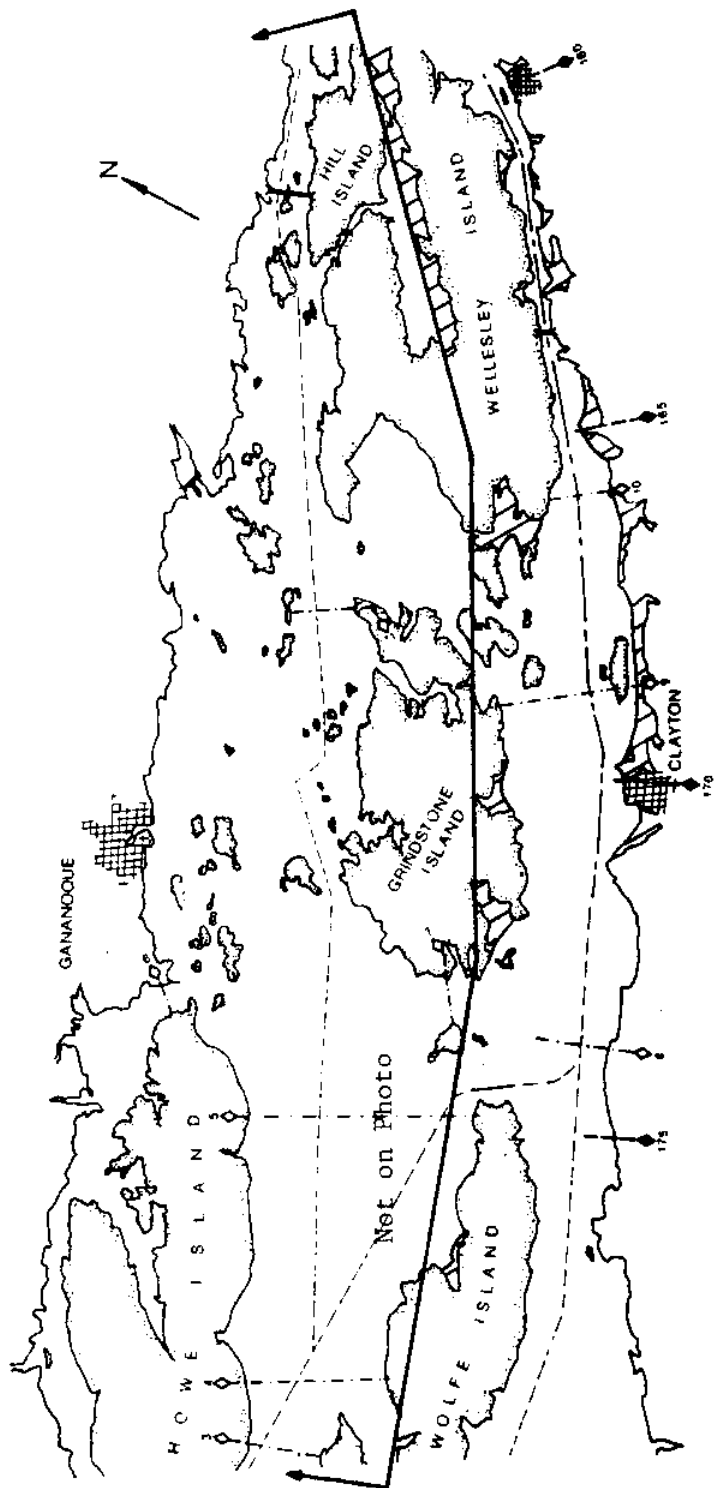


0 Scale of Miles 5

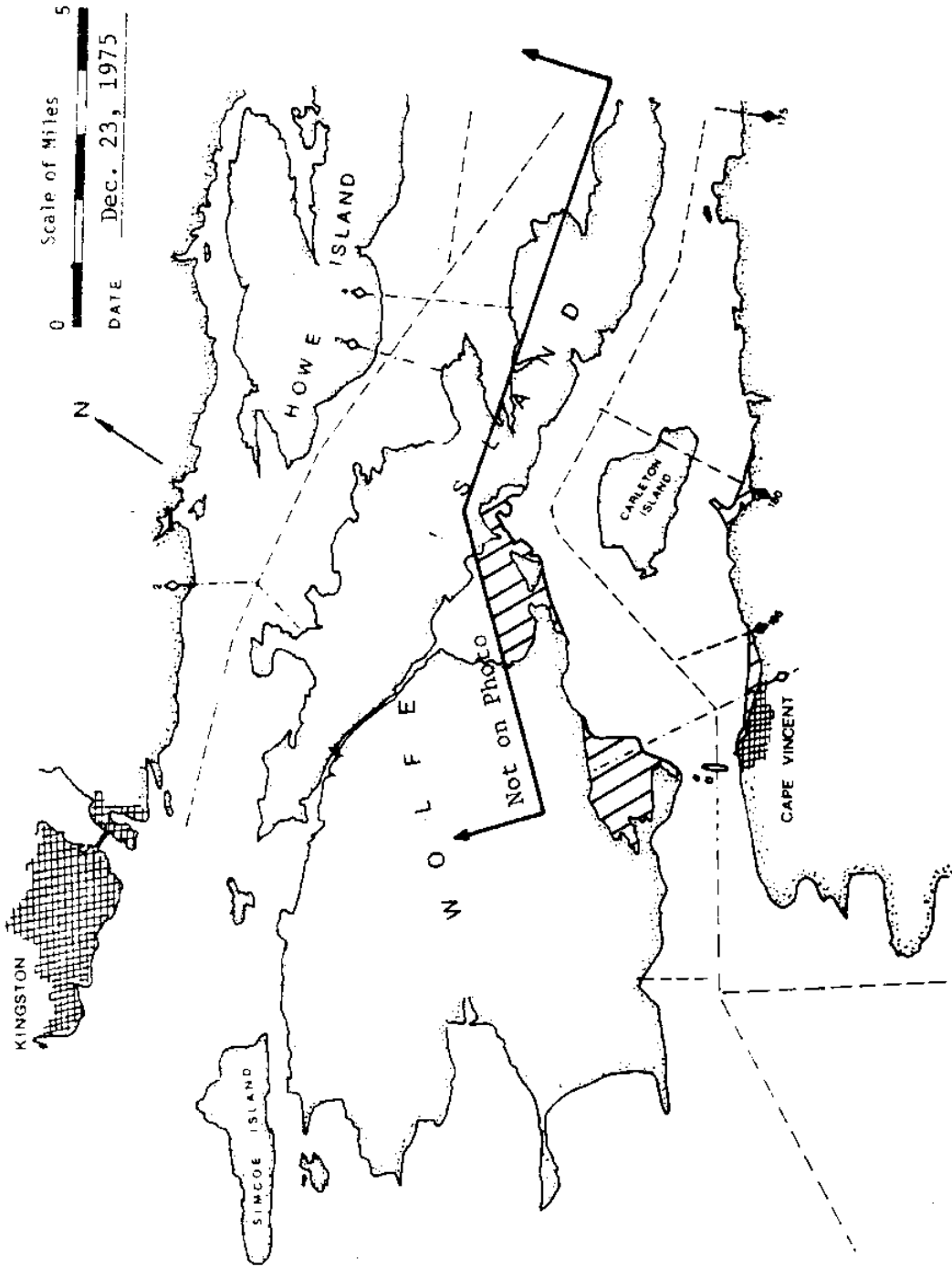
DATE Dec. 23, 1975

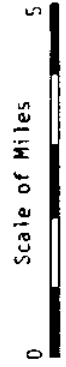
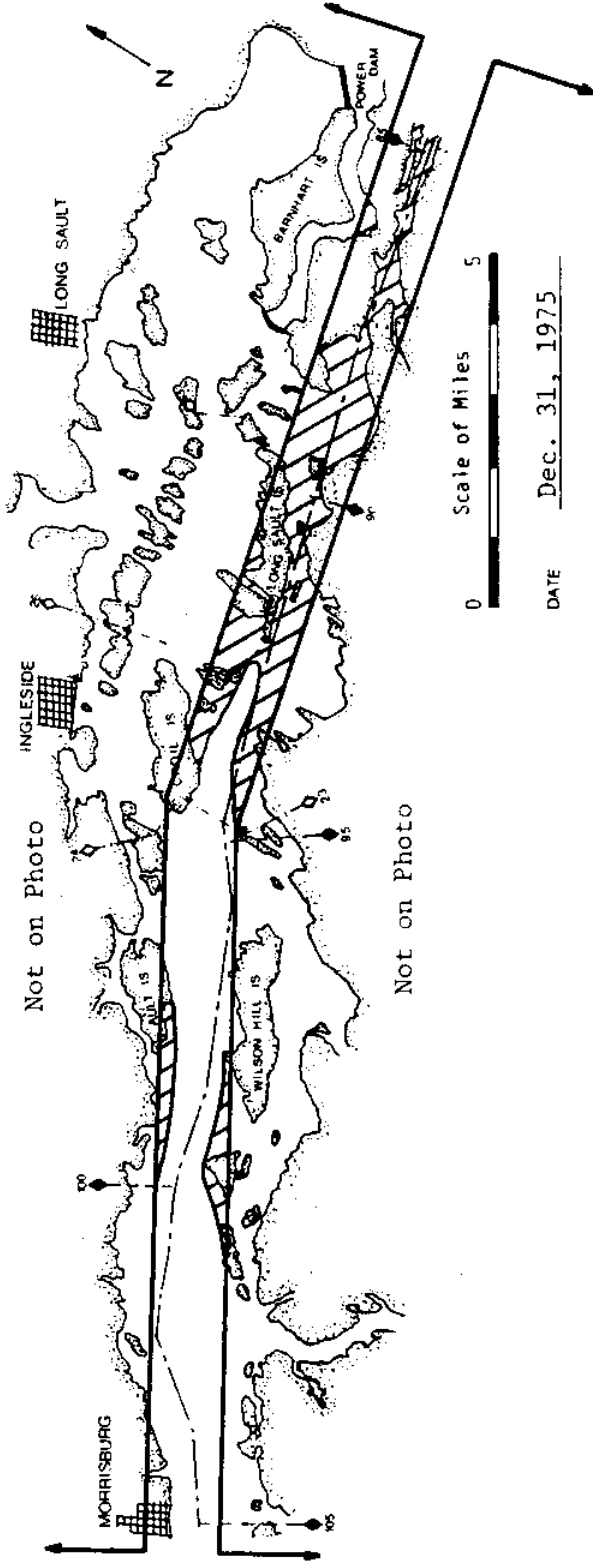
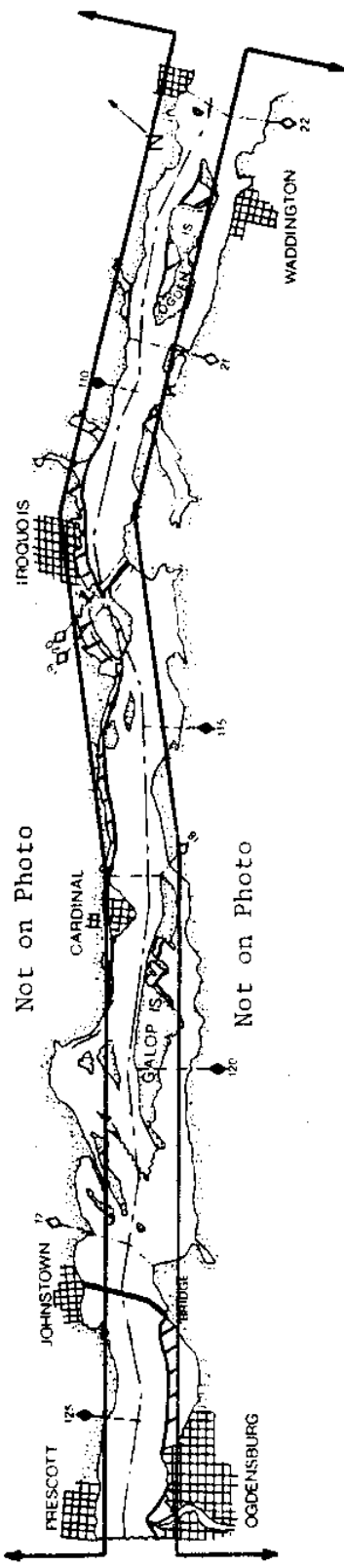


0 Scale of Miles 5
DATE Dec. 23, 1975

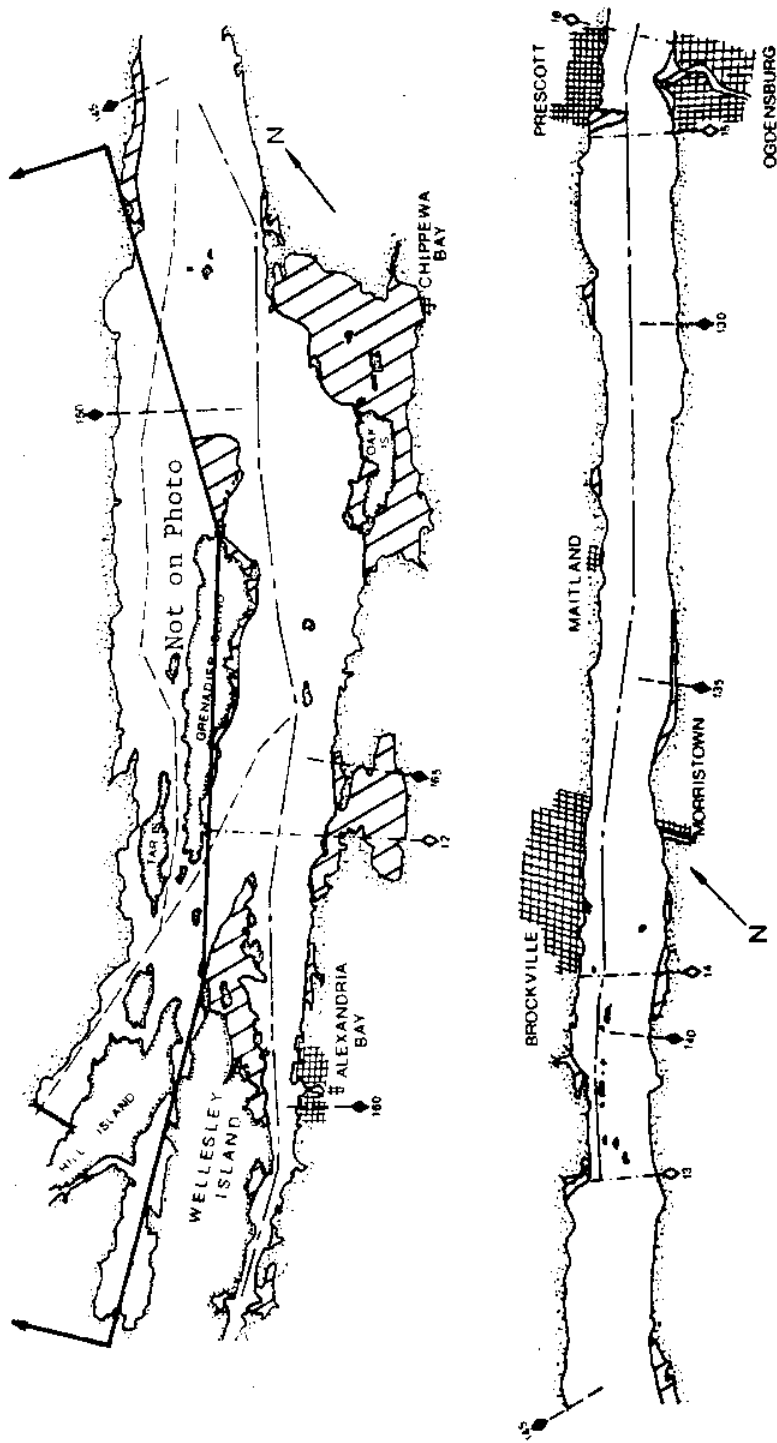


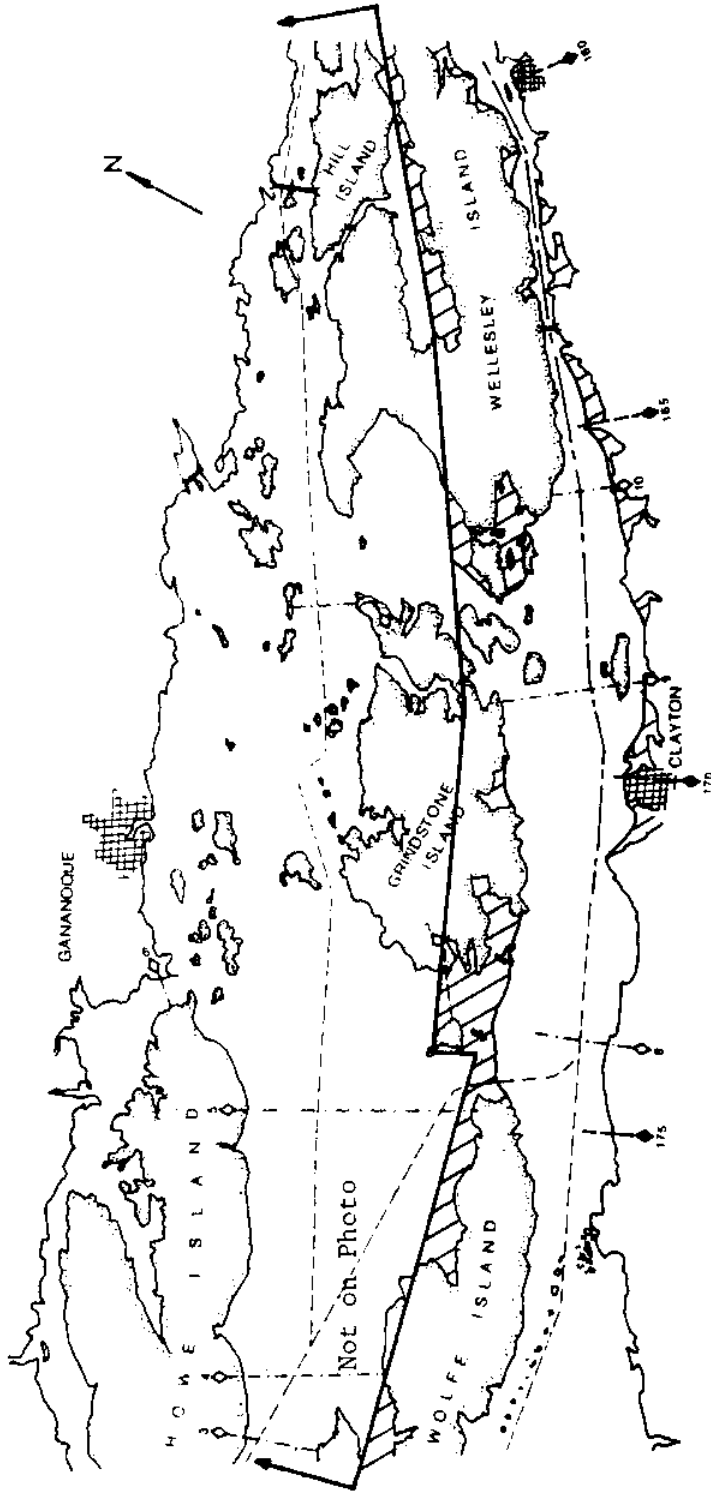
DATE Dec. 23, 1975





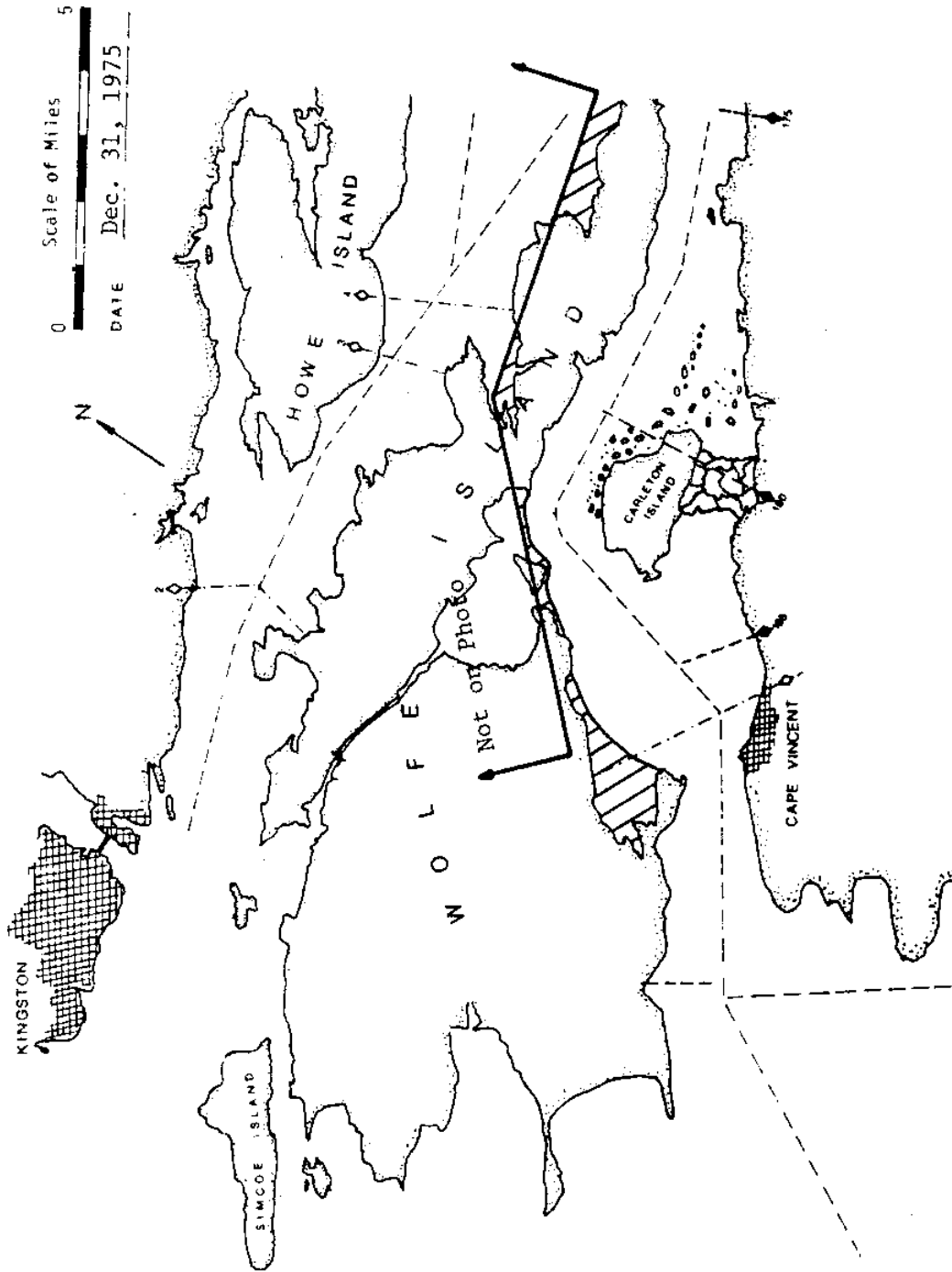
DATE Dec. 31, 1975

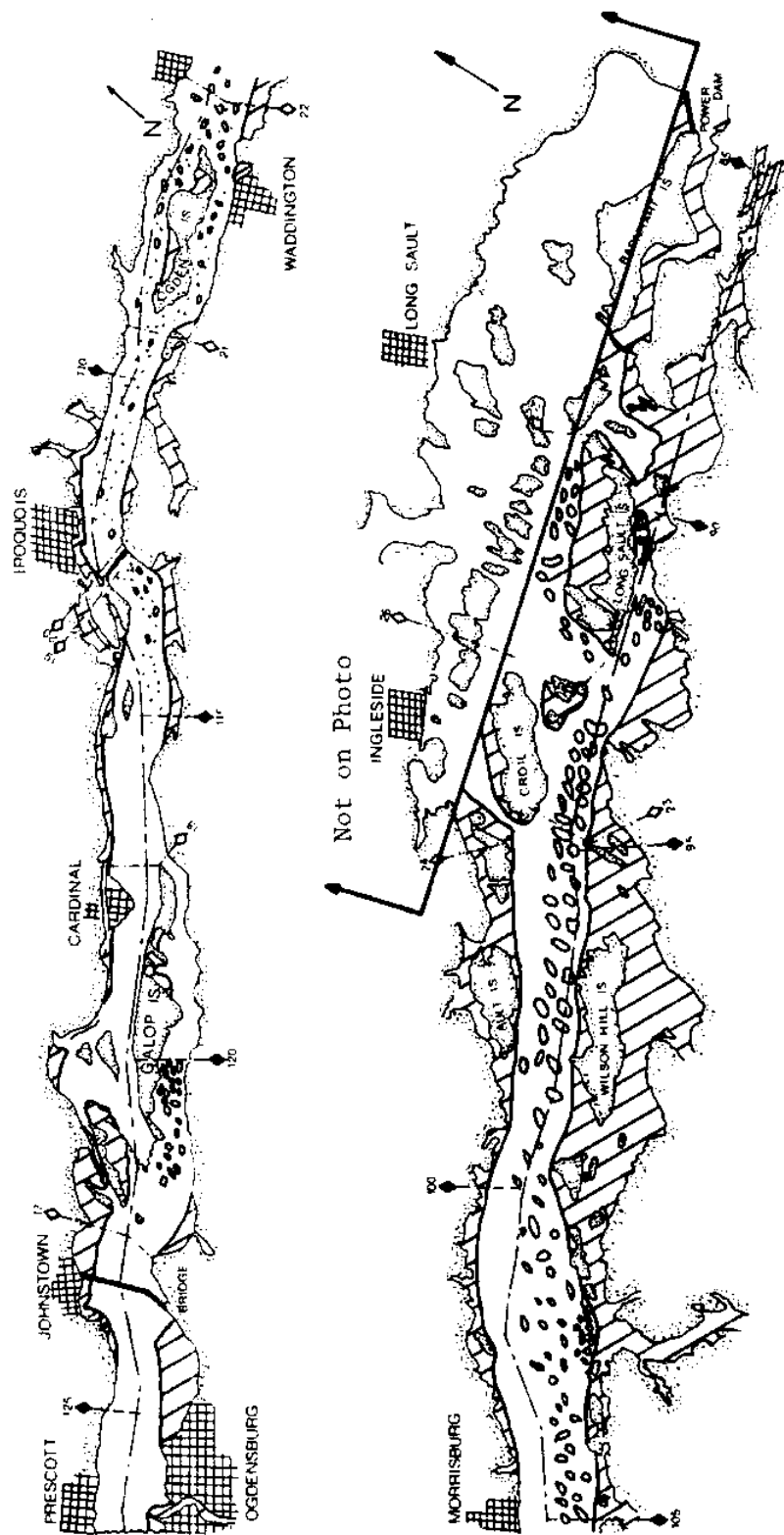




0 Scale of Miles 5

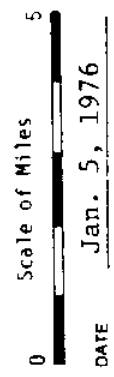
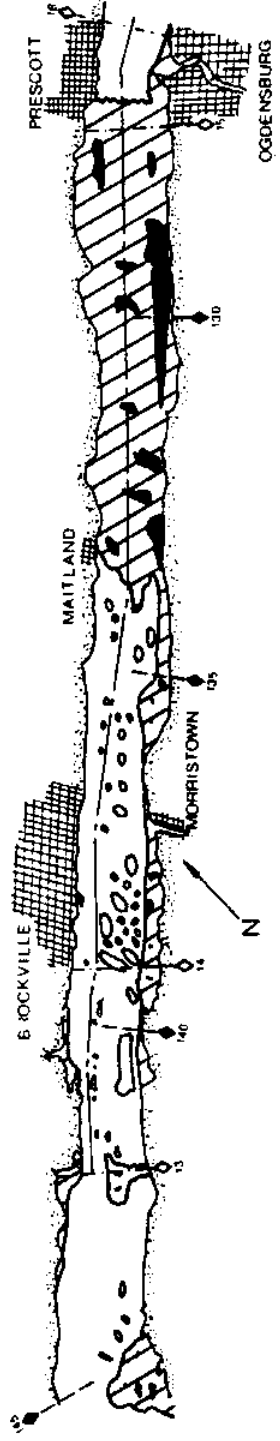
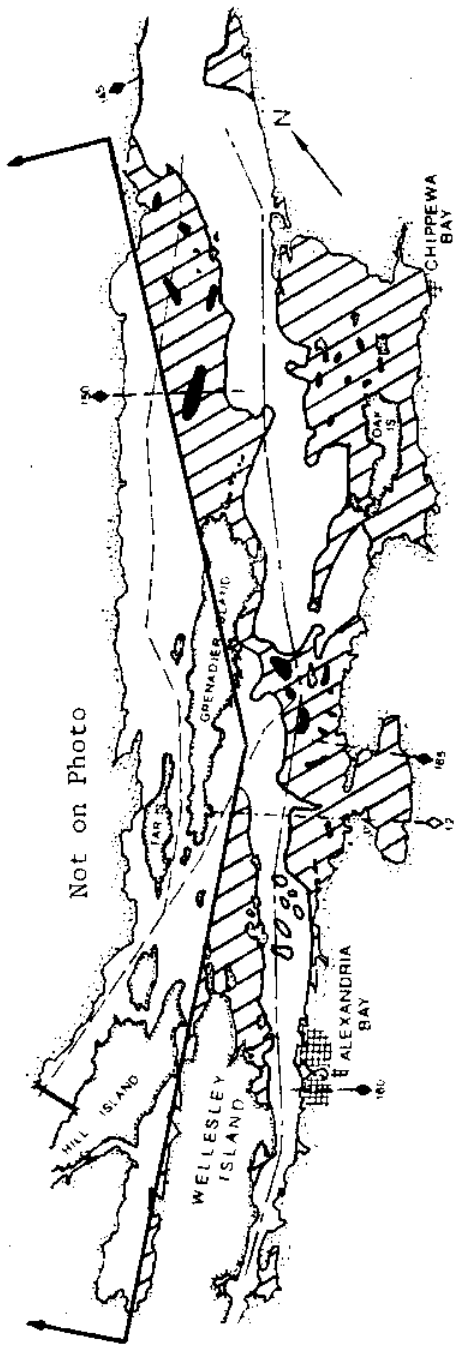
DATE Dec. 31, 1975

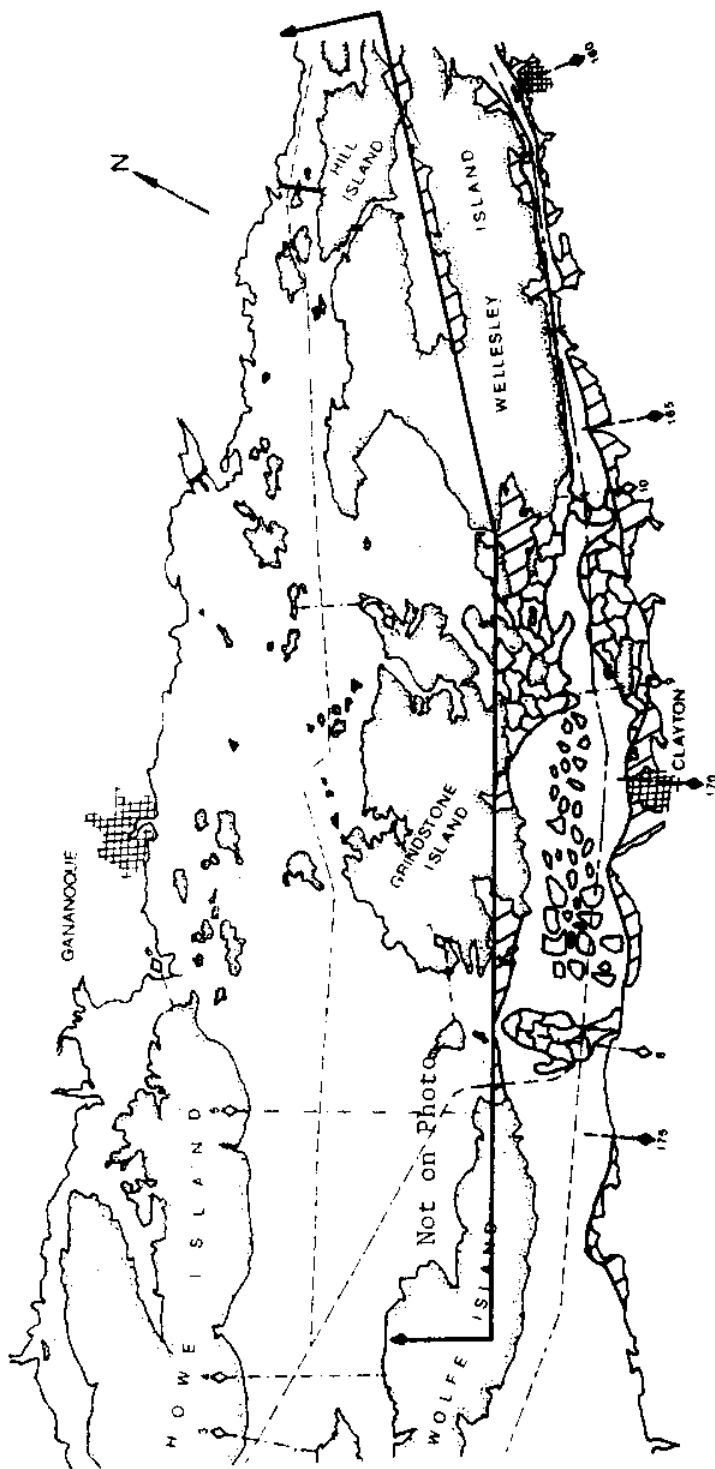




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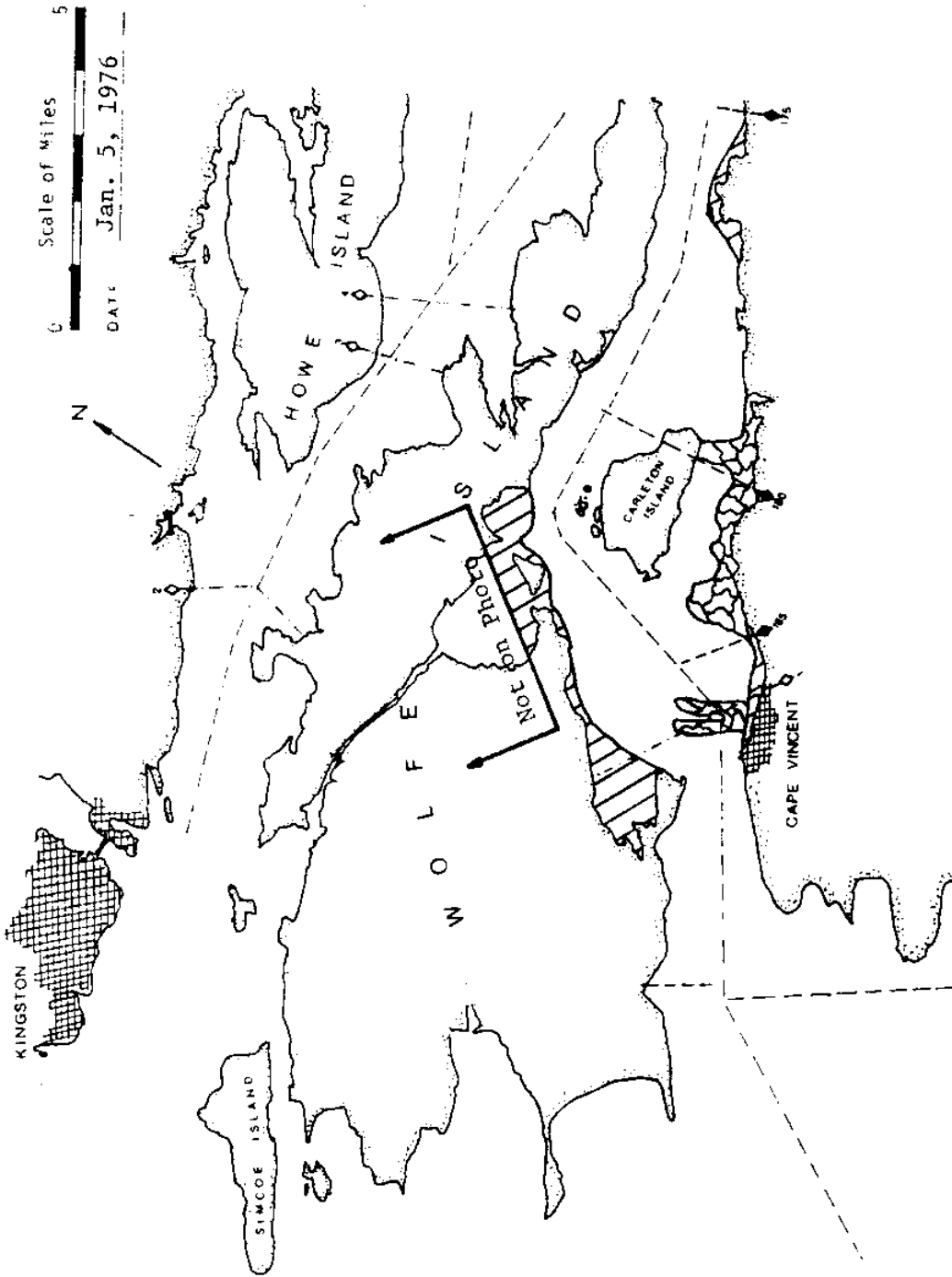
DATE Jan. 5, 1976

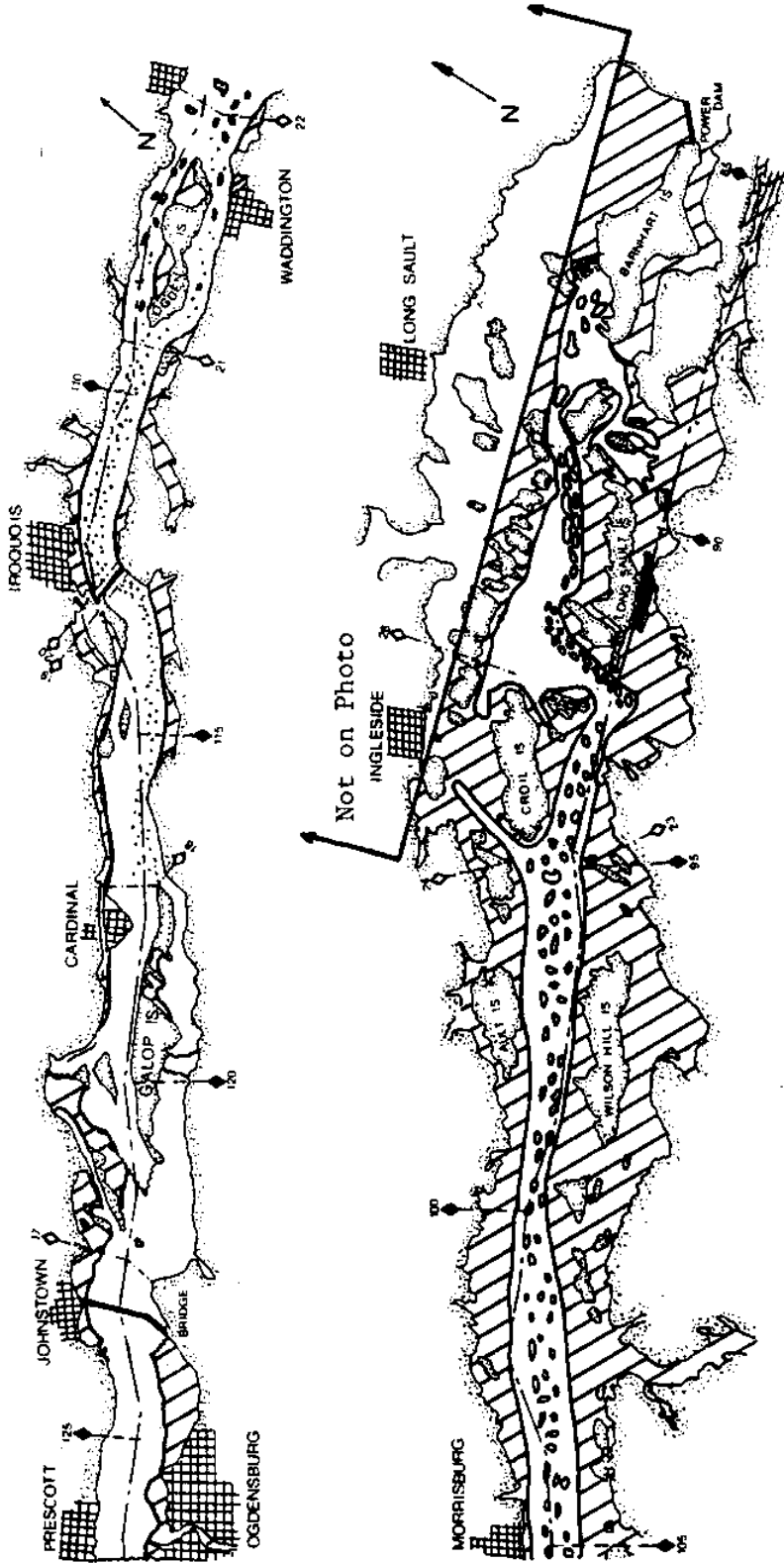




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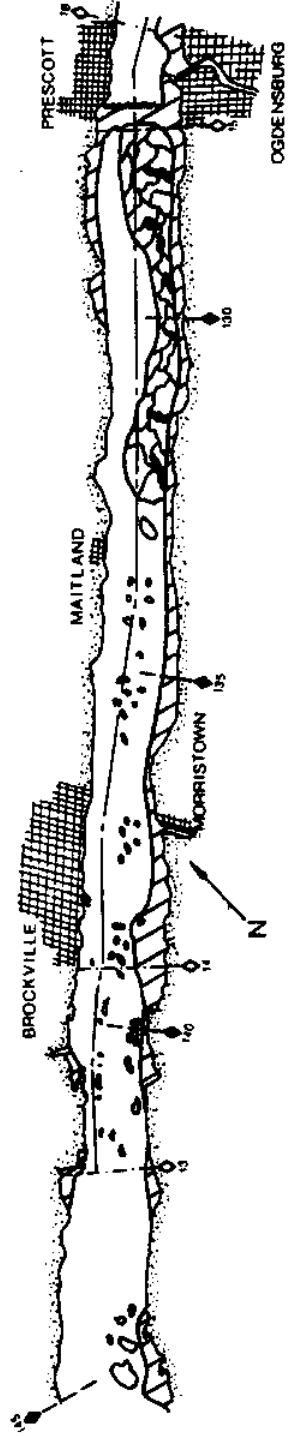
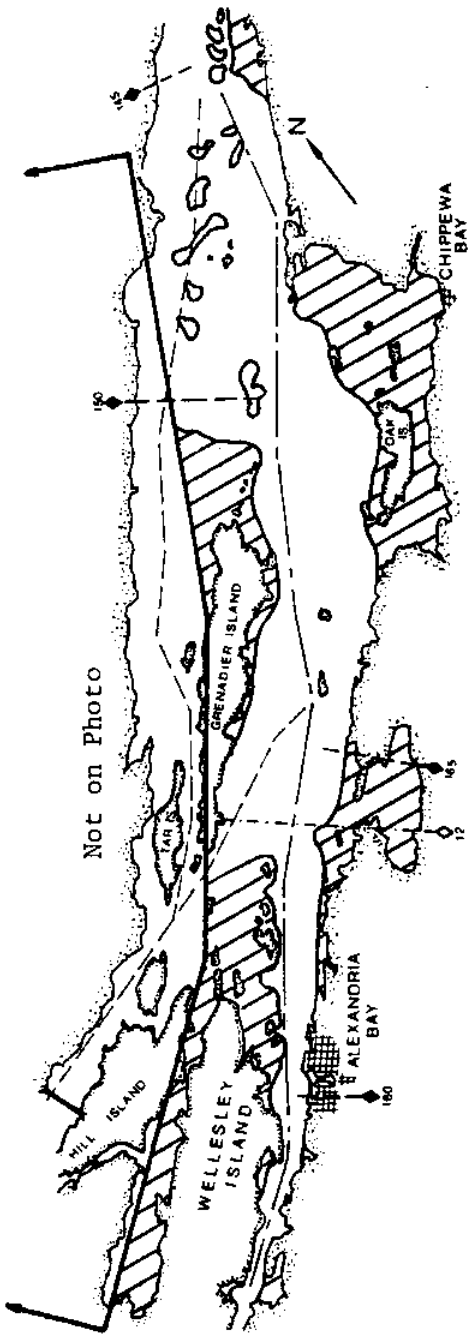
DATE Jan. 5, 1976





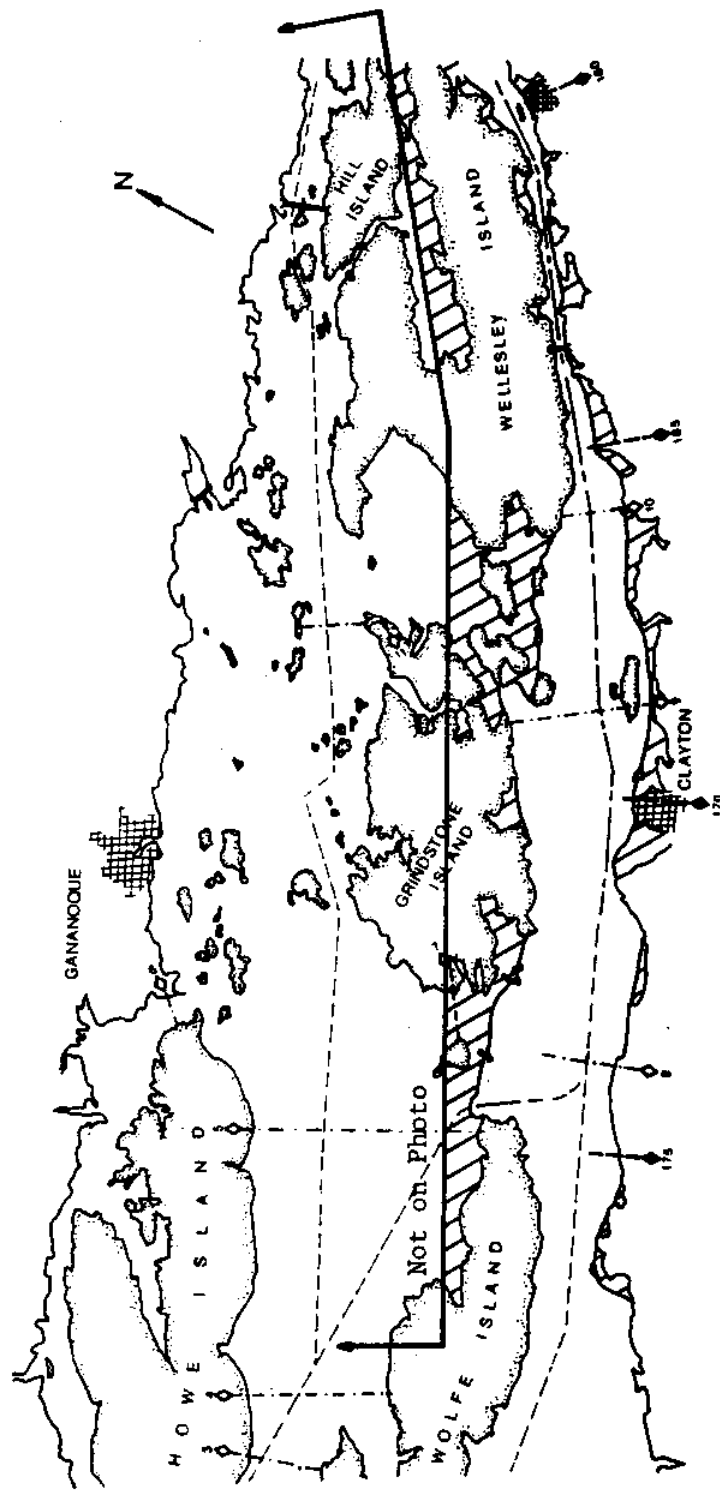
0 Scale of Miles 5

DATE Jan. 8, 1976



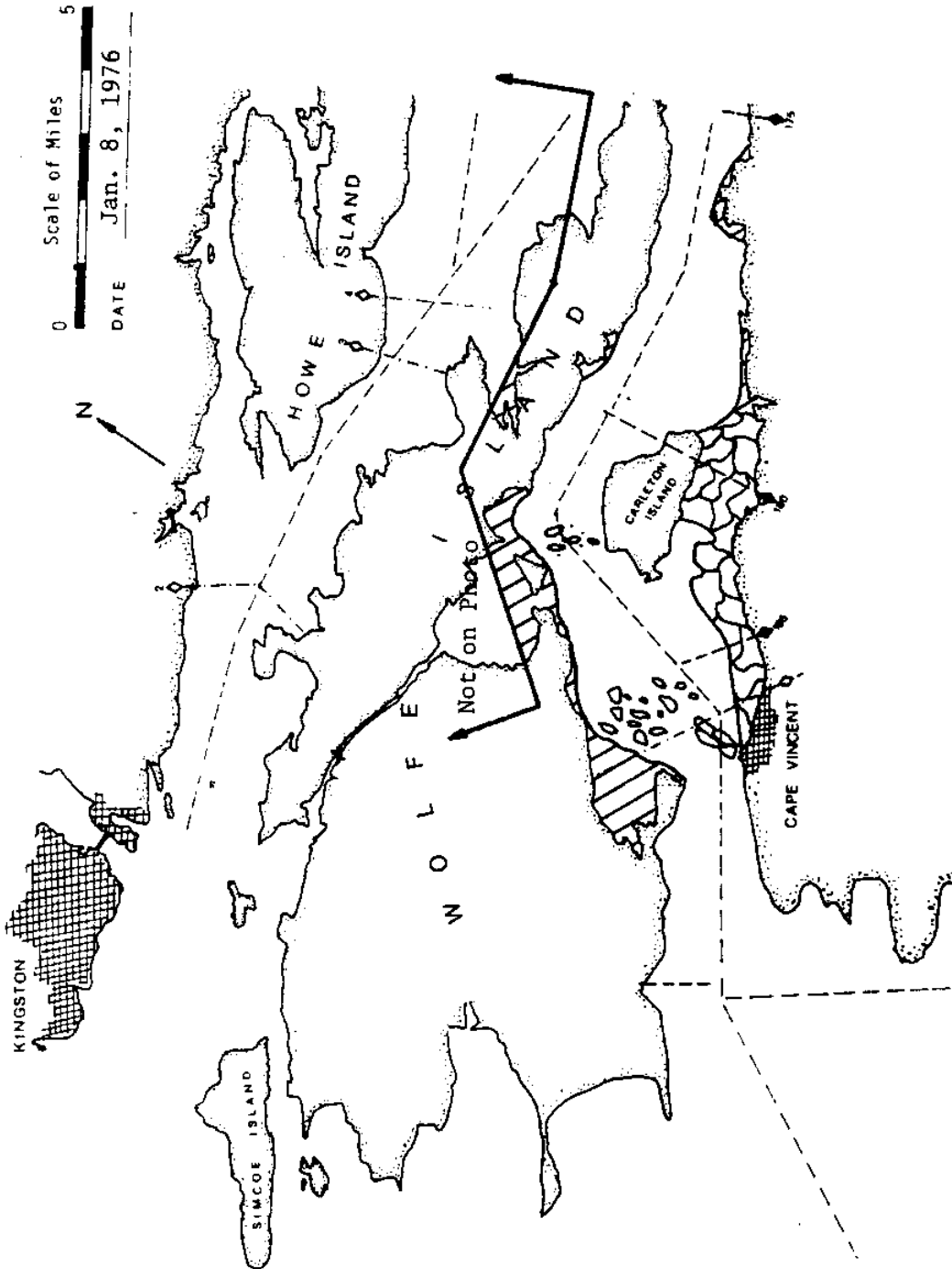
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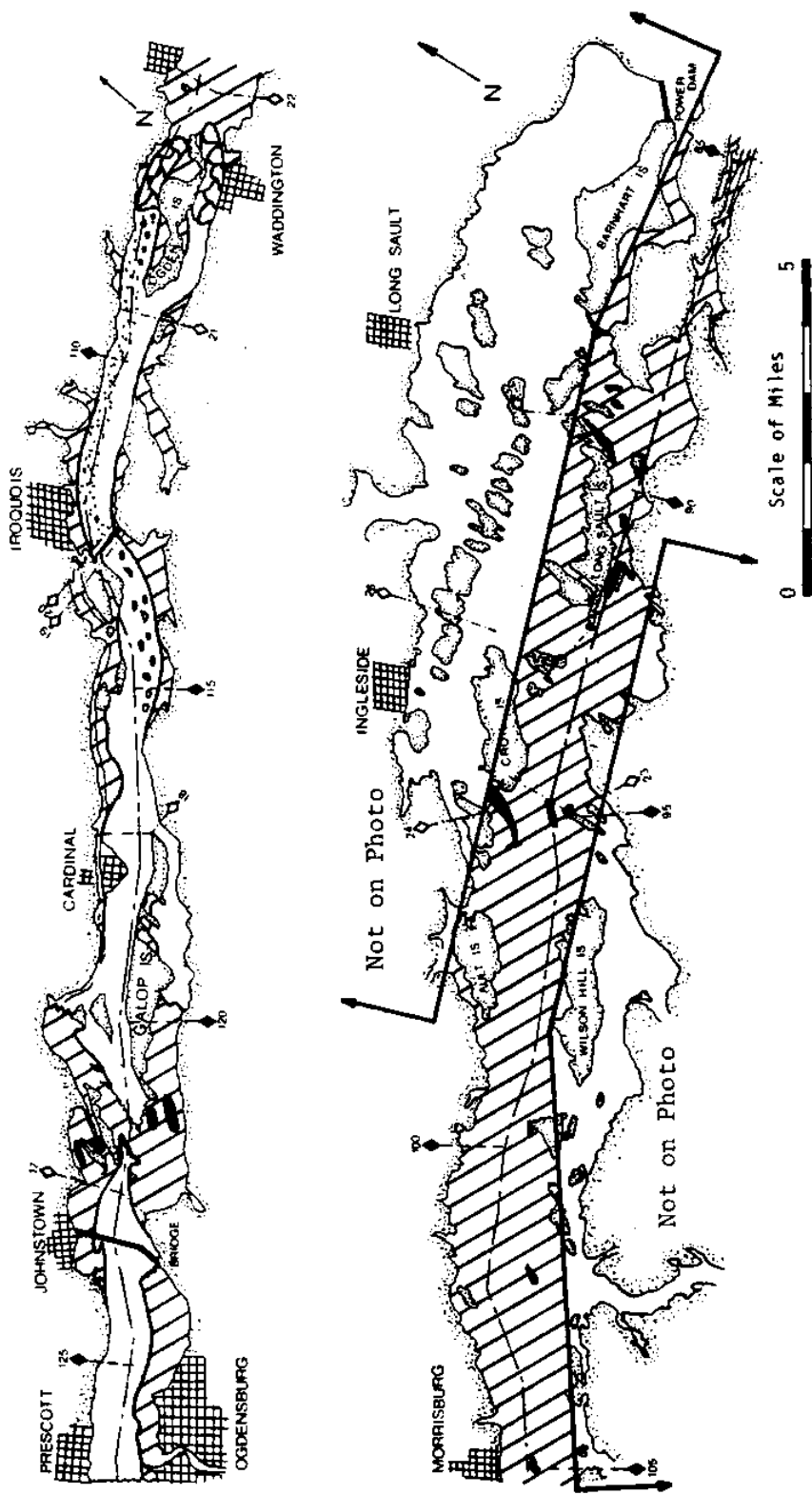
DATE Jan. 8, 1976

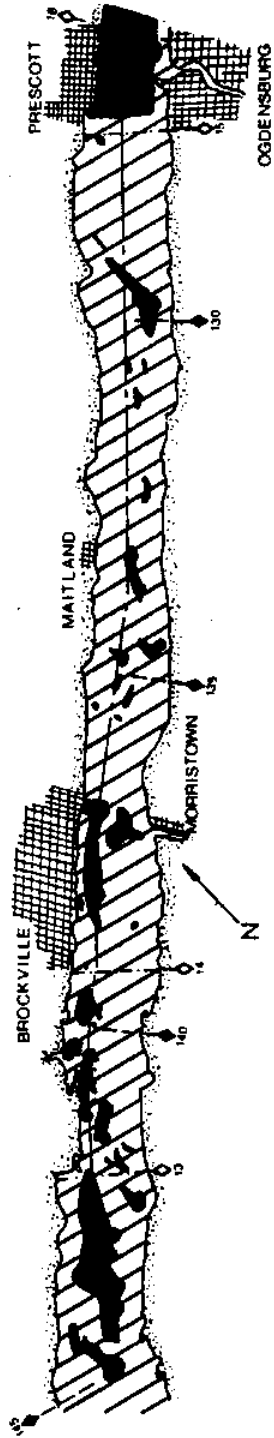
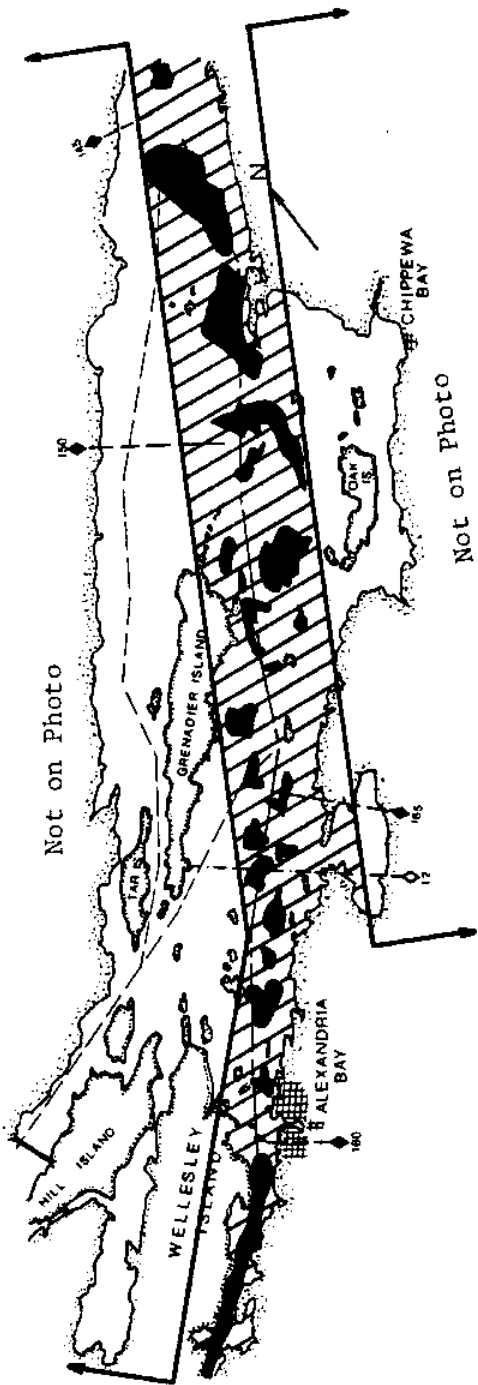


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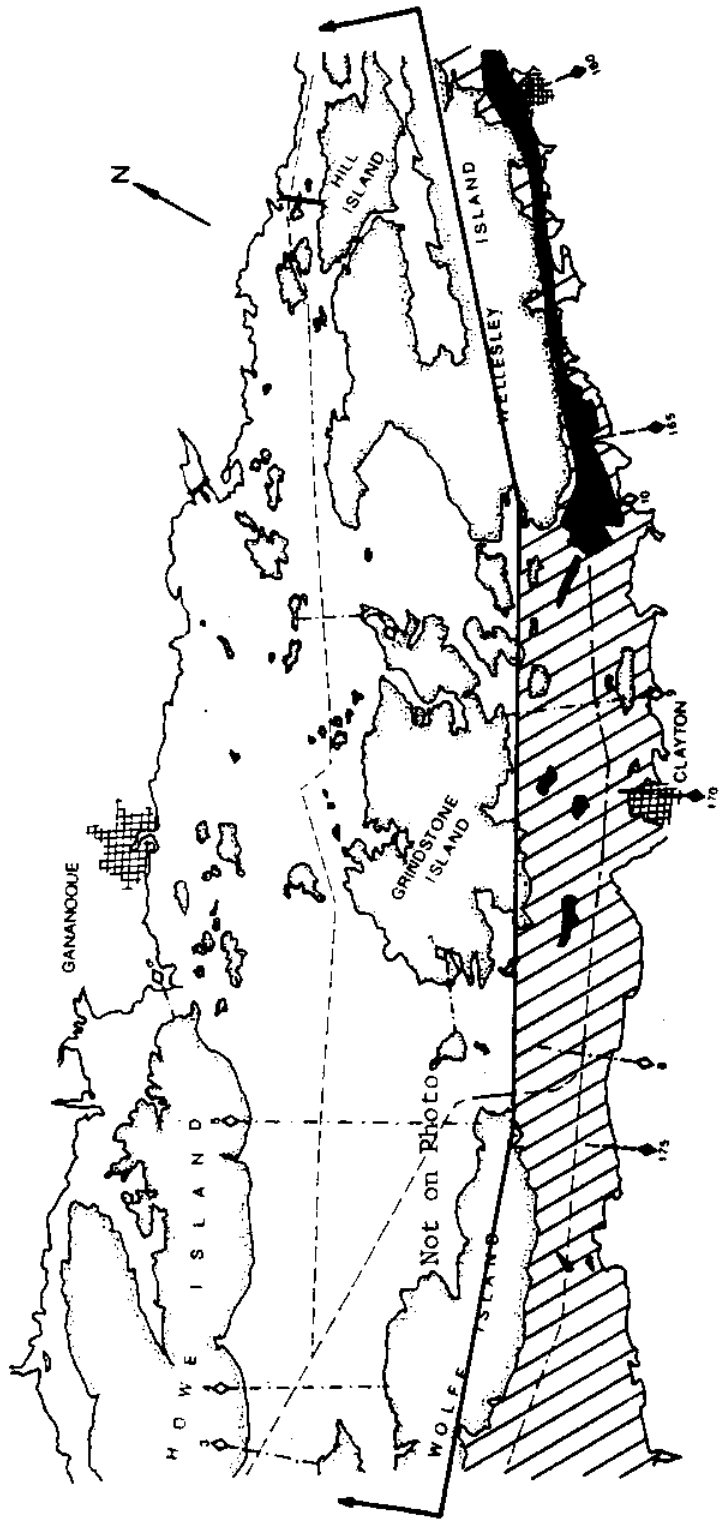
DATE Jan. 8, 1976





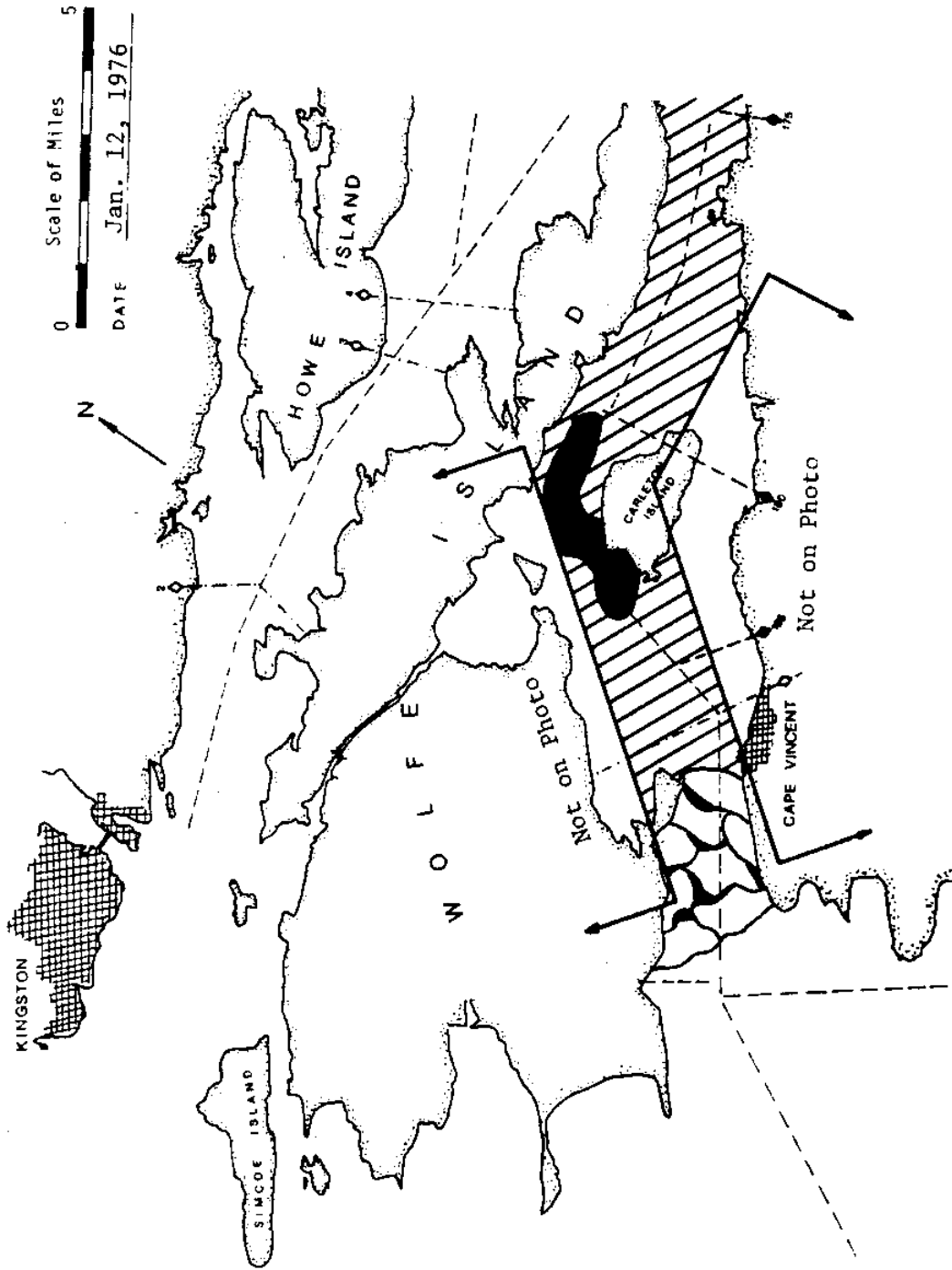


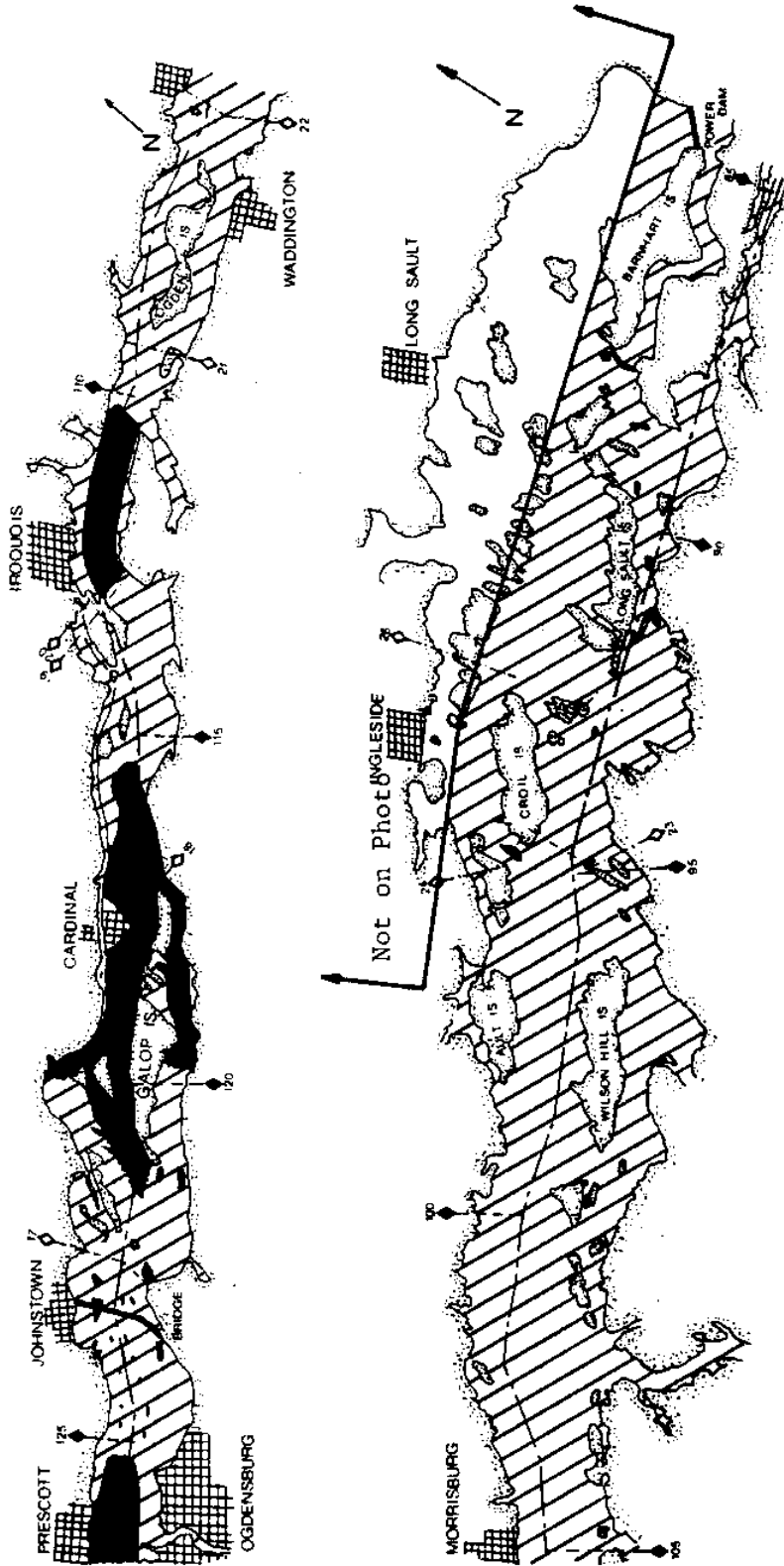
0 Scale of Miles 5
 DATE Jan. 12, 1976



0 Scale of Miles 5

DATE Jan. 12, 1976

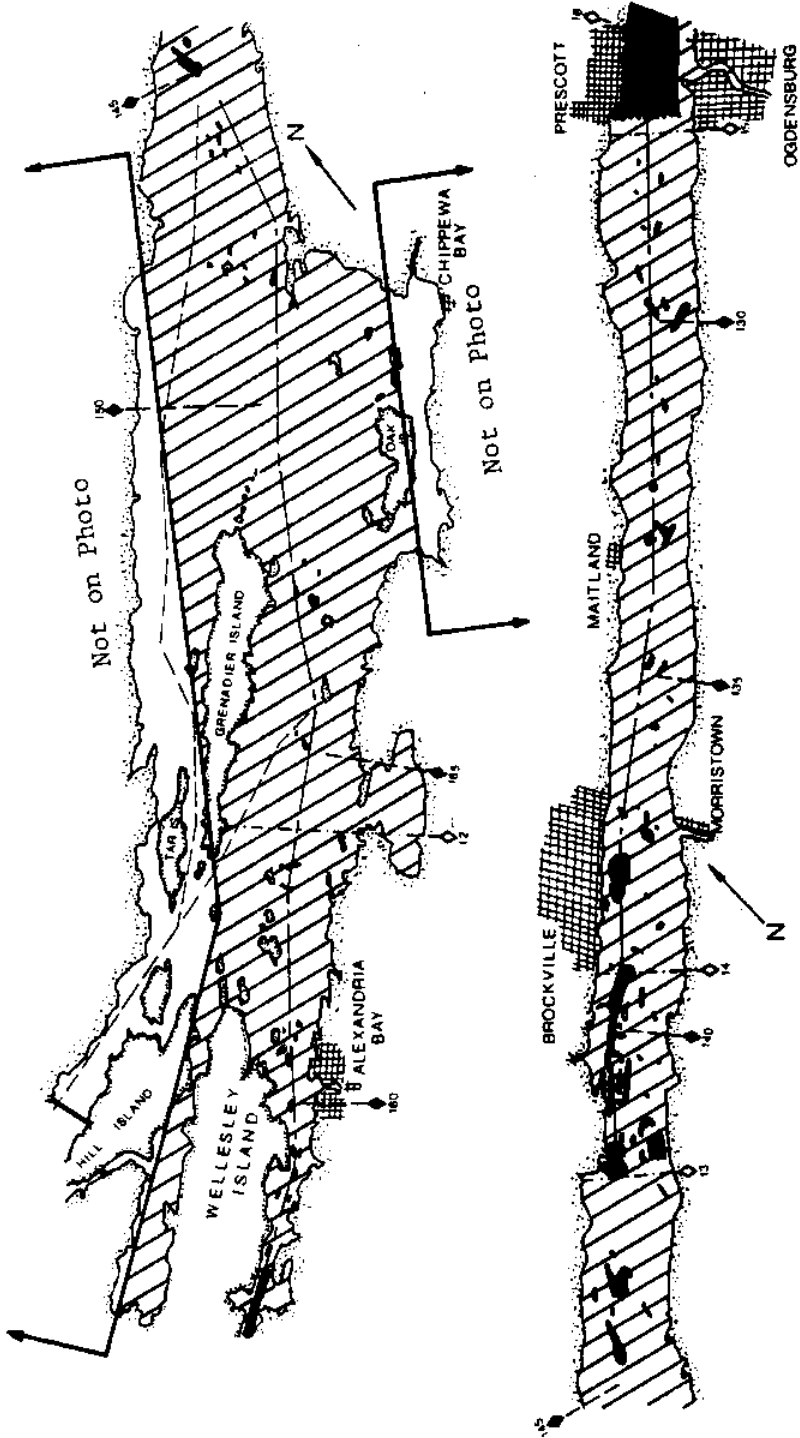


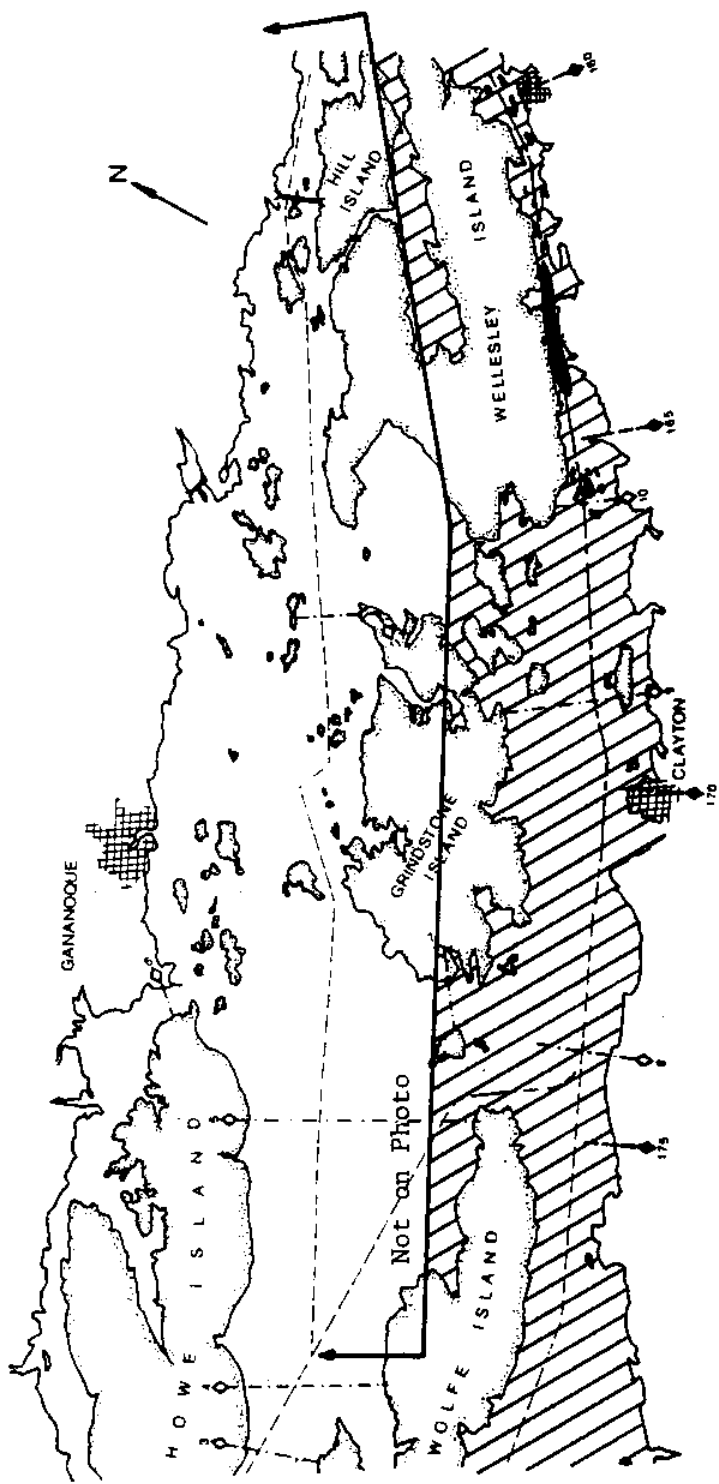


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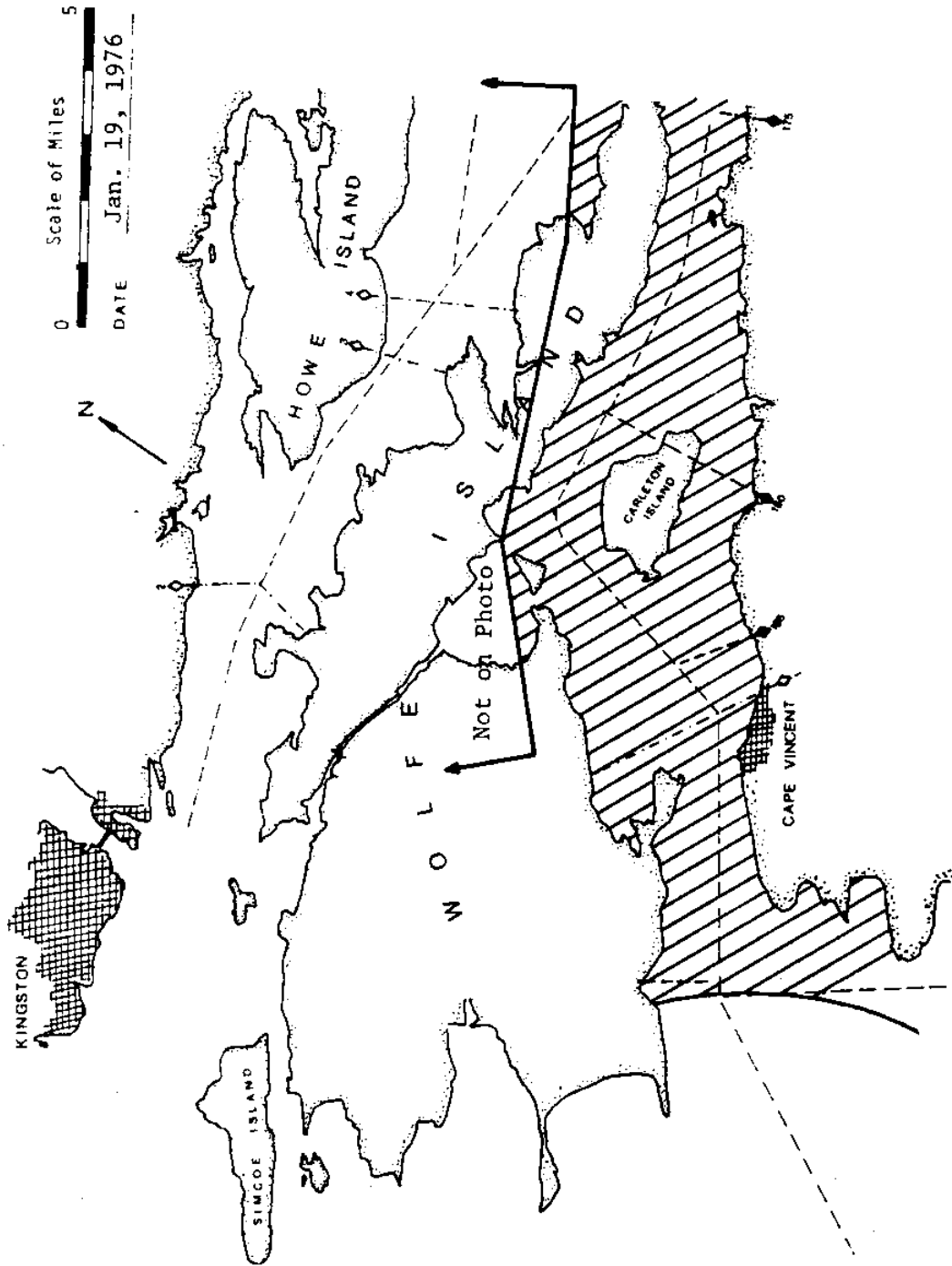
DATE Jan. 19, 1976

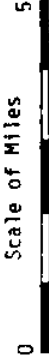
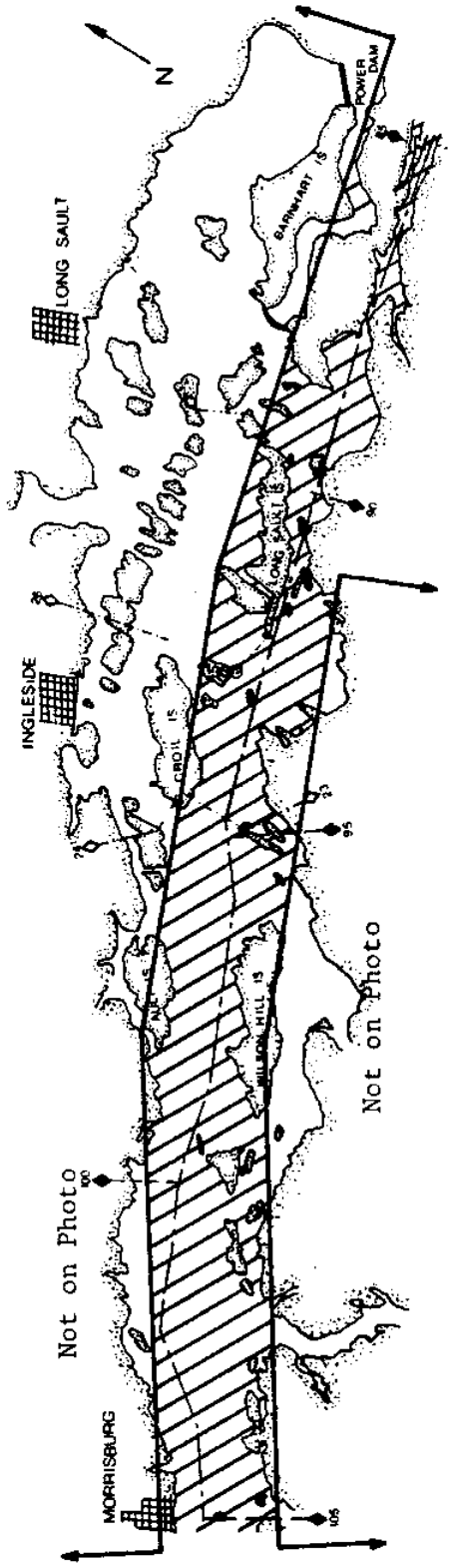
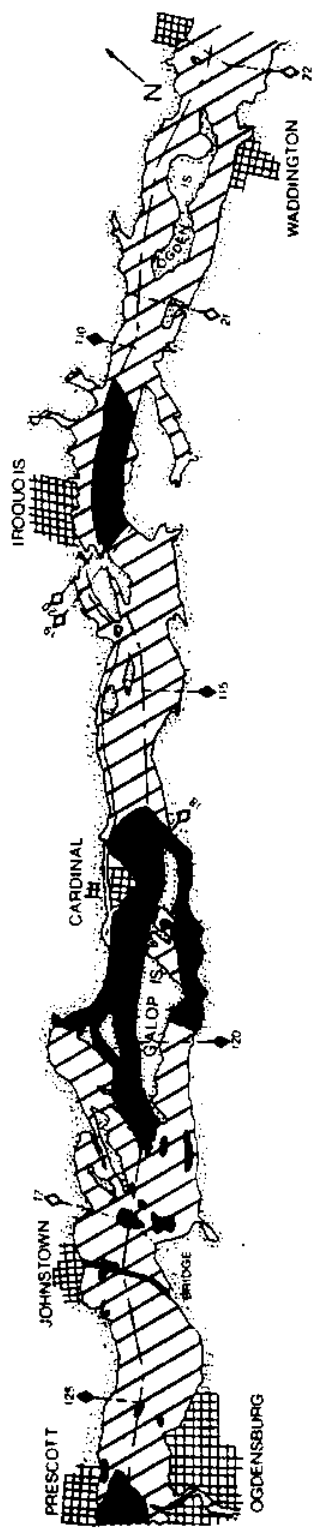
Not on Photogrammetric





DATE Jan. 19, 1976

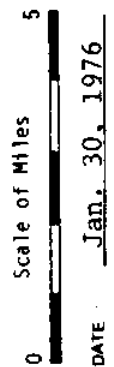
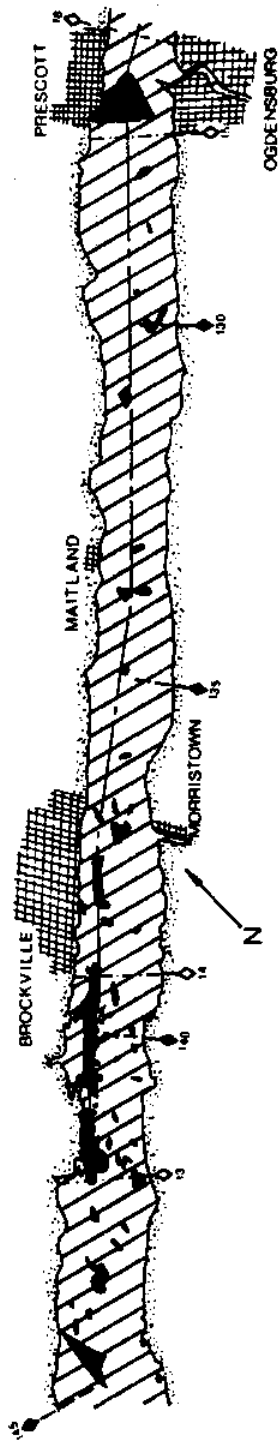
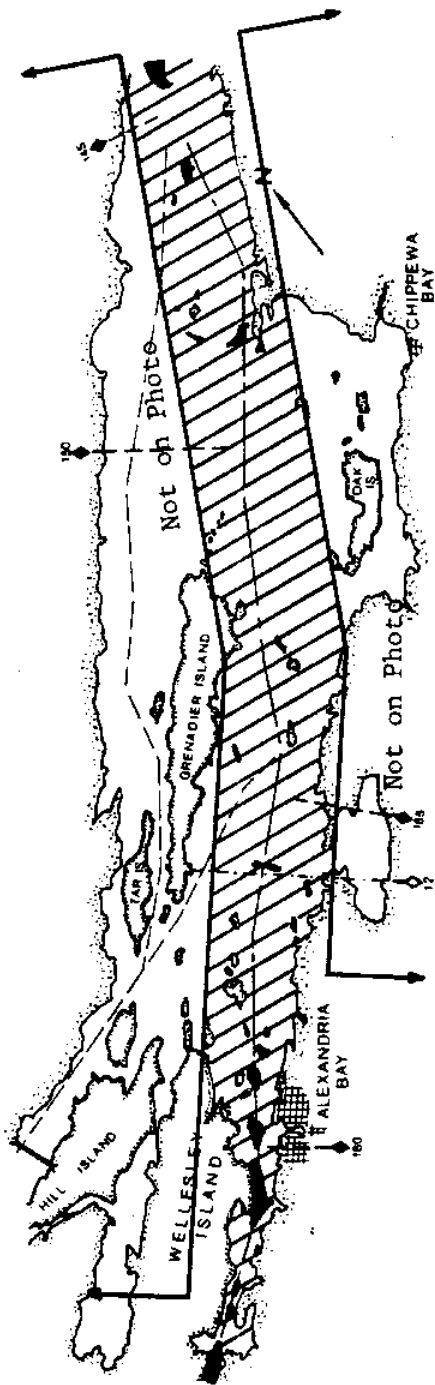


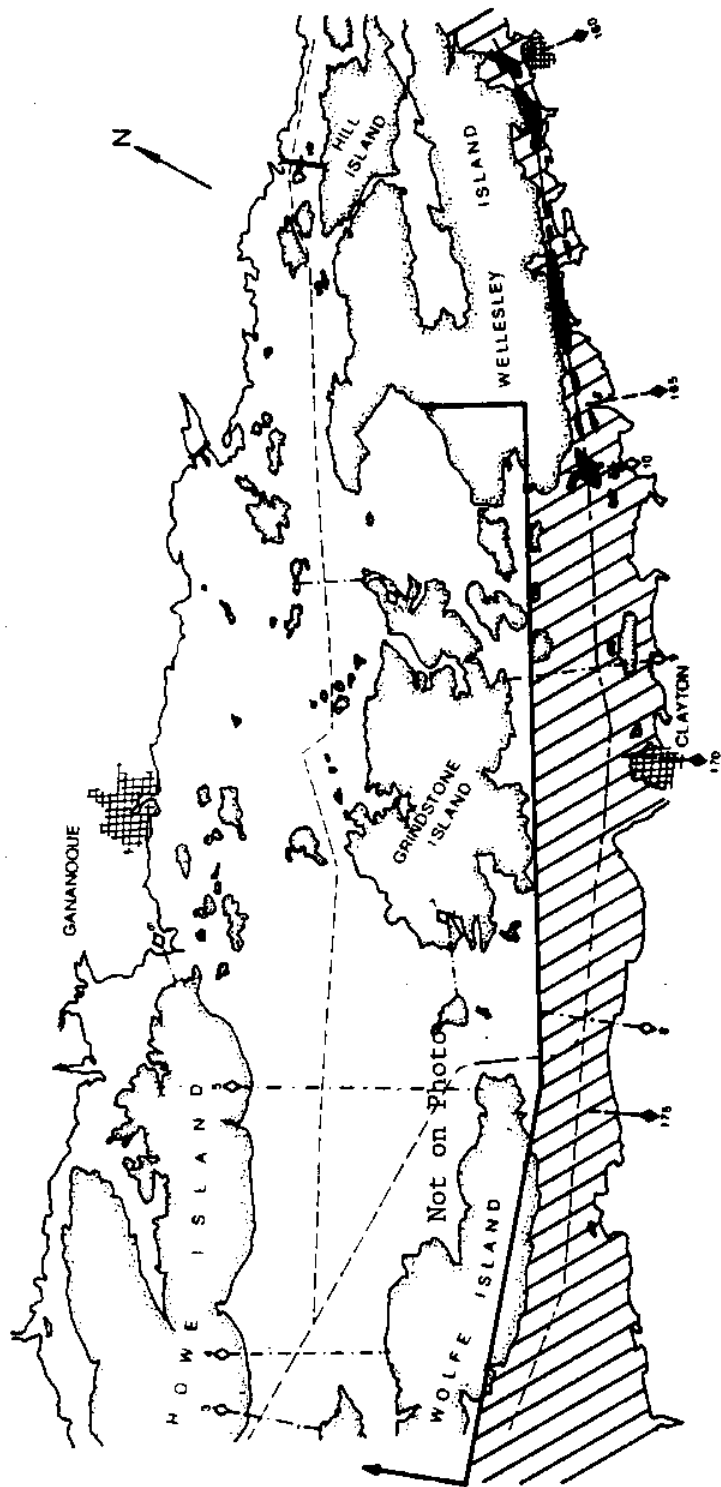


DATE Jan. 30, 1976

Not on Photo

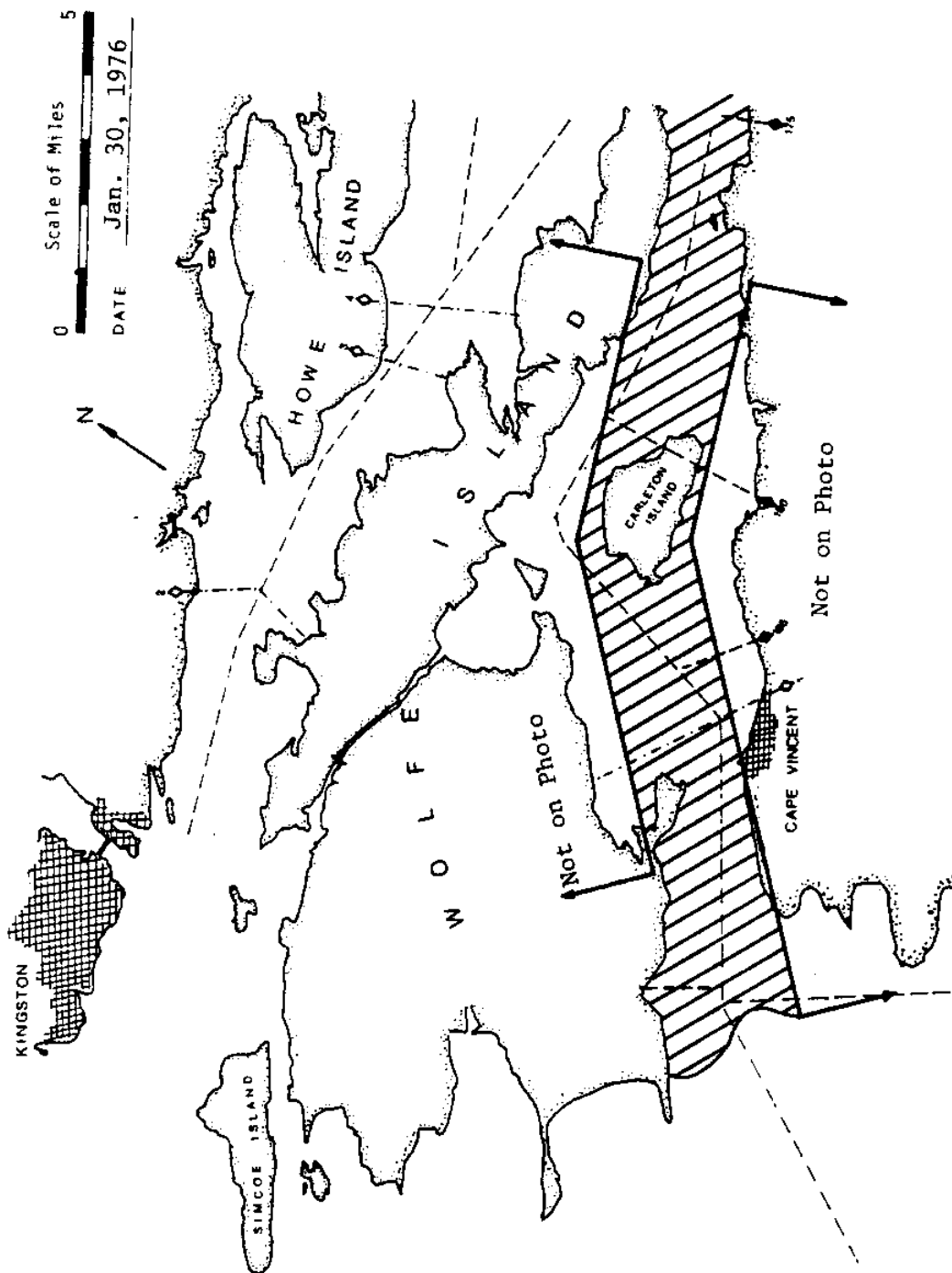
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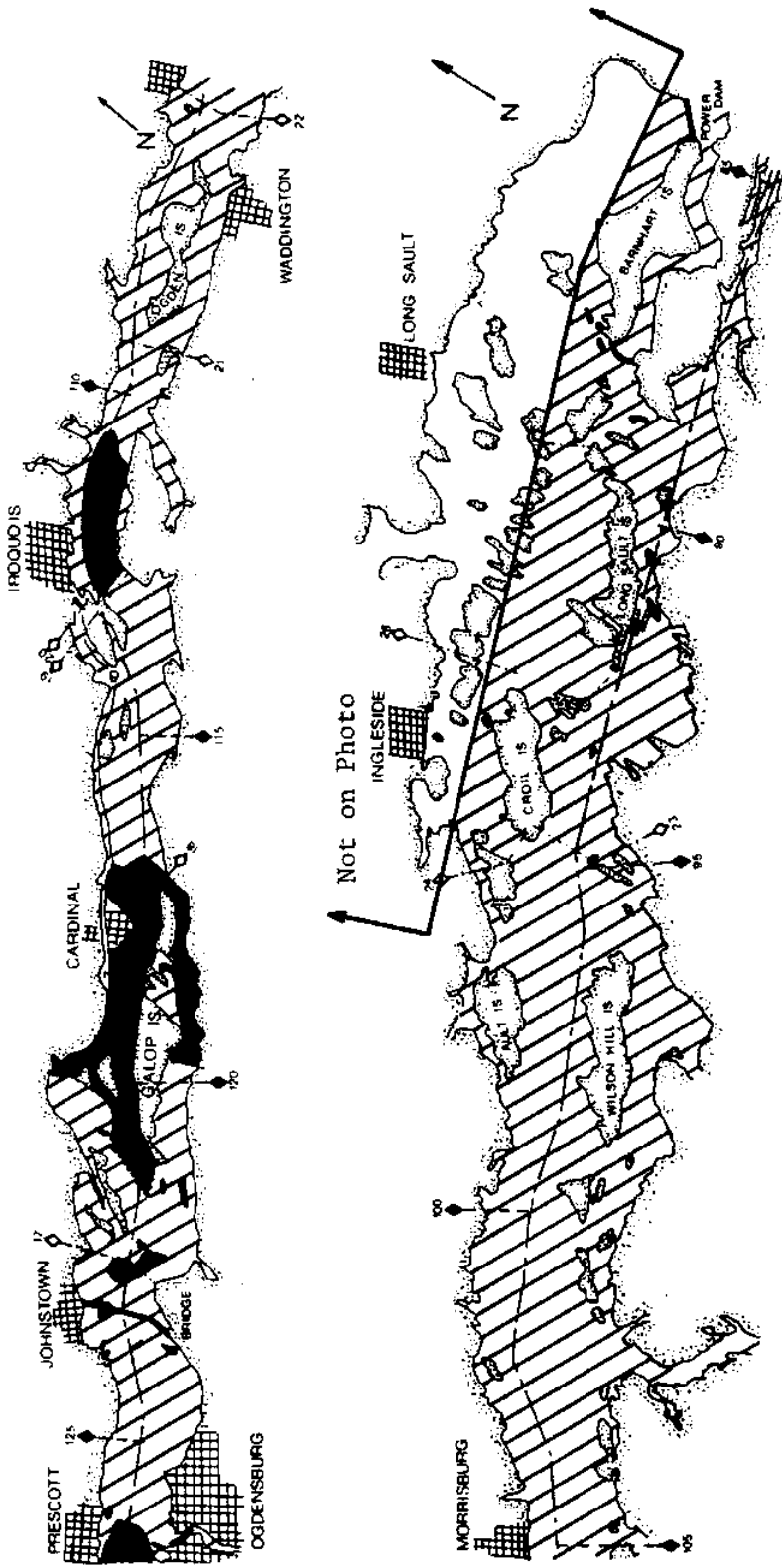




0 Scale of Miles 5

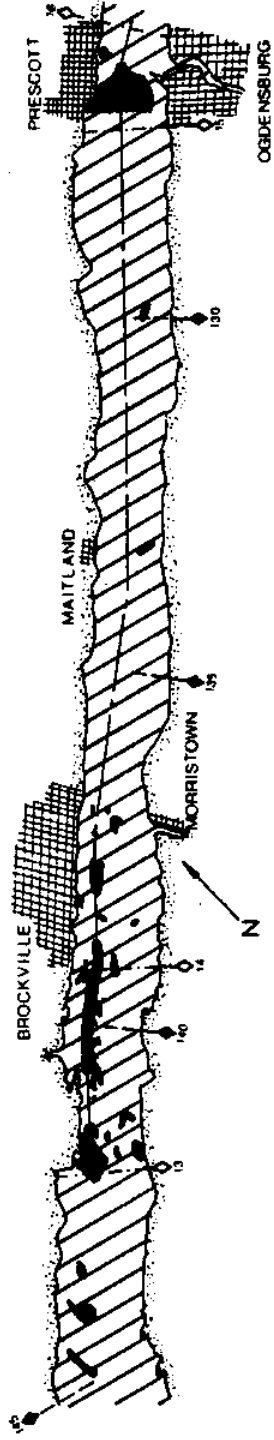
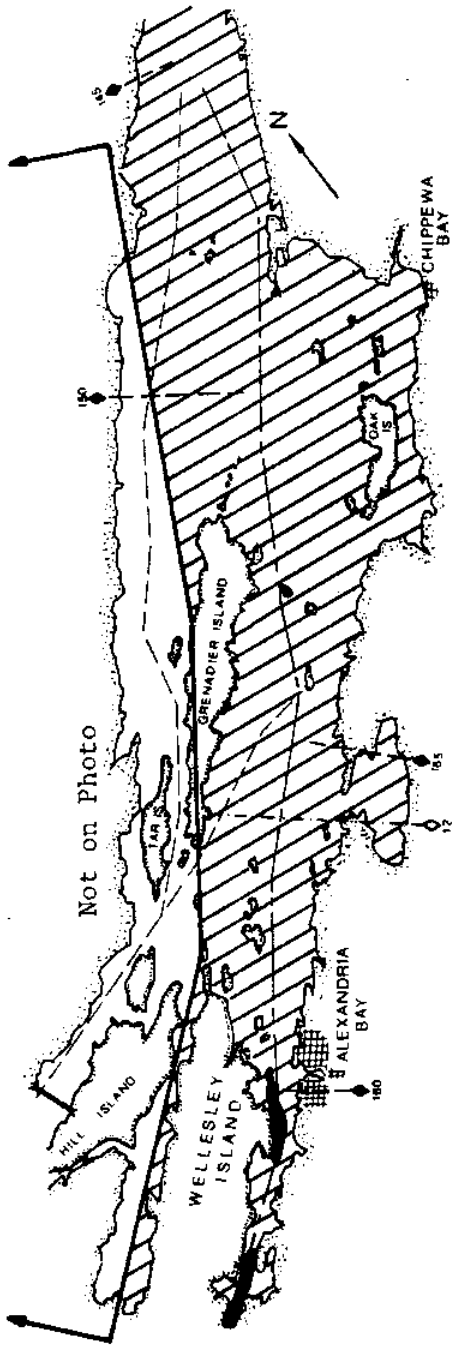
DATE Jan. 30, 1976



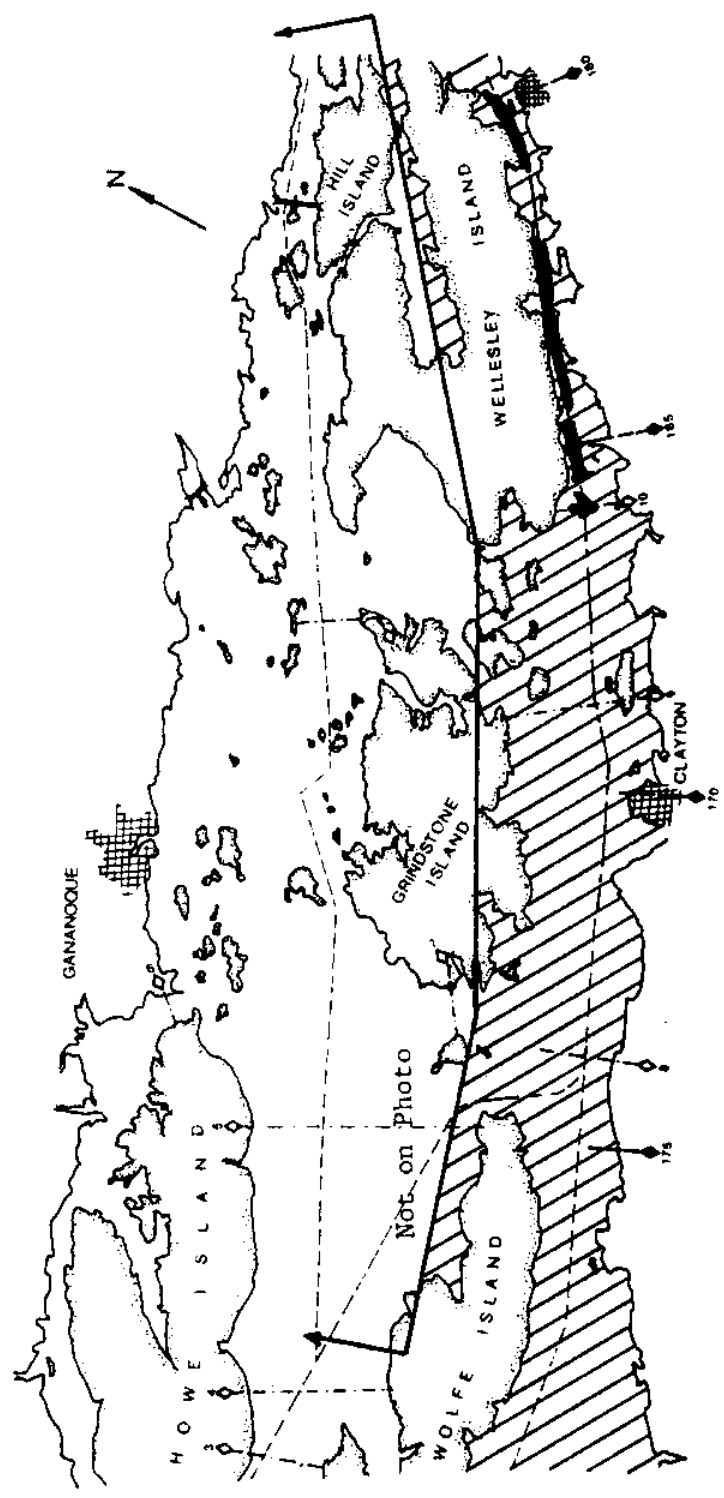


0 Scale of Miles 5

DATE Feb. 5, 1976

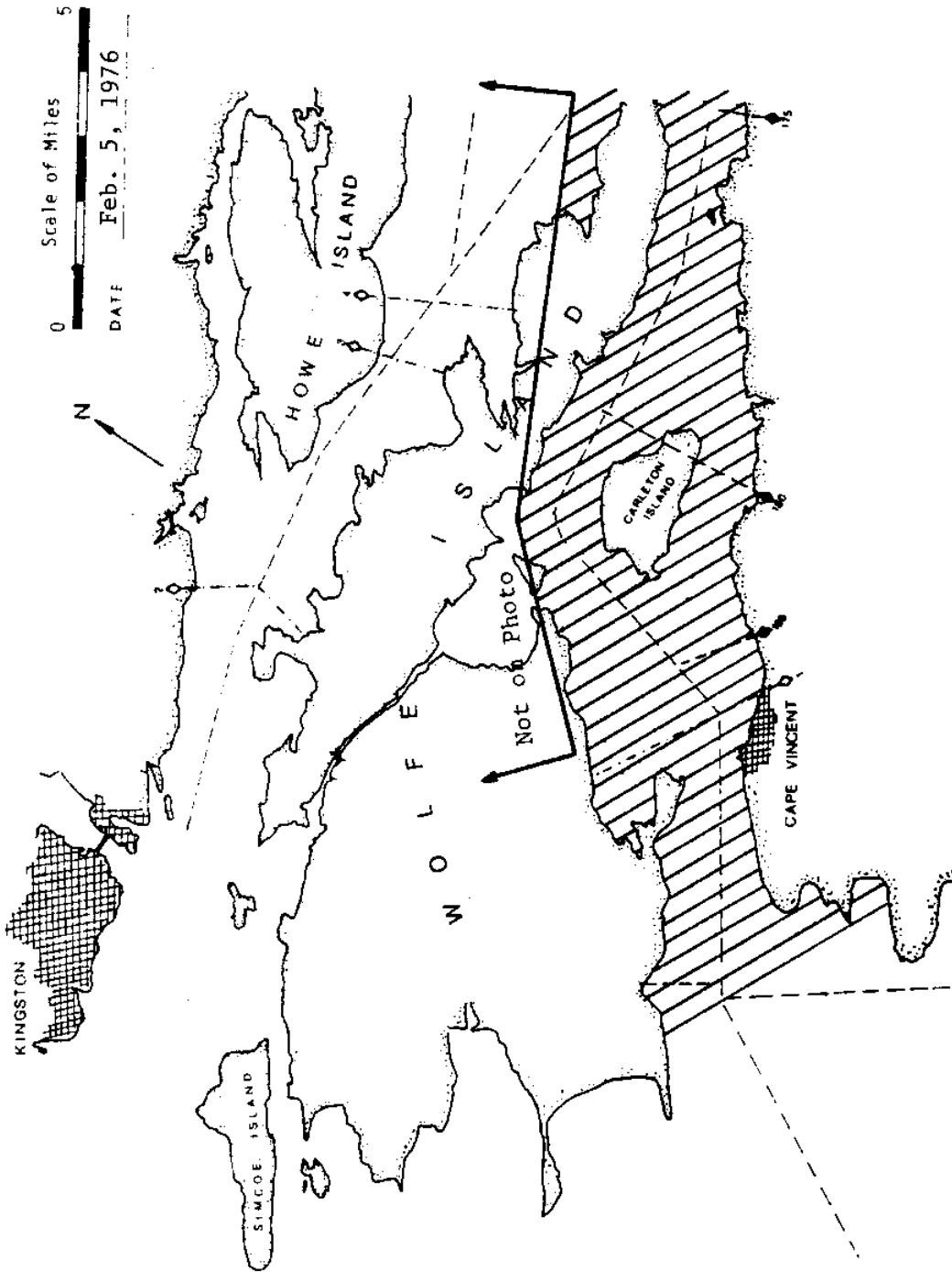


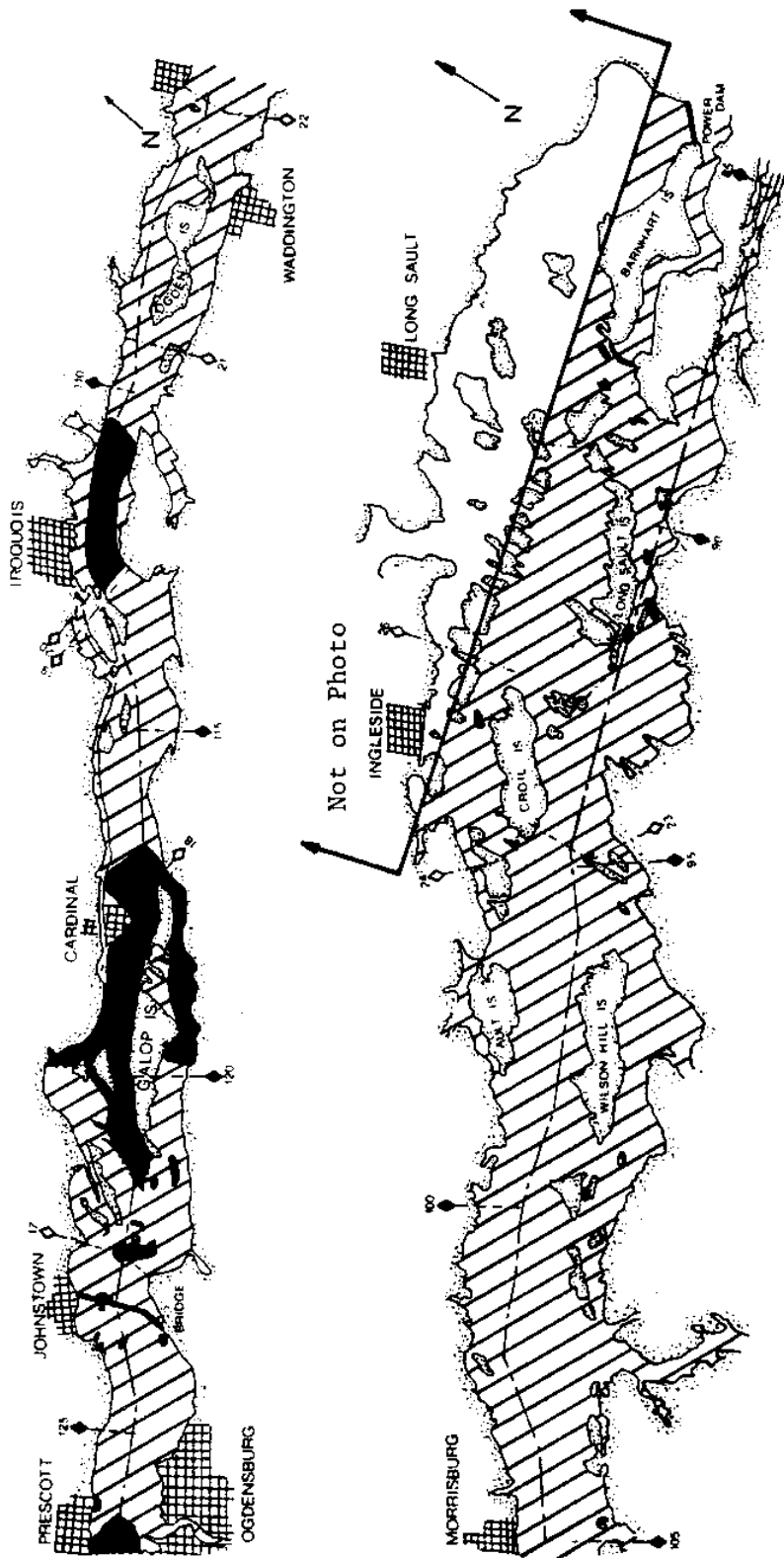
0 Scale of Miles 5
 DATE Feb. 5, 1976



Scale of Miles 0 5

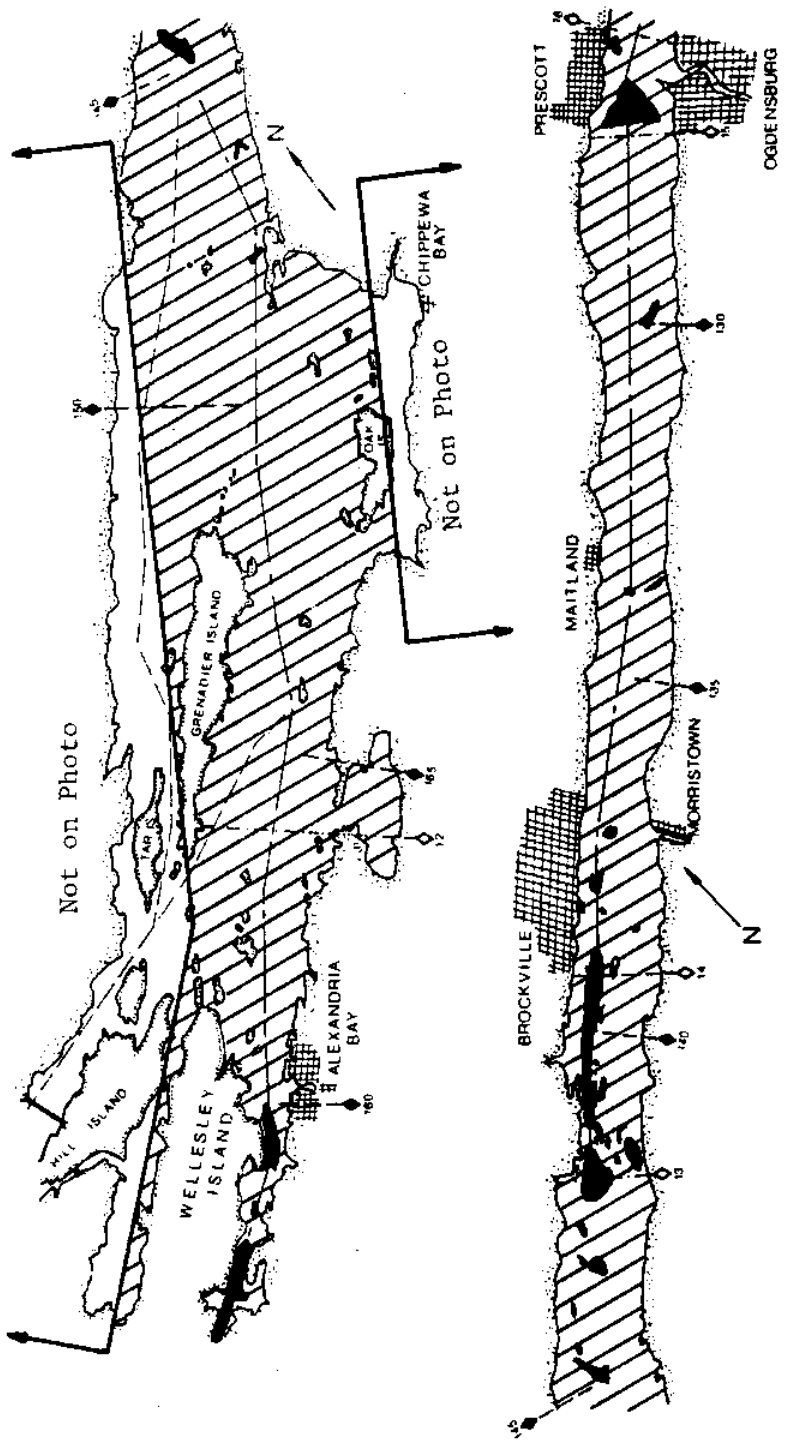
DATE: Feb. 5, 1976



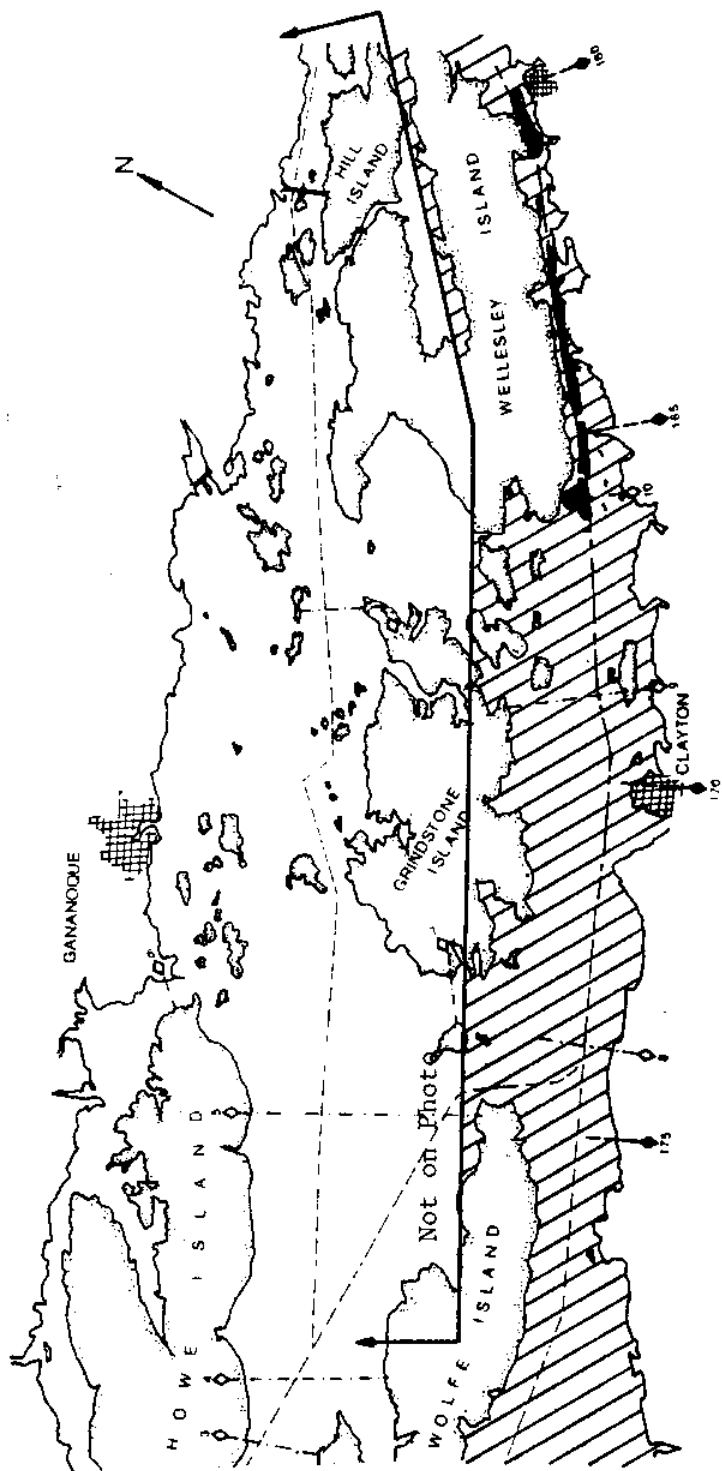


0 Scale of Miles 5

DATE Feb. 9, 1976

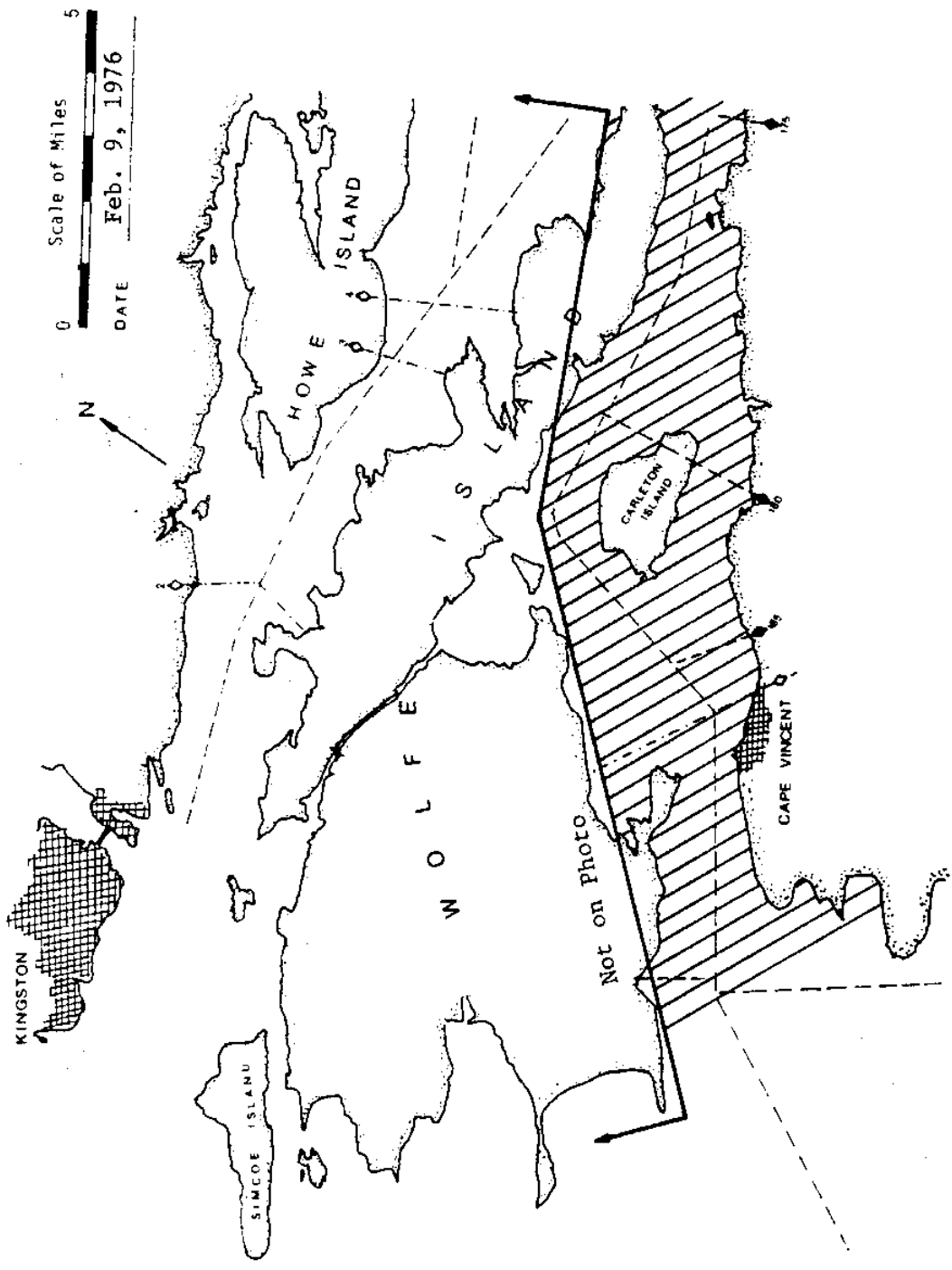


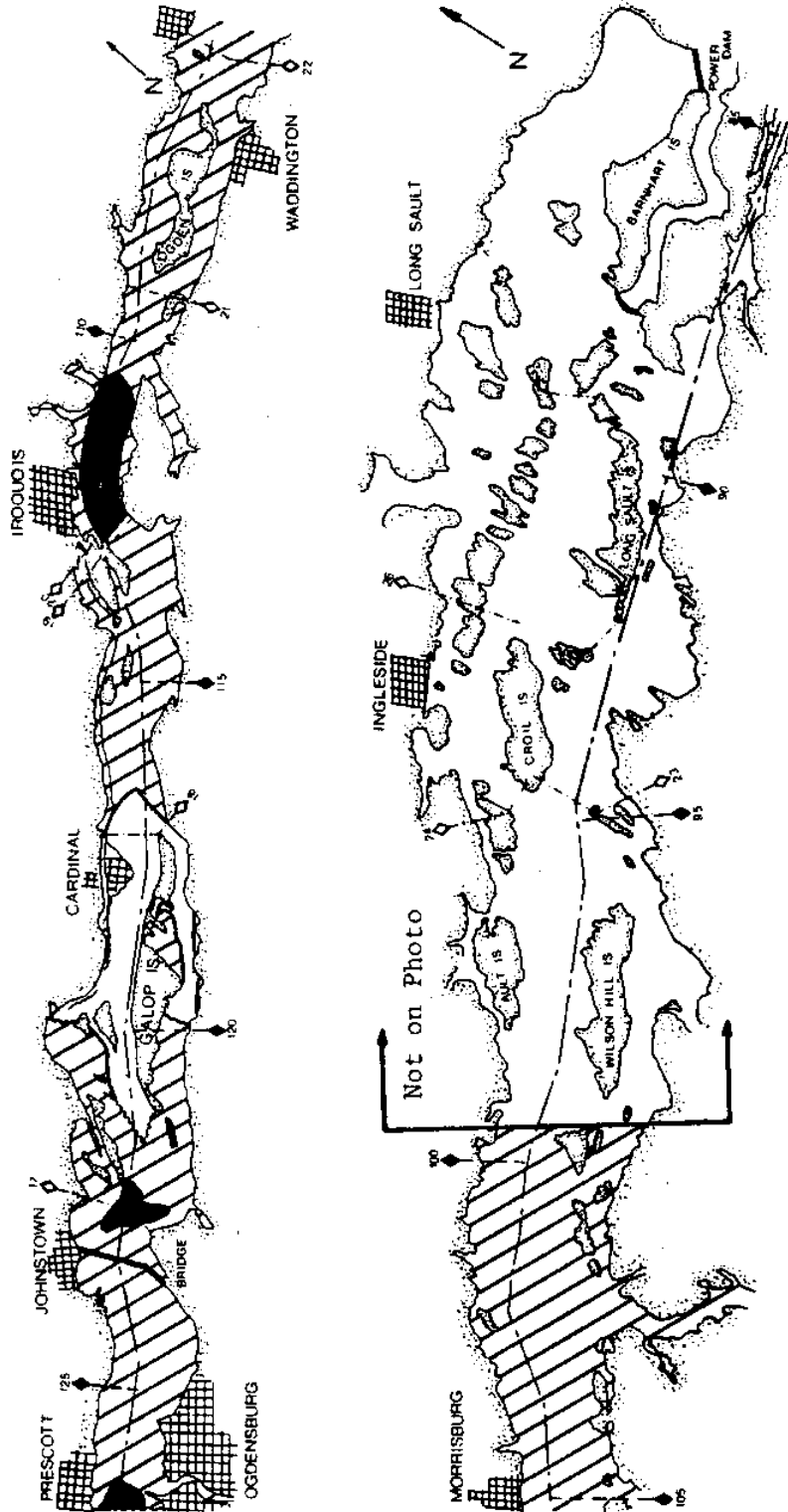
0 5
 Scale of Miles
 DATE Feb. 9, 1976



0 Scale of Miles 5

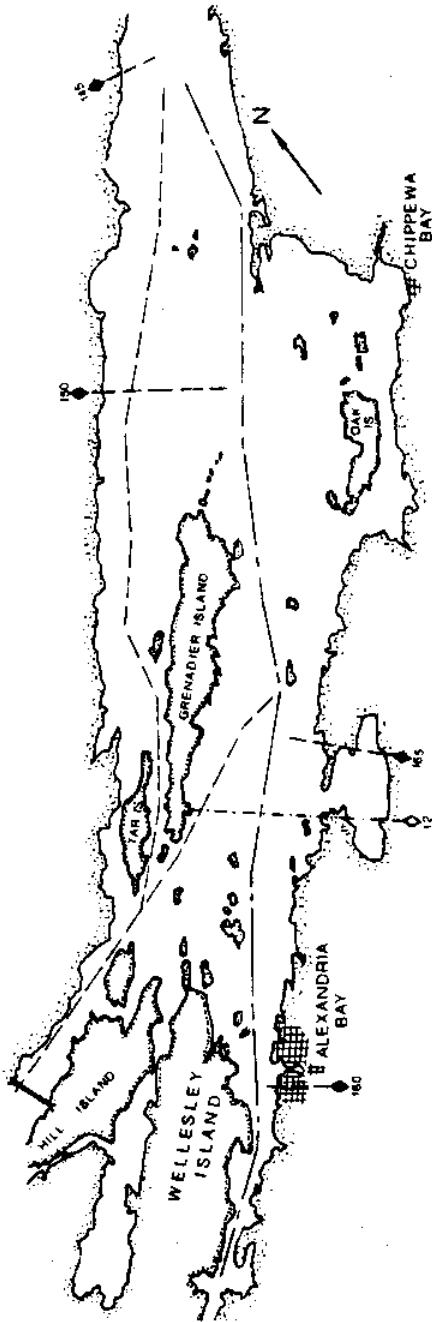
DATE Feb. 9, 1976



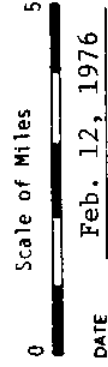
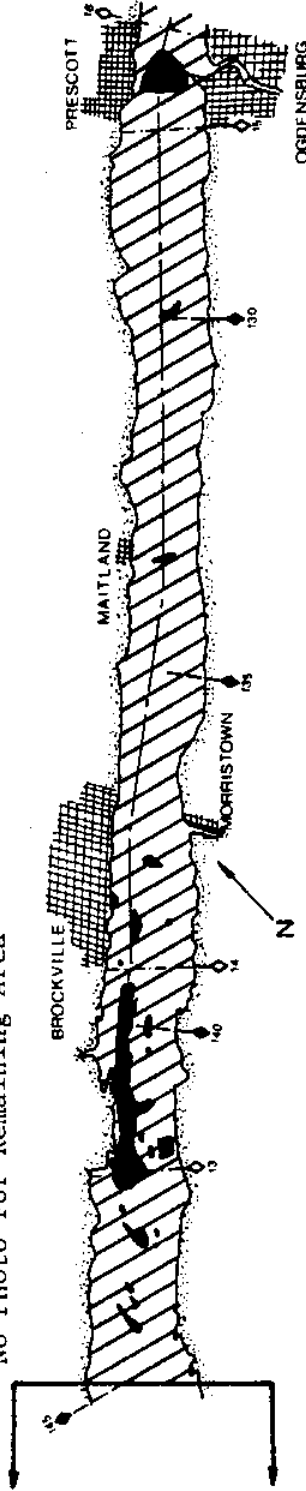


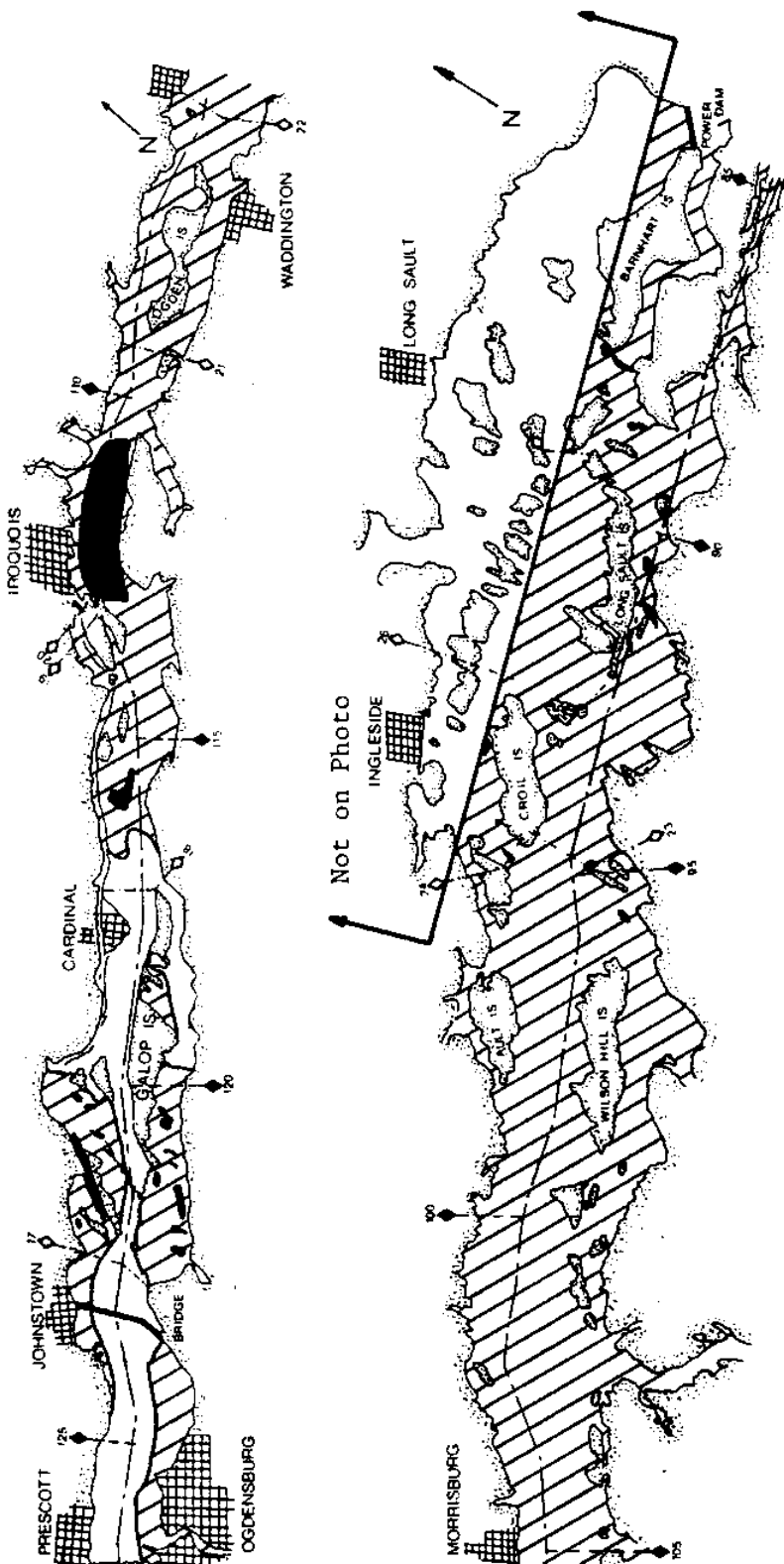
0 Scale of Miles 5

DATE Feb. 12, 1976



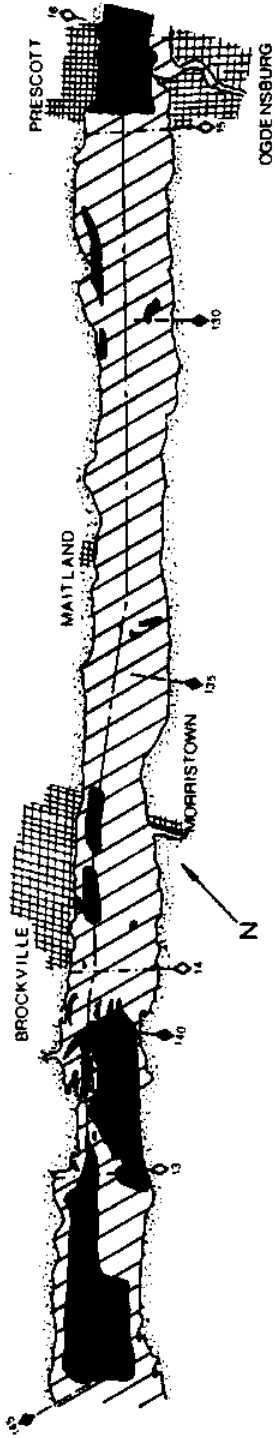
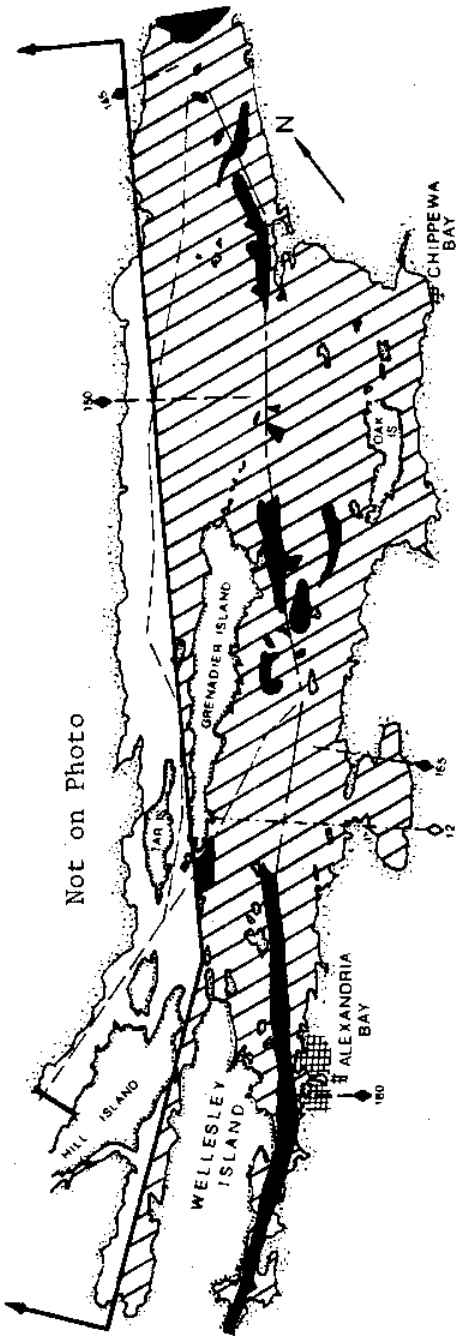
No Photo For Remaining Area

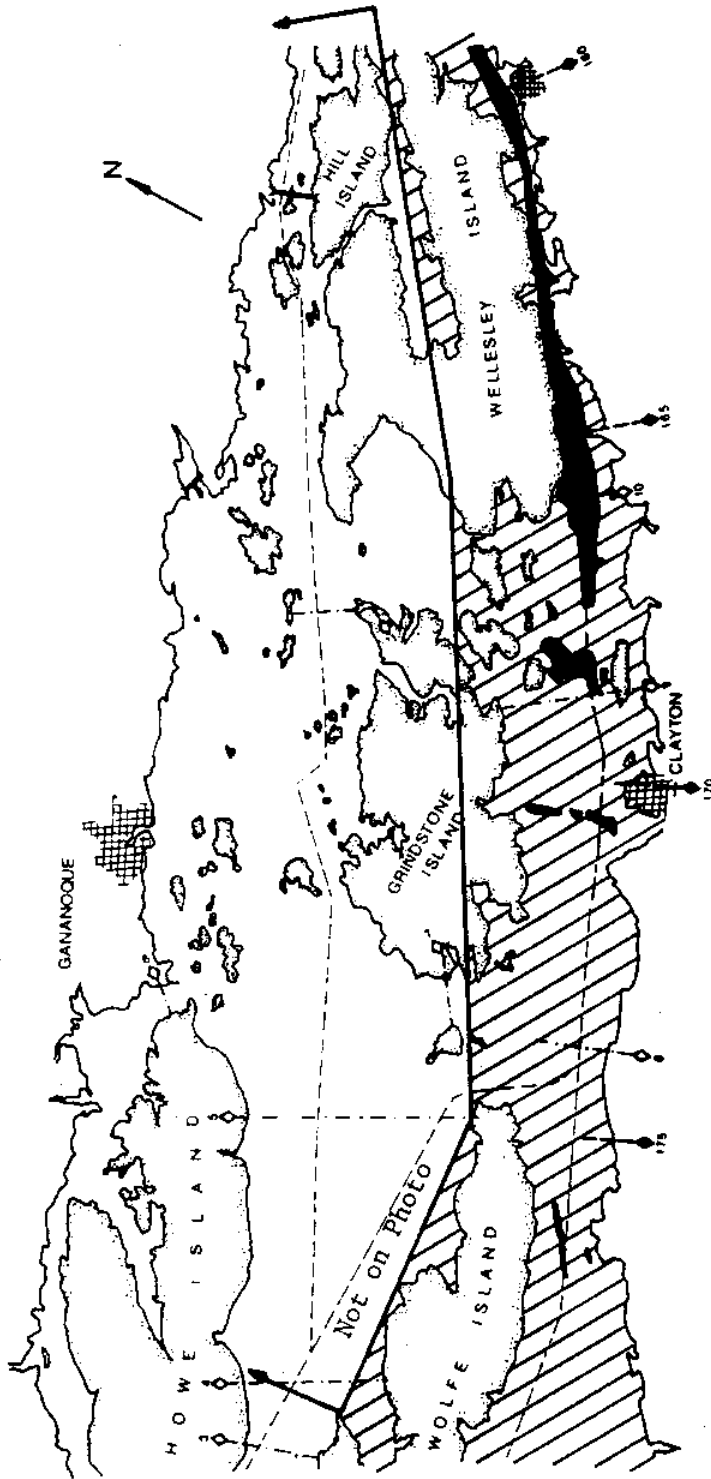




0 Scale of Miles 5

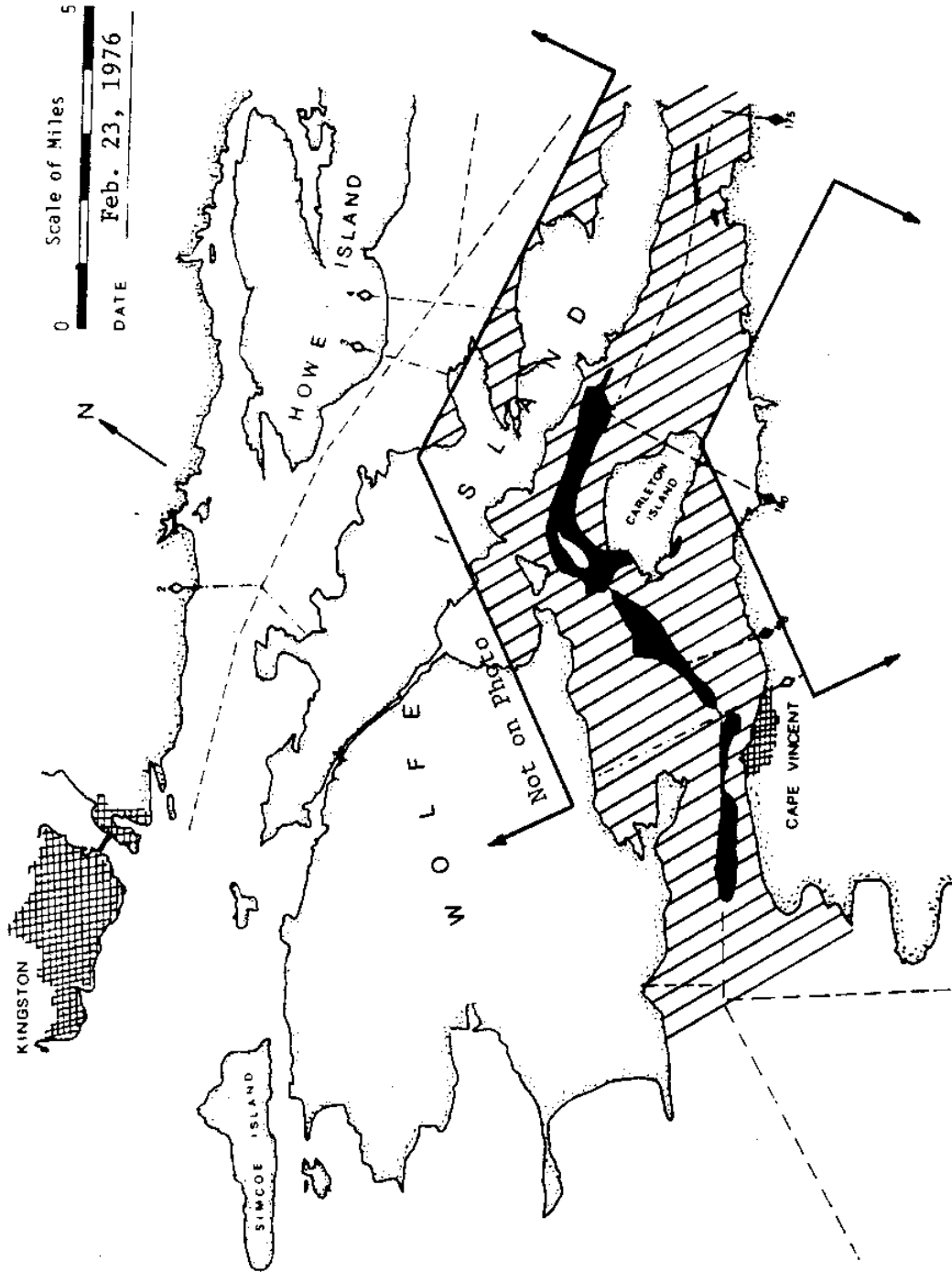
DATE Feb. 23, 1976

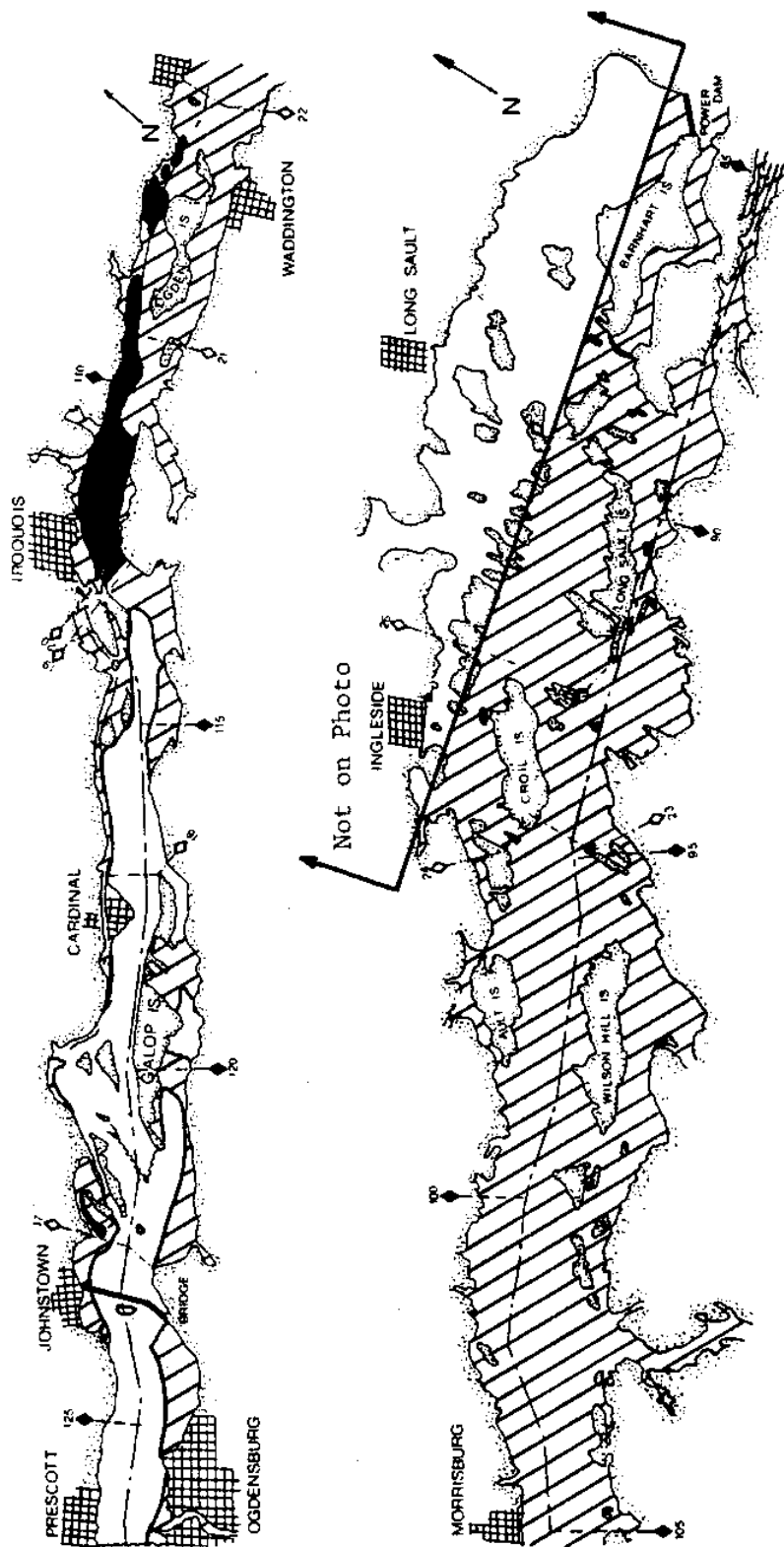




0 Scale of Miles 5

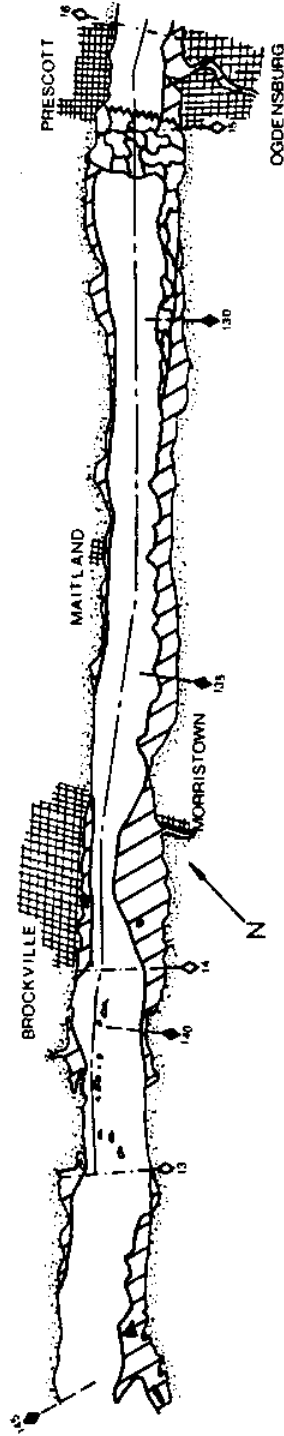
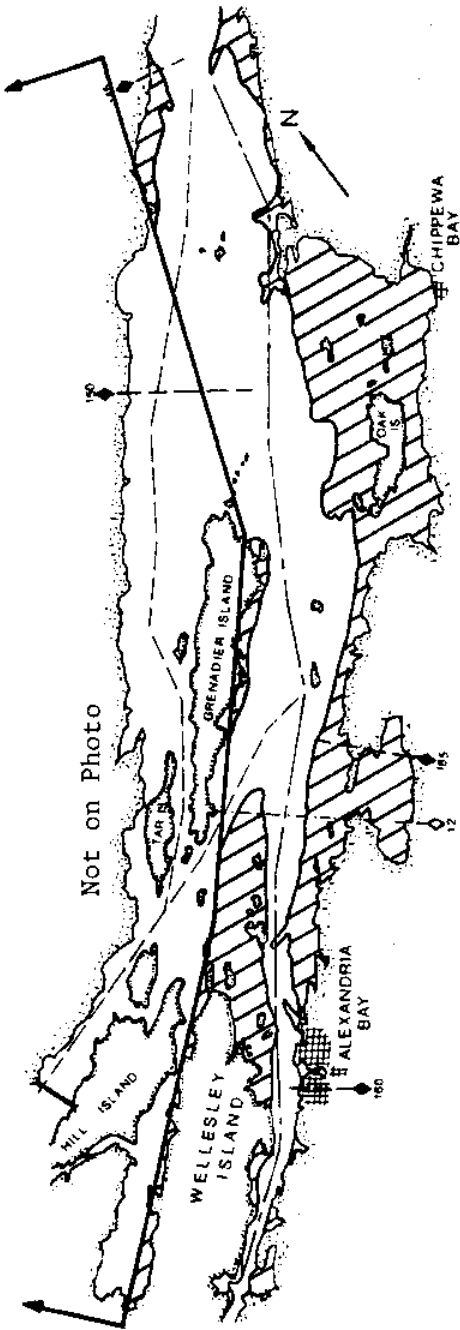
DATE Feb. 23, 1976





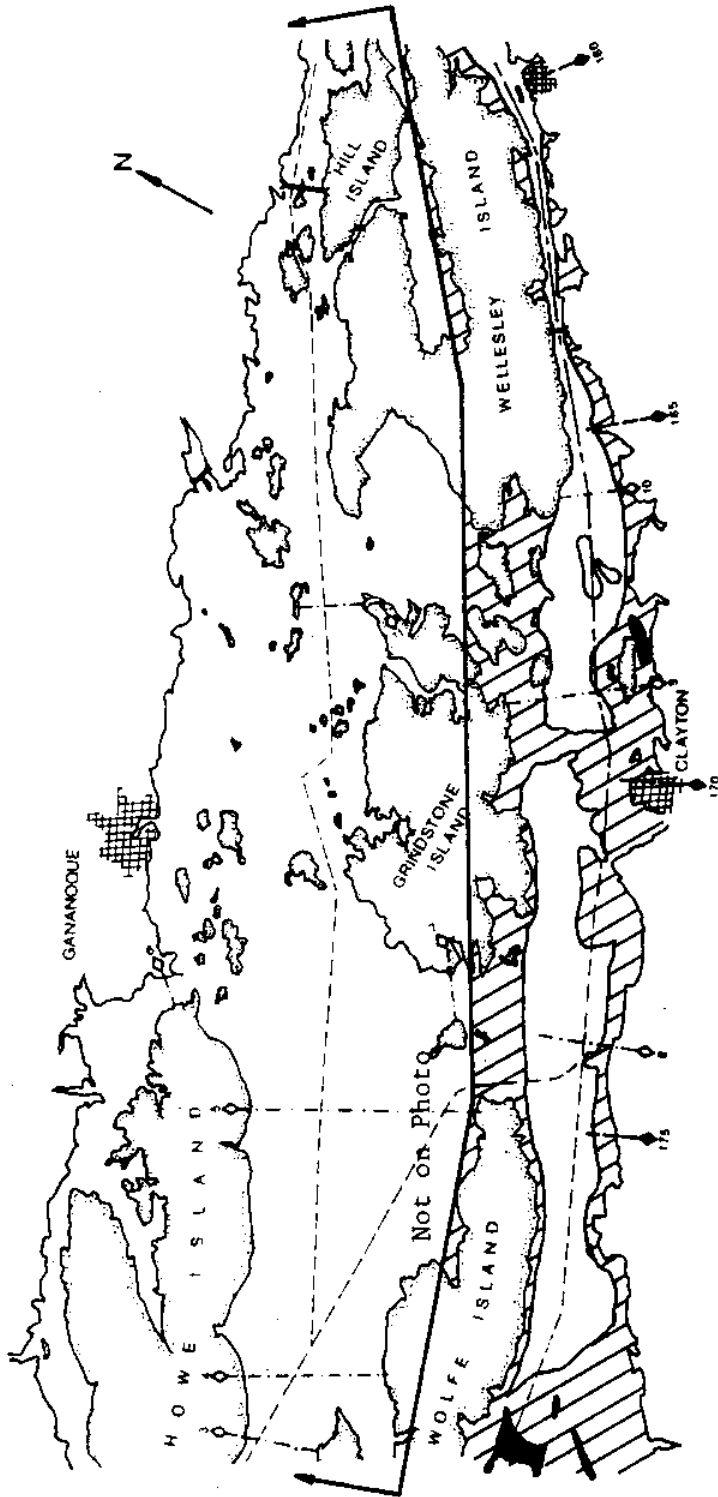
0 Scale of Miles 5

DATE Mar. 1, 1976



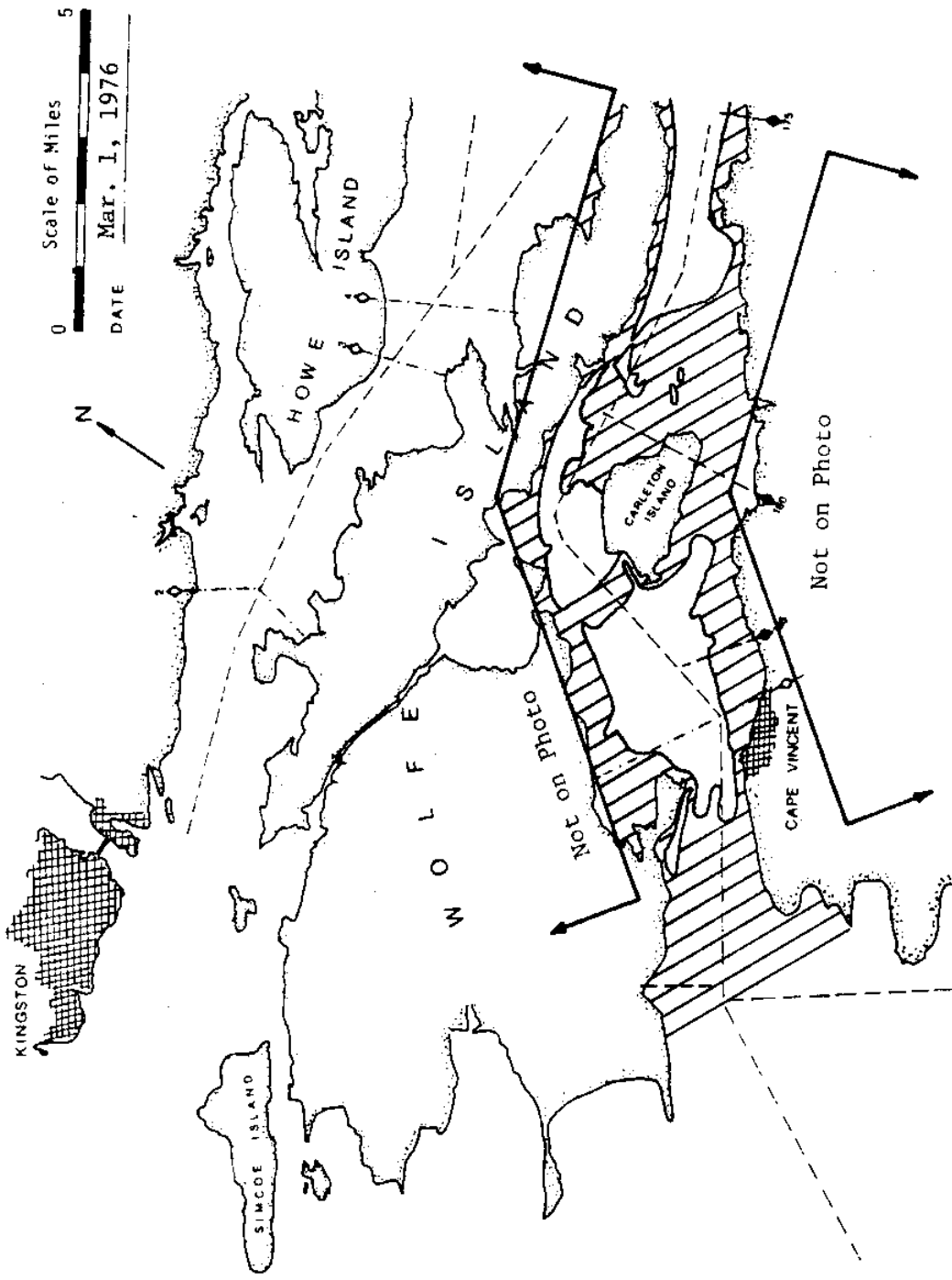
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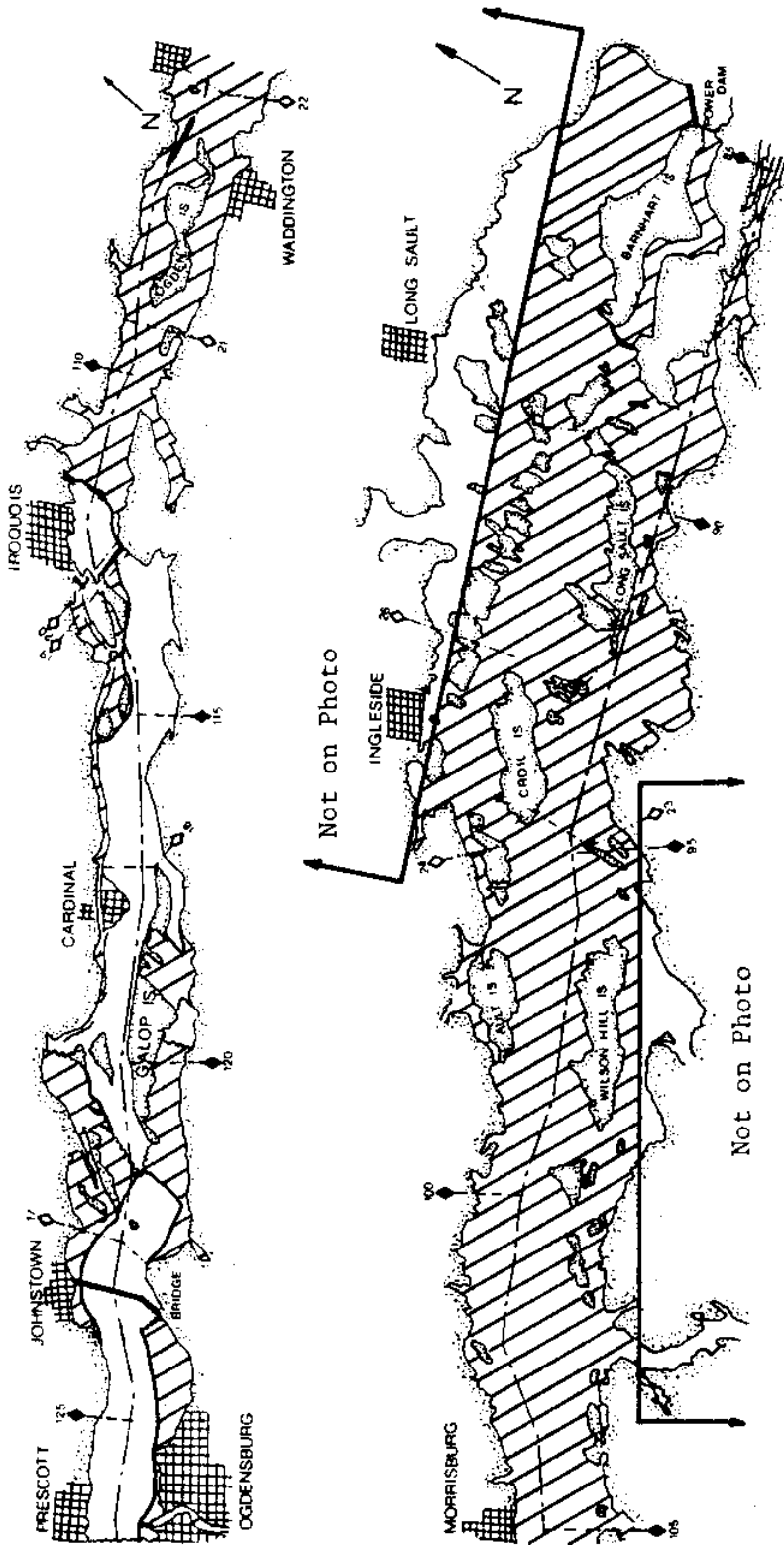
DATE Mar. 1, 1976

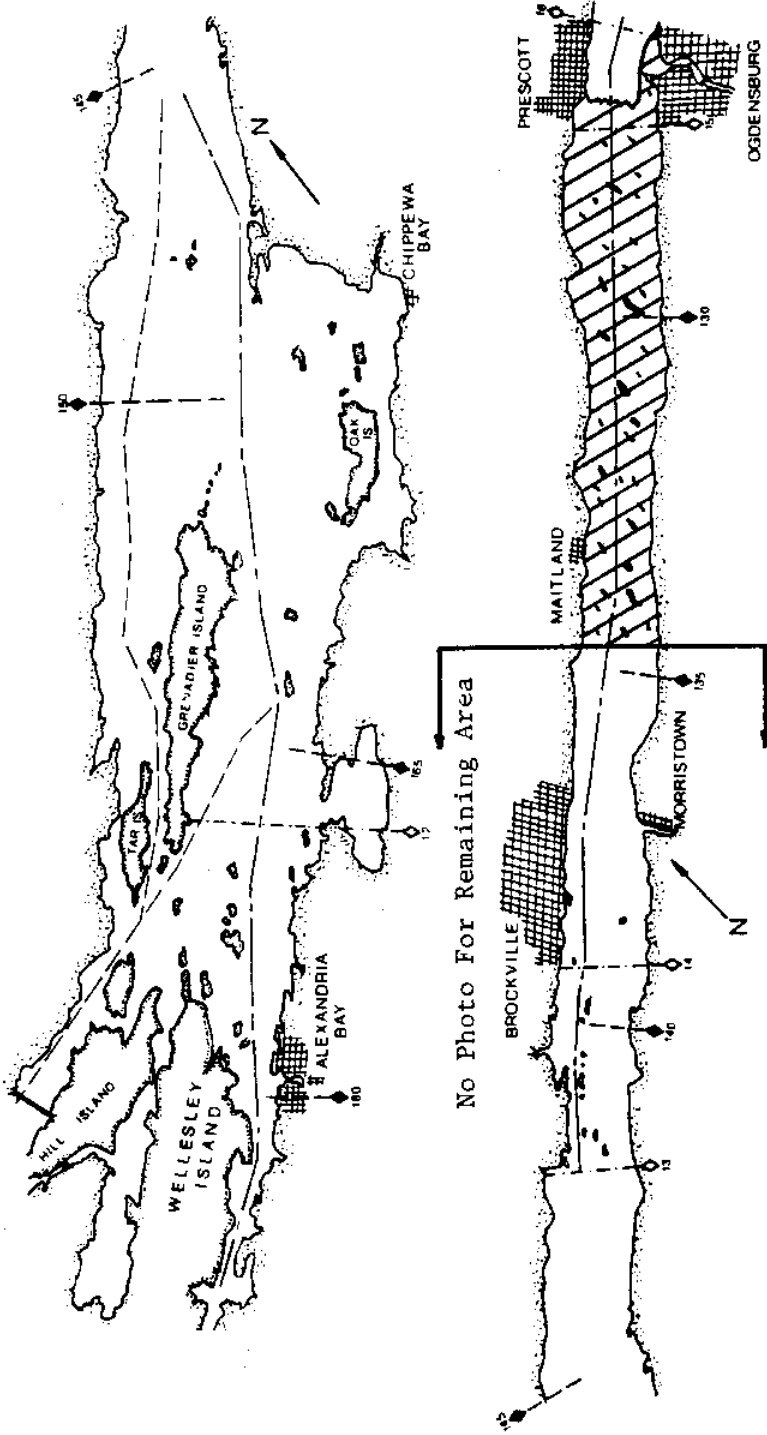


0 Scale of Miles 5

DATE Mar. 1, 1976

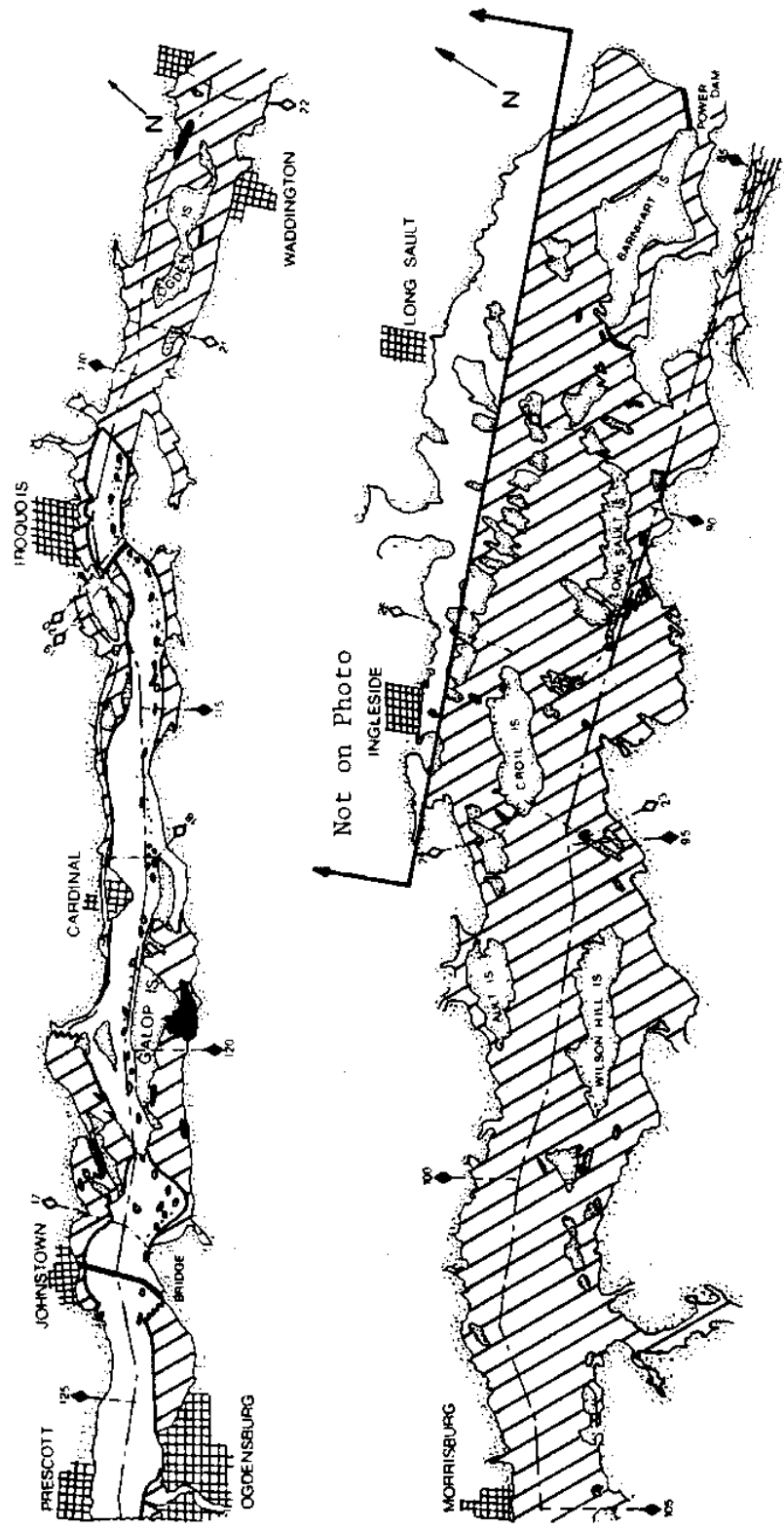






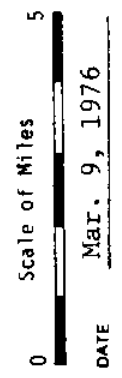
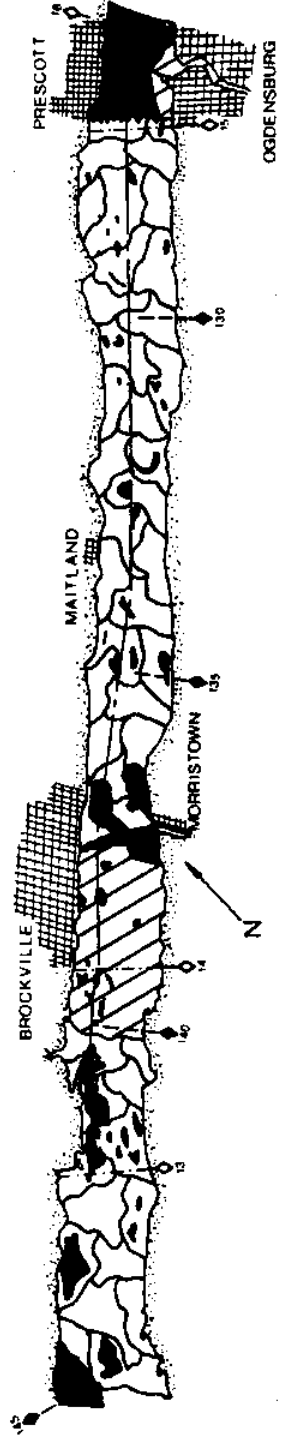
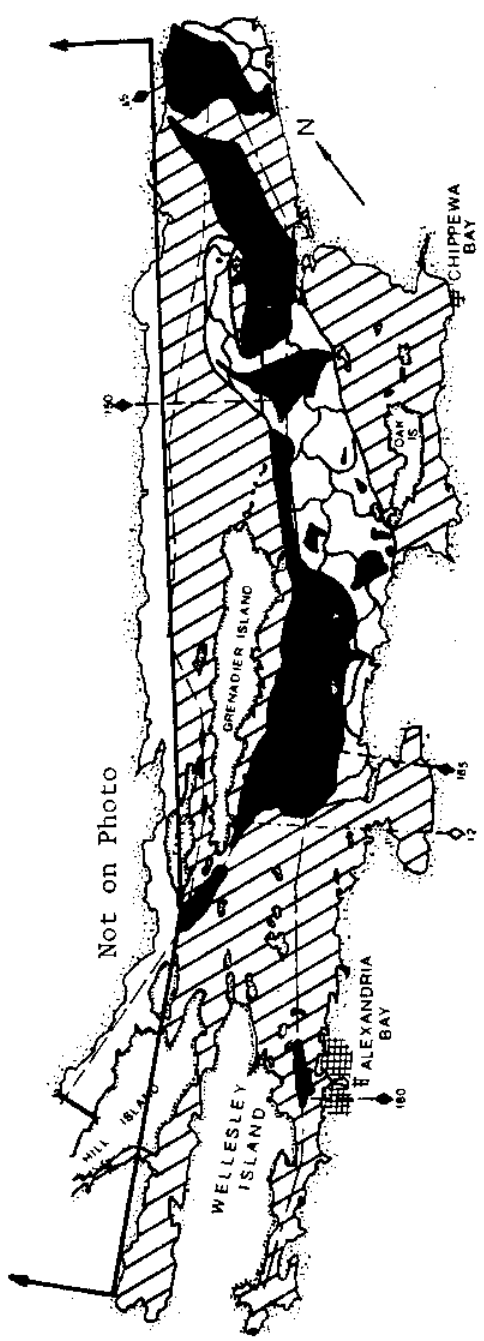
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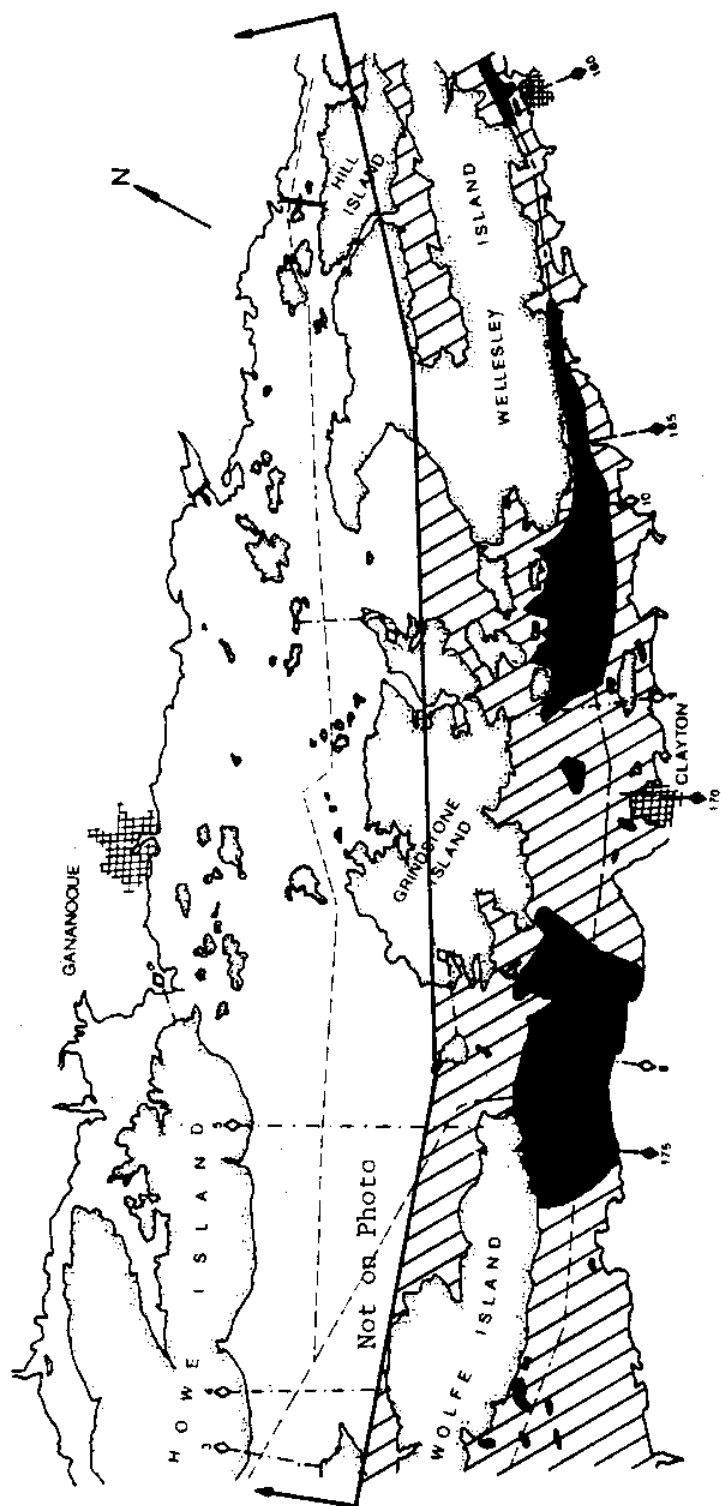
DATE Mar. 8, 1976



0 Scale of Miles 5

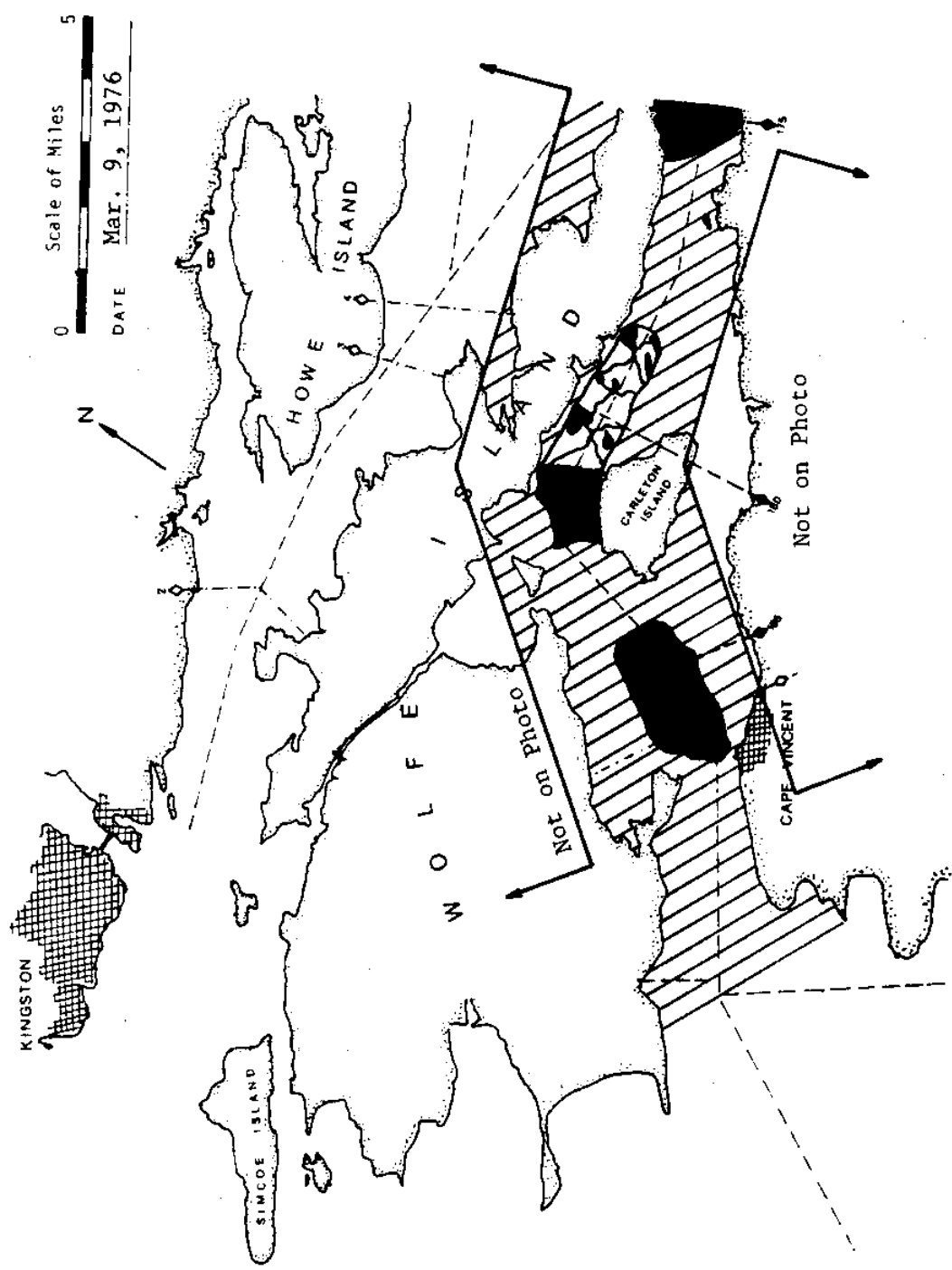
DATE Mar. 9, 1976

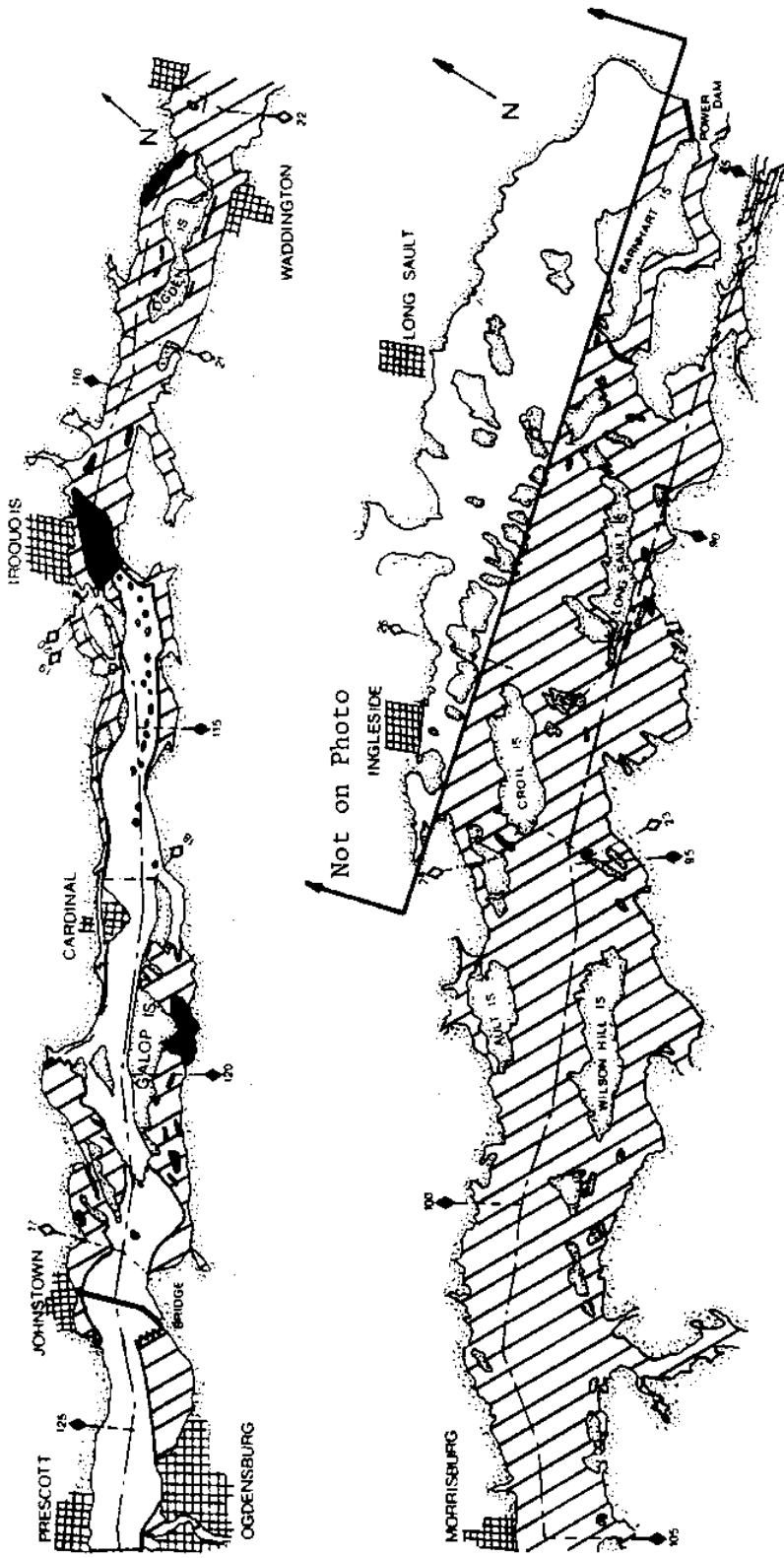




Scale of Miles 0 5

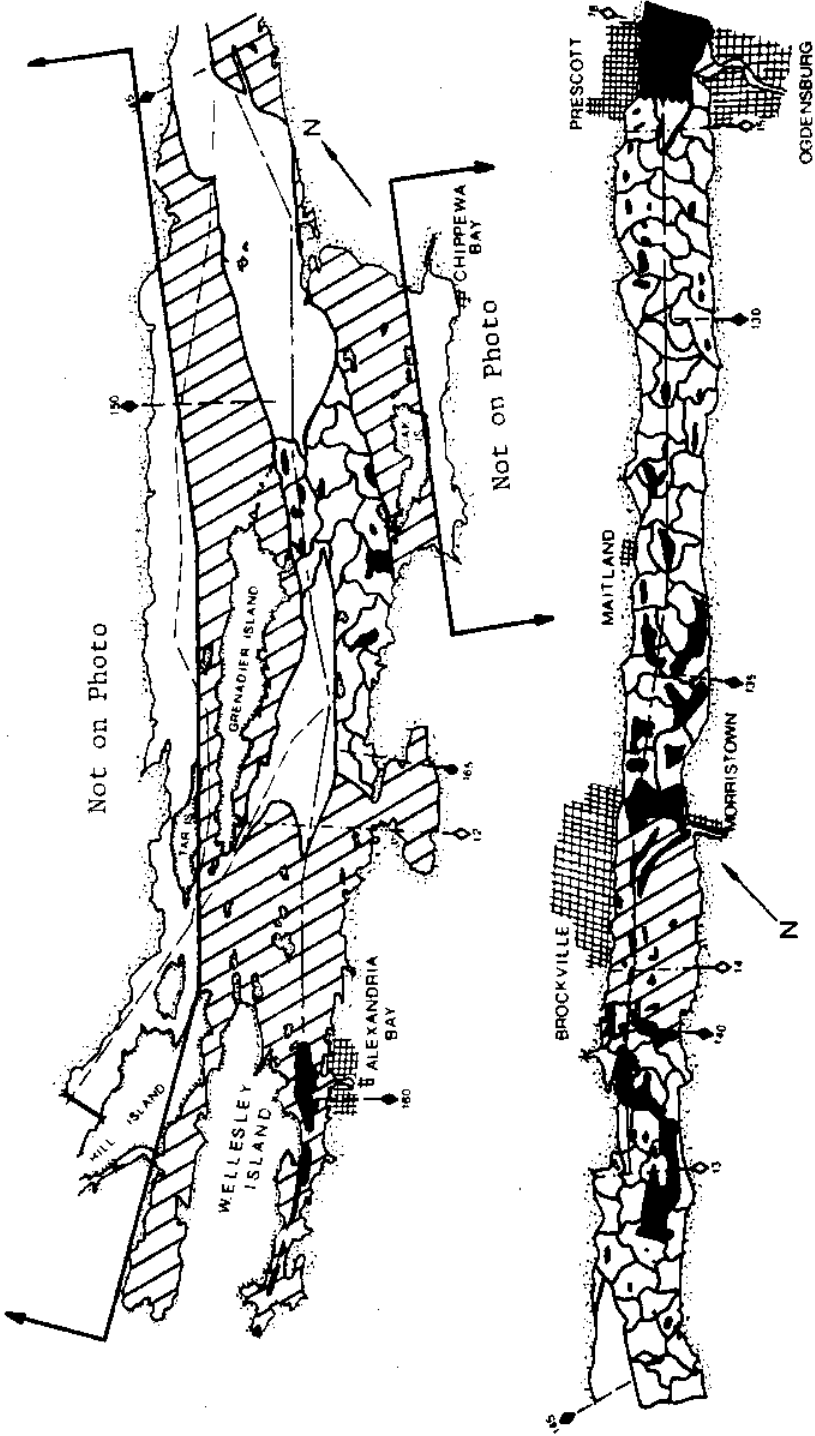
DATE Mar. 9, 1976

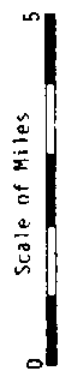
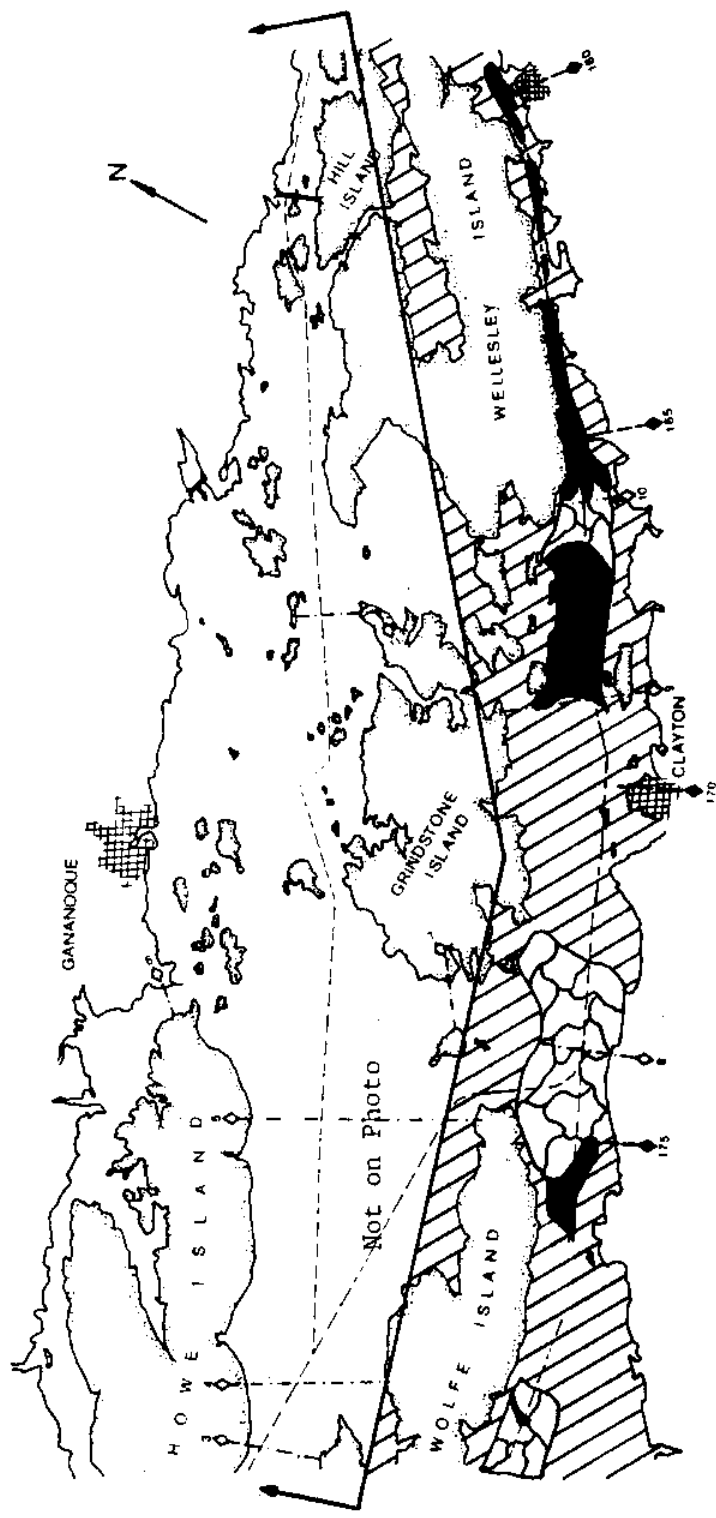




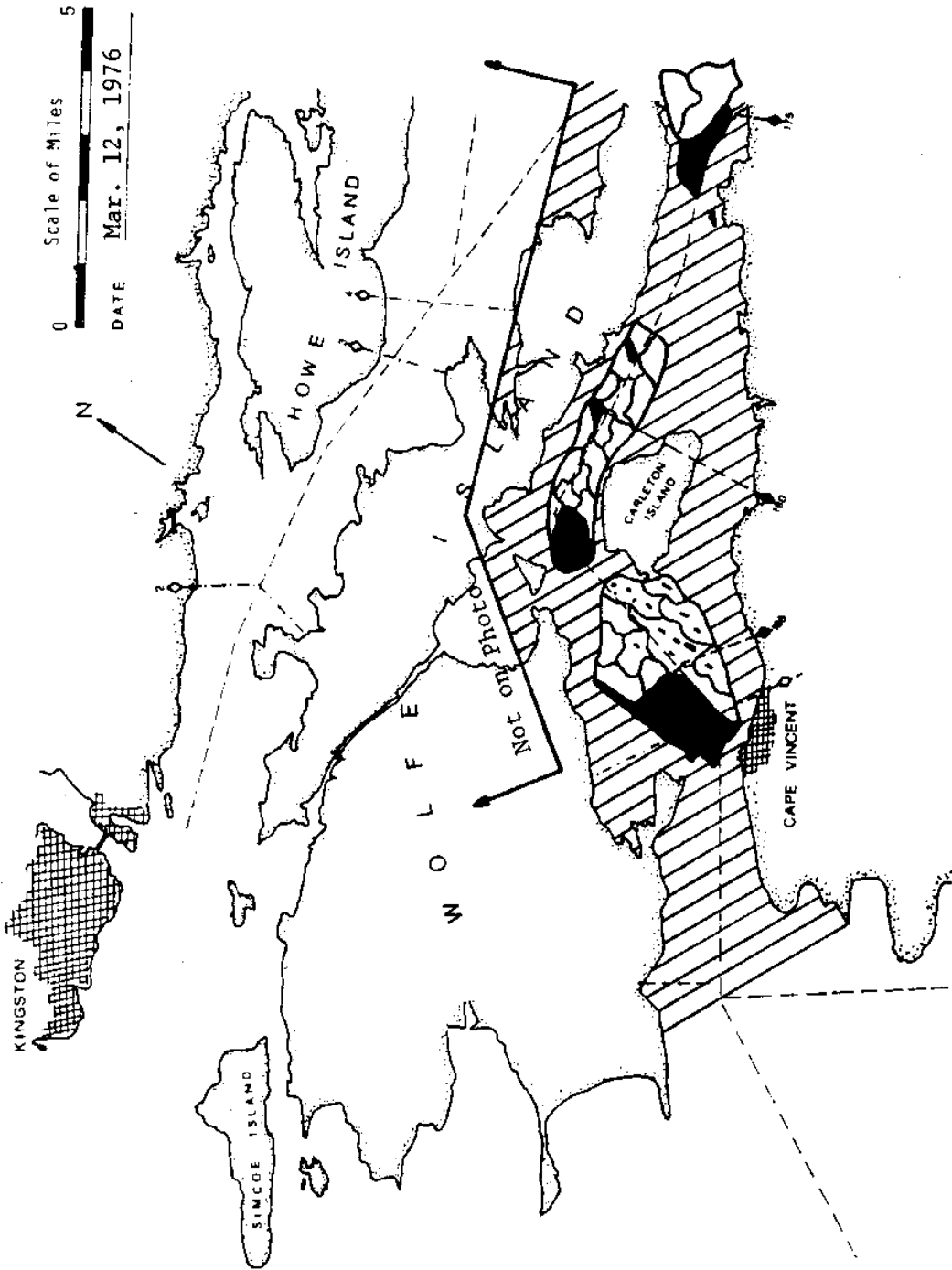
0 Scale of Miles 5

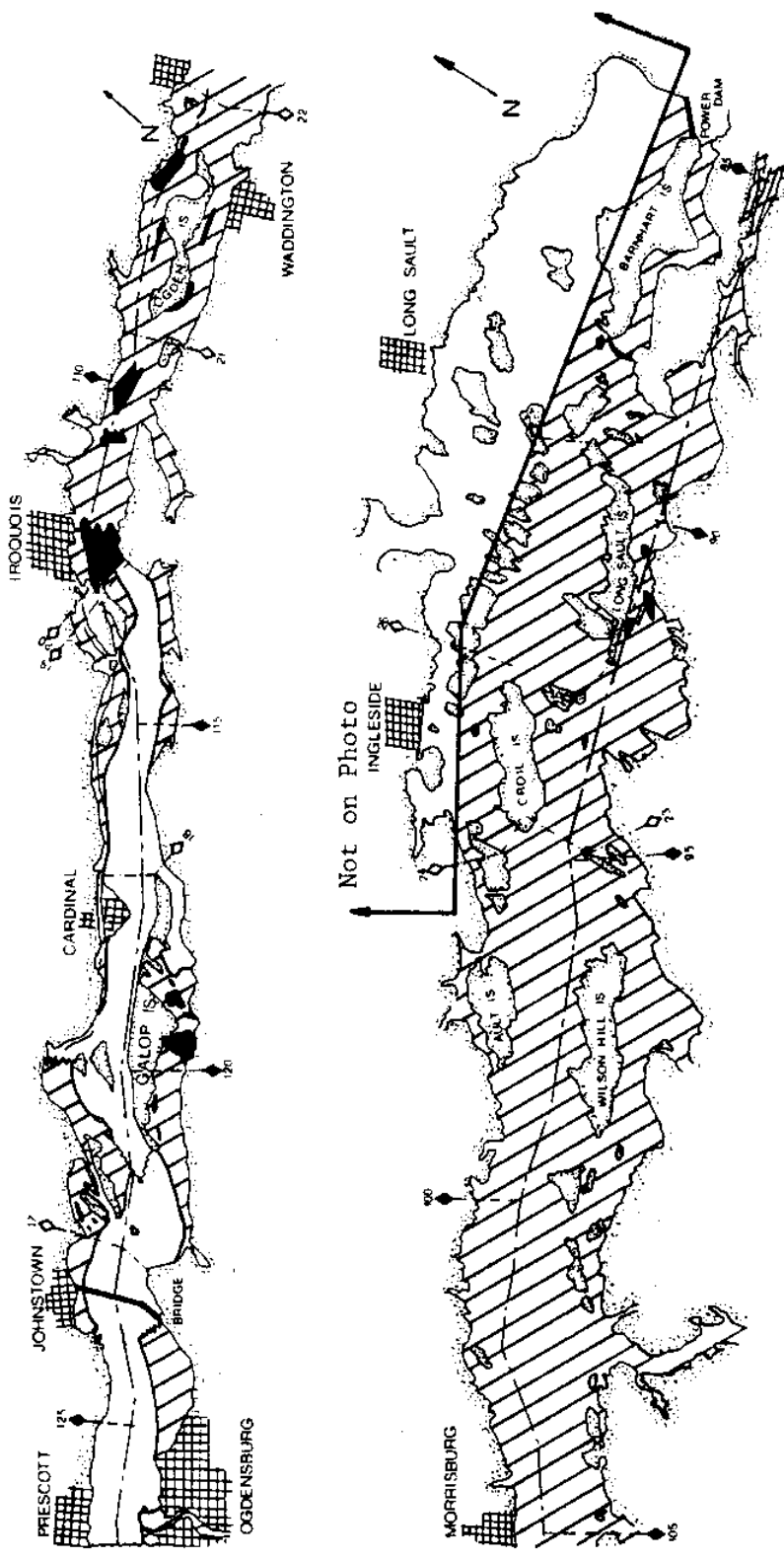
DATE Mar. 12, 1976





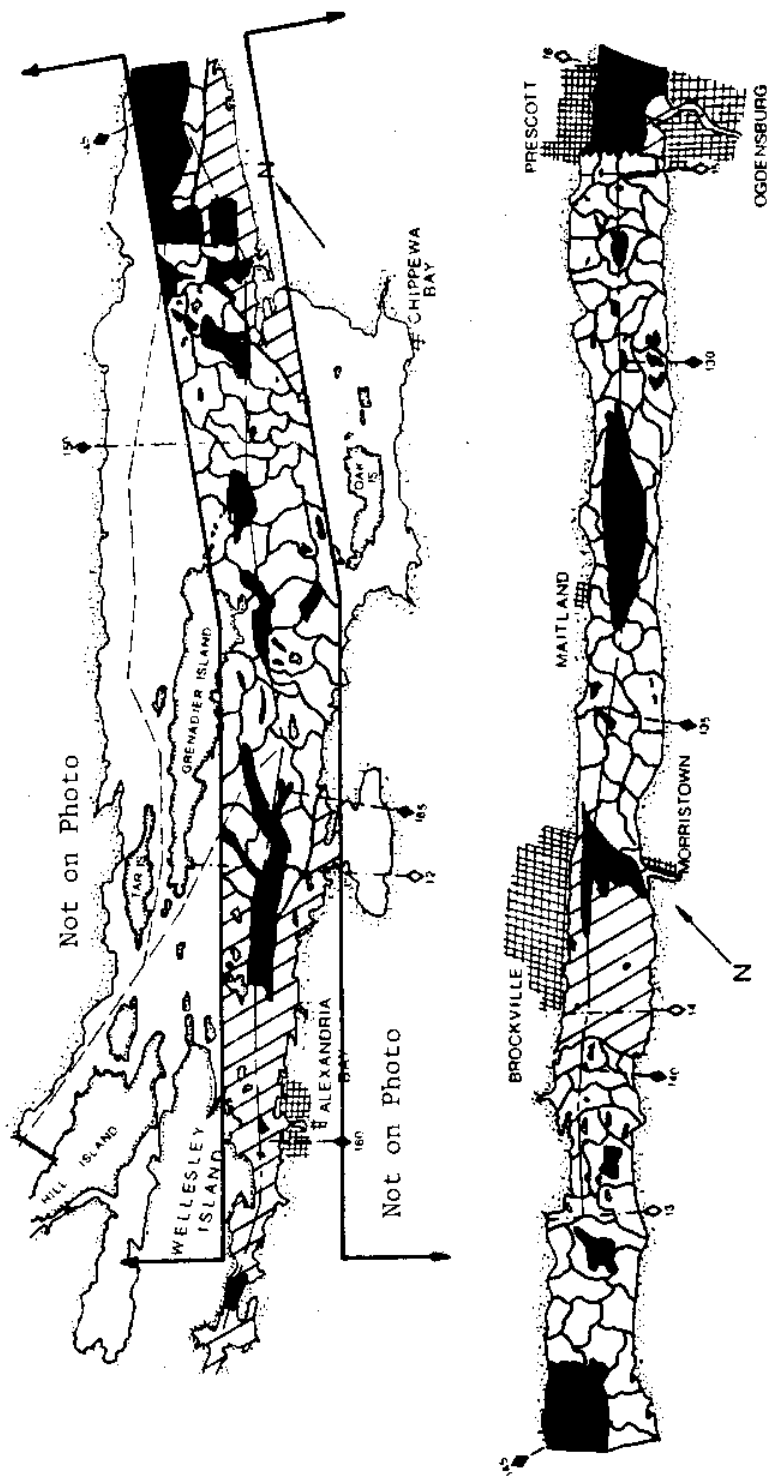
DATE Mar. 12, 1976





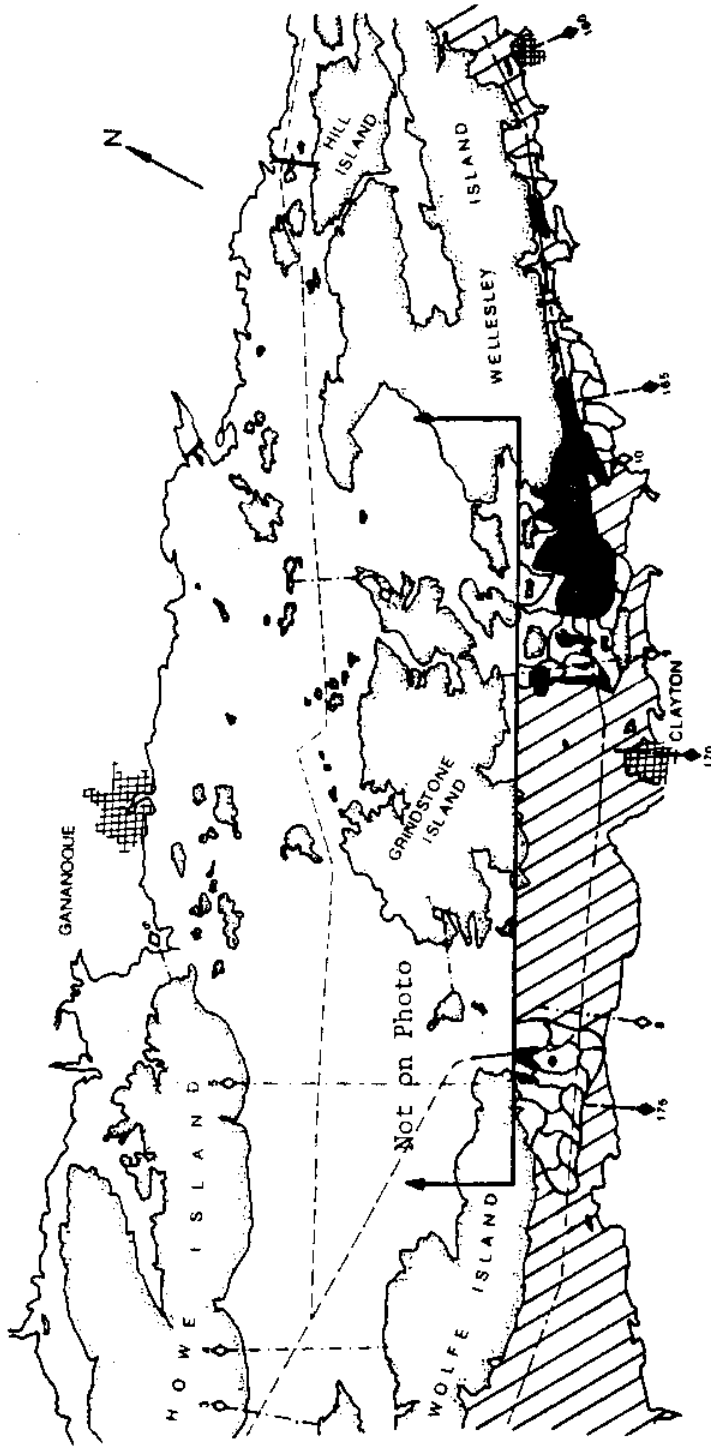
0 Scale of Miles 5

DATE Mar. 18, 1976



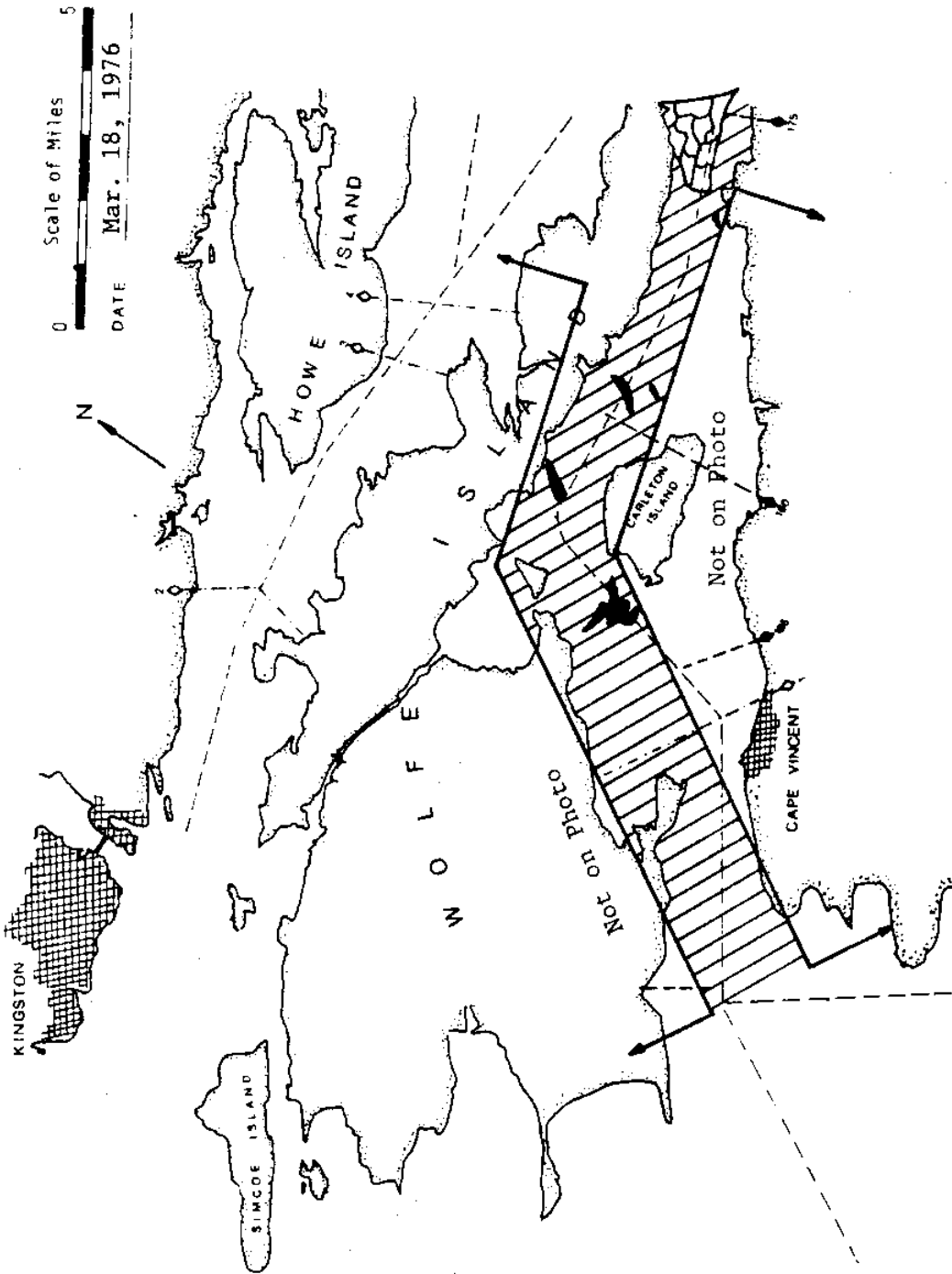
Note: Areas of snow cover or ice made determination of its condition difficult. Ice conditions are largely estimated from aerial photos taken before and after Mar. 18, 1976.

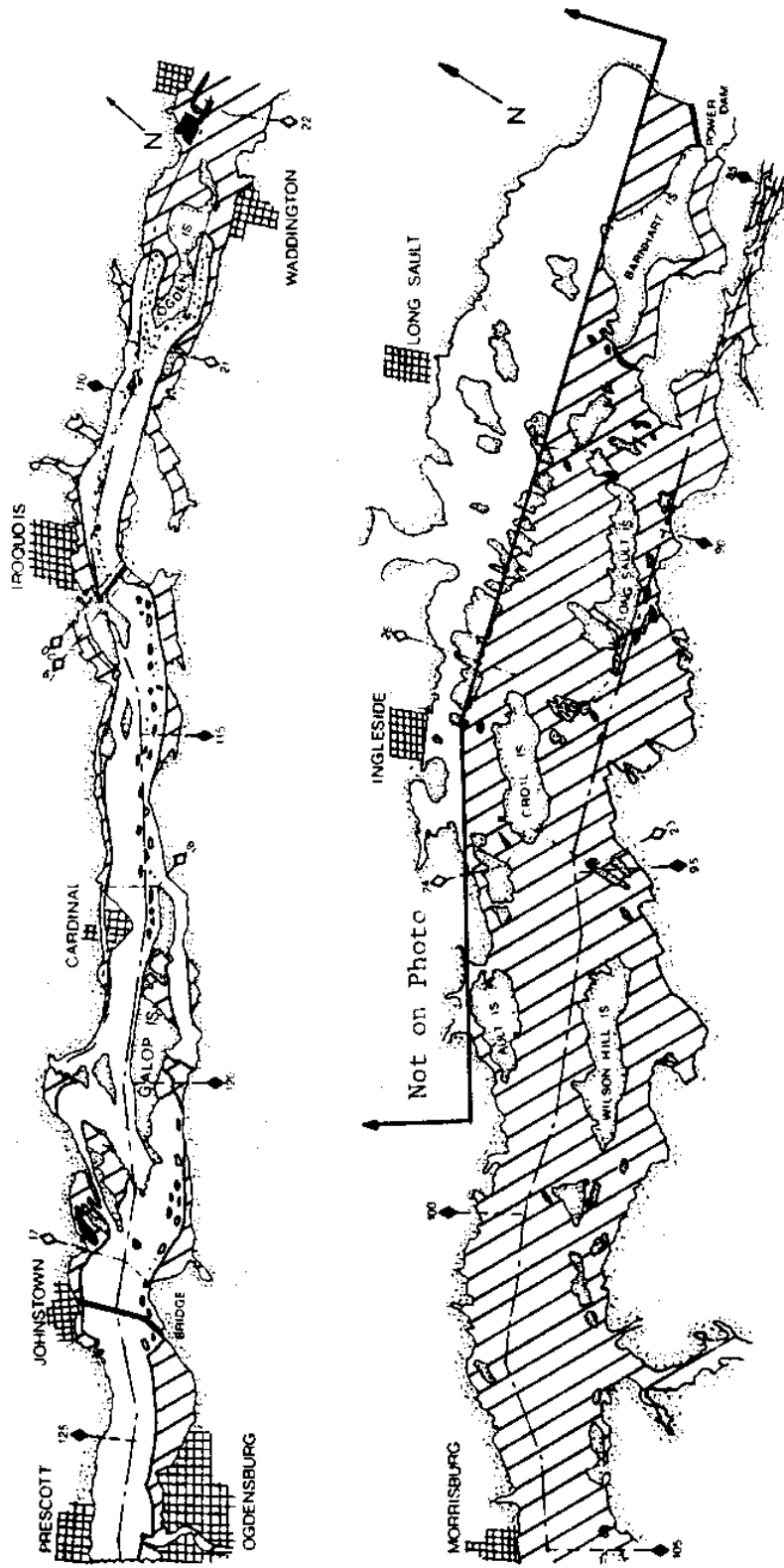
0 Scale of Miles 5
 DATE Mar. 18, 1976



0 Scale of Miles 5

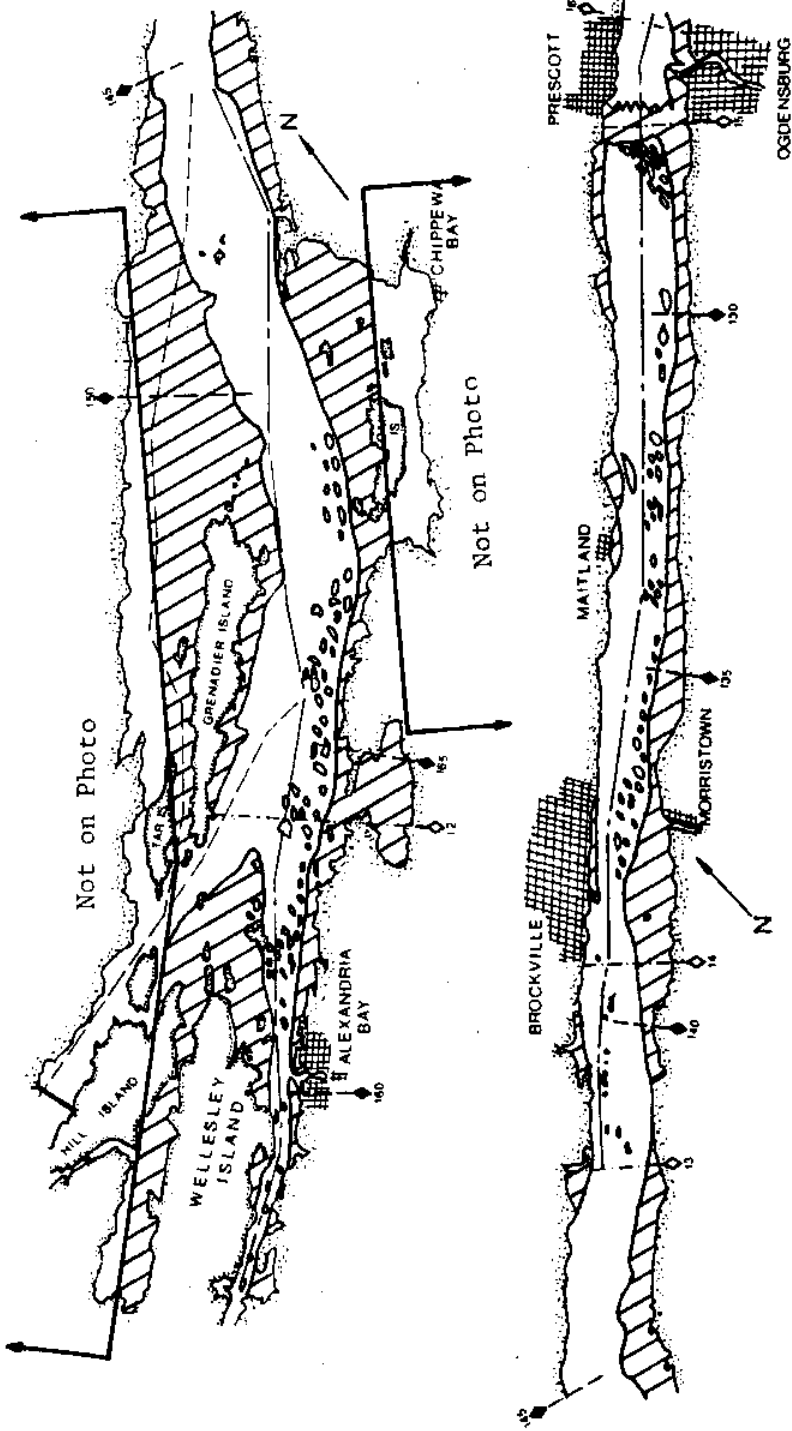
DATE Mar. 18, 1976





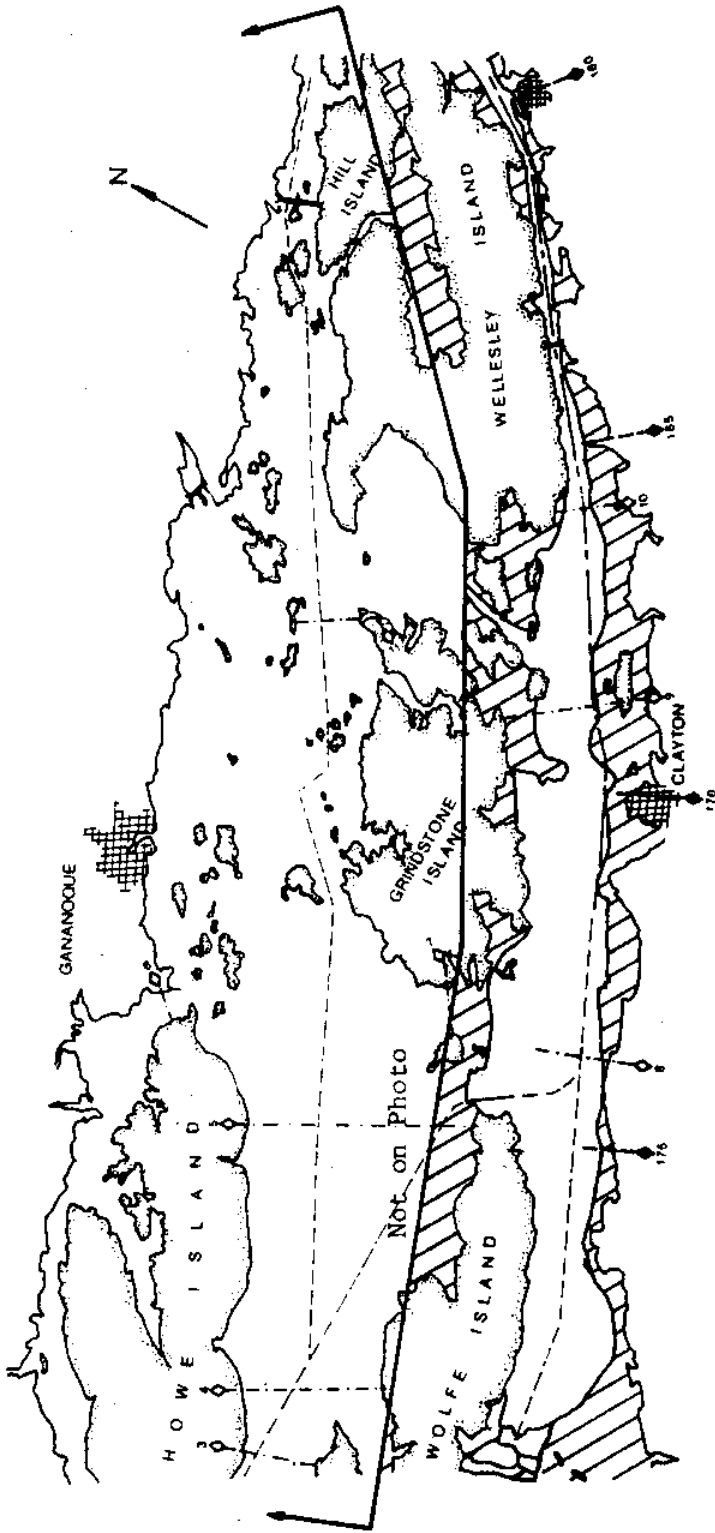
0 Scale of Miles 5

DATE Mar. 22, 1976



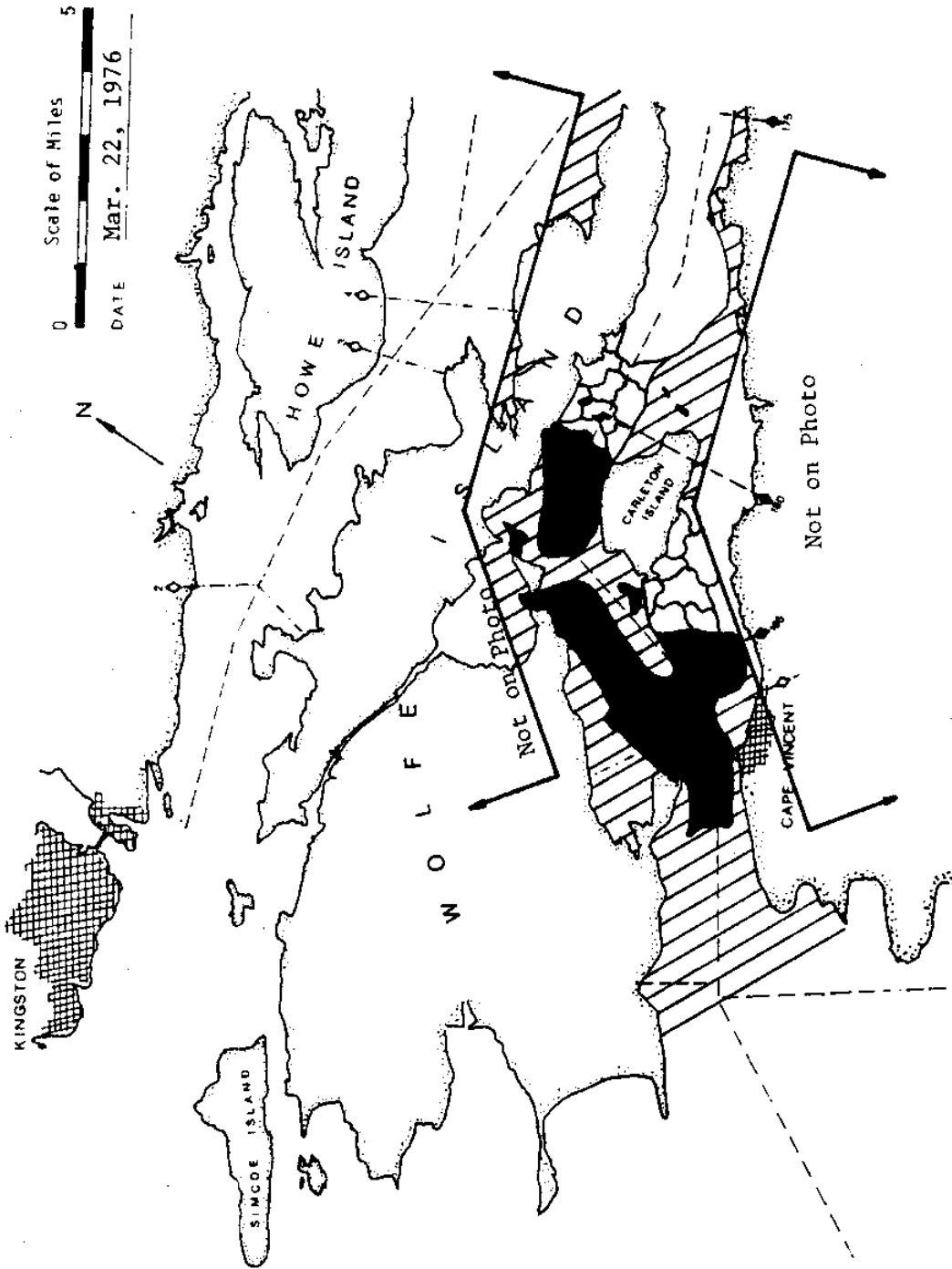
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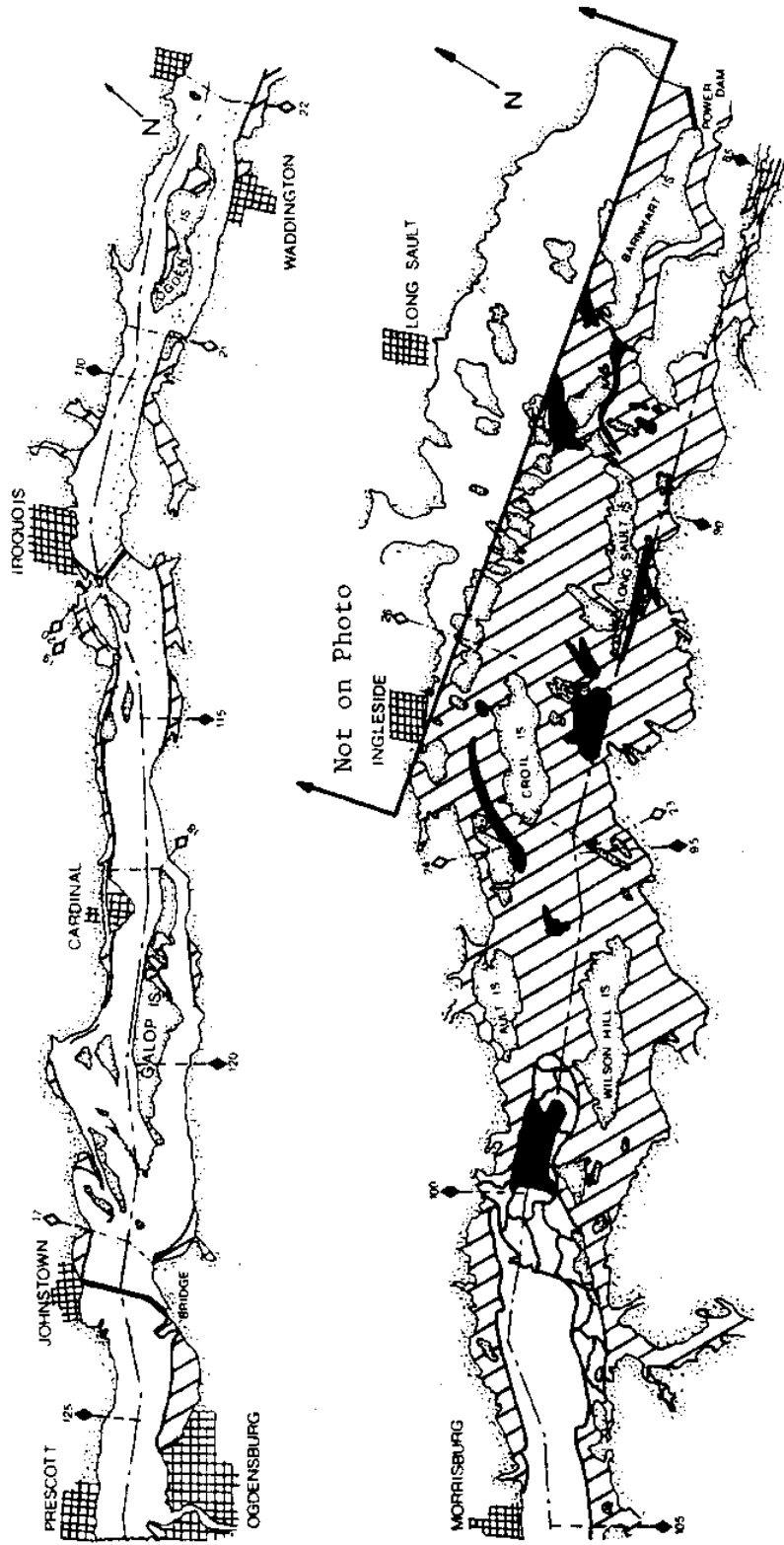
DATE Mar. 22, 1976



0 Scale of Miles 5

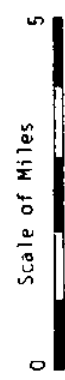
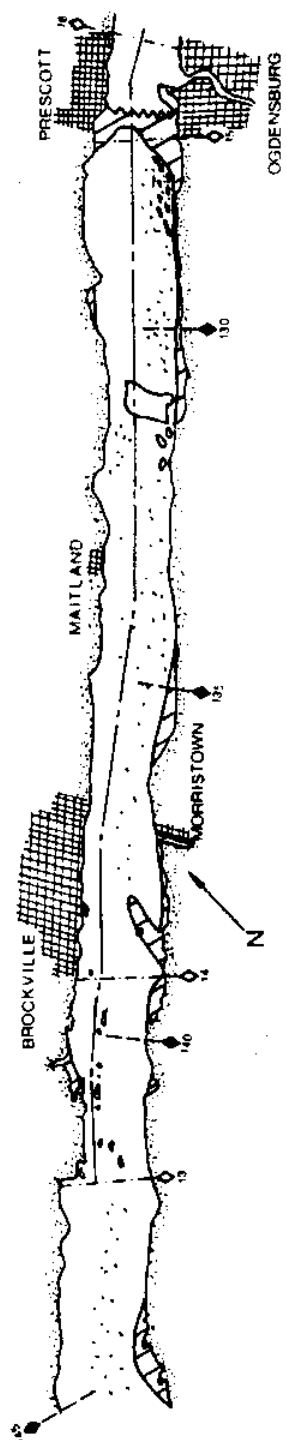
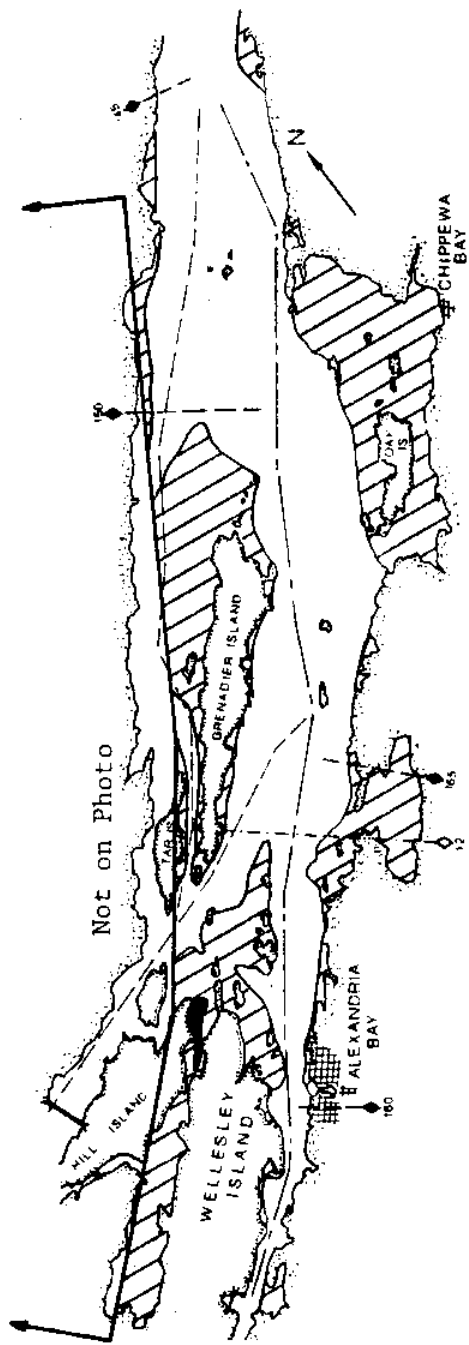
DATE Mar. 22, 1976



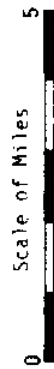
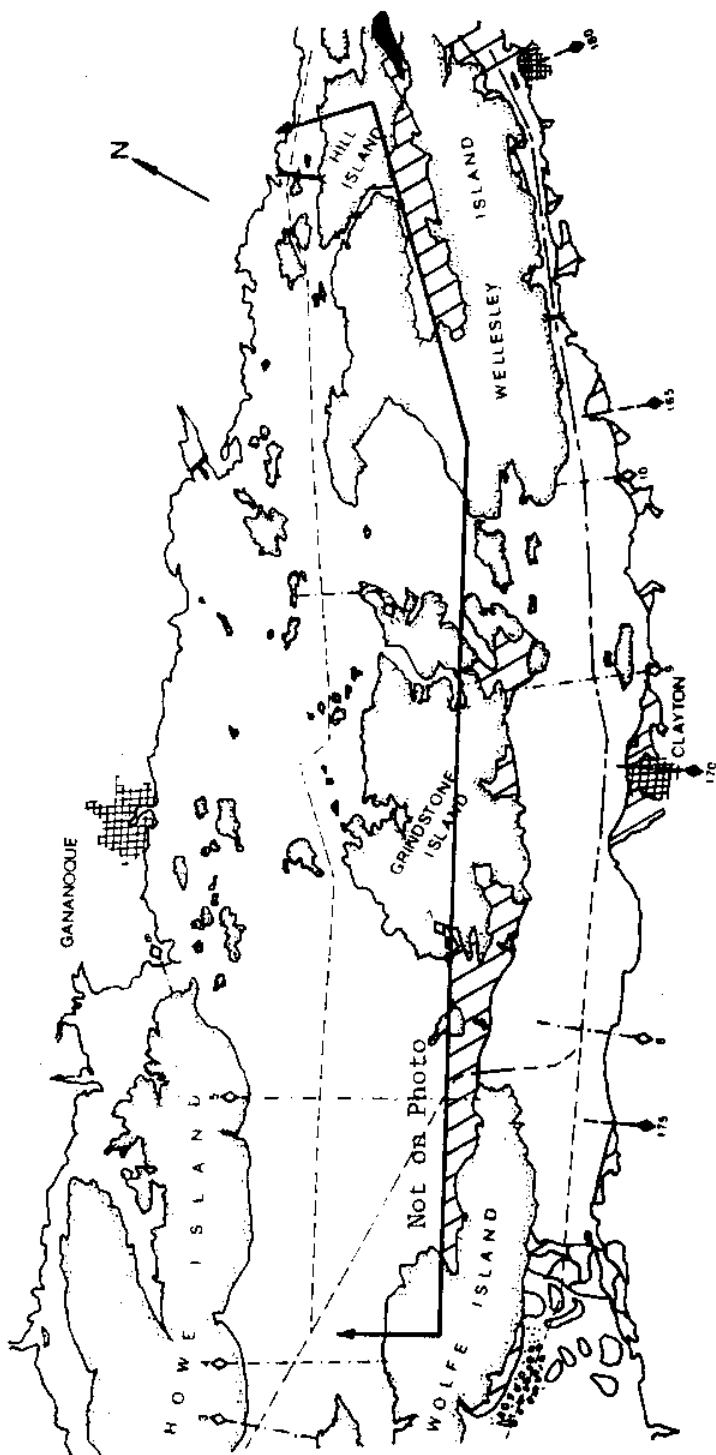


0 Scale of Miles 5

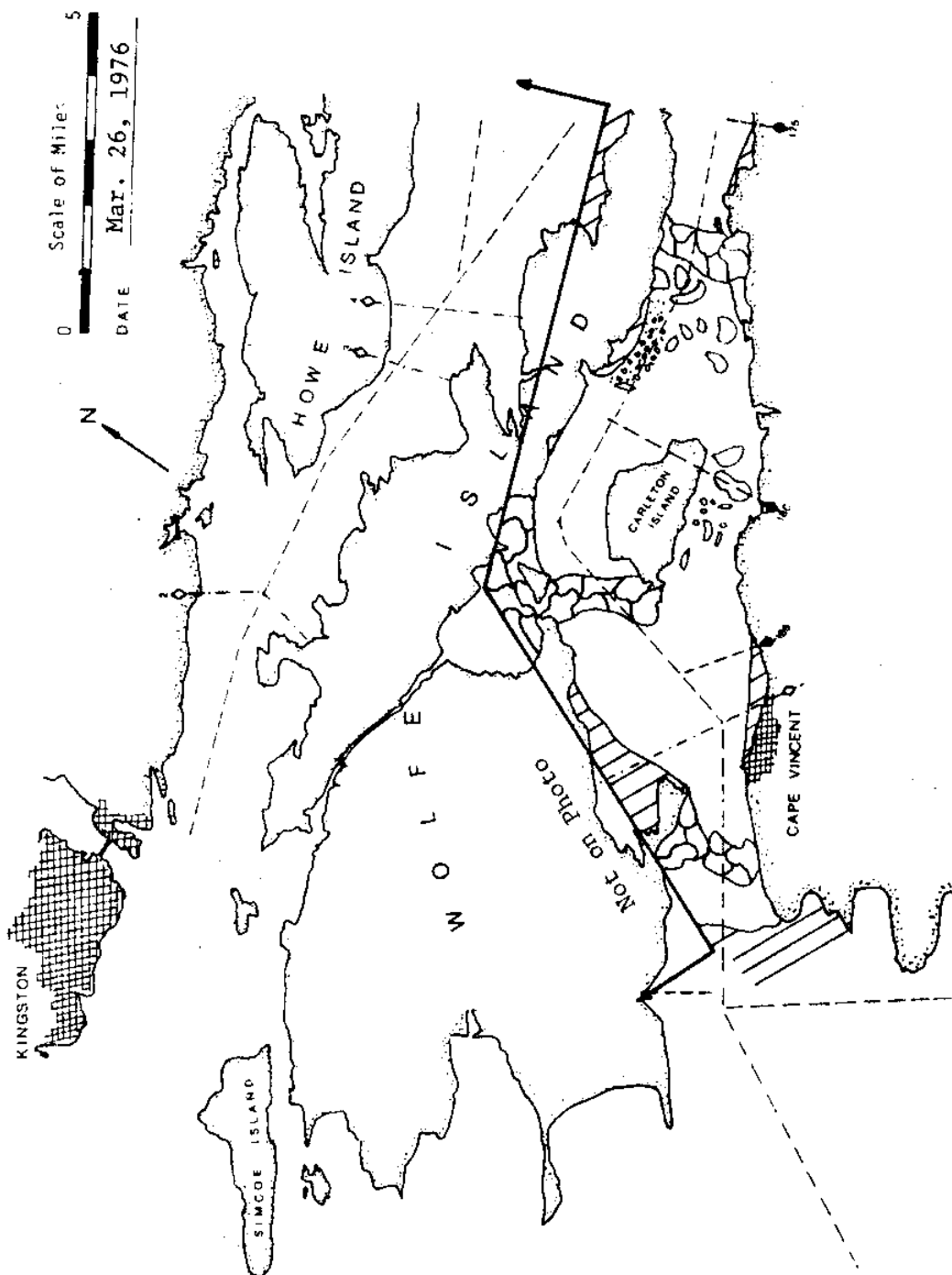
DATE Mar. 26, 1976

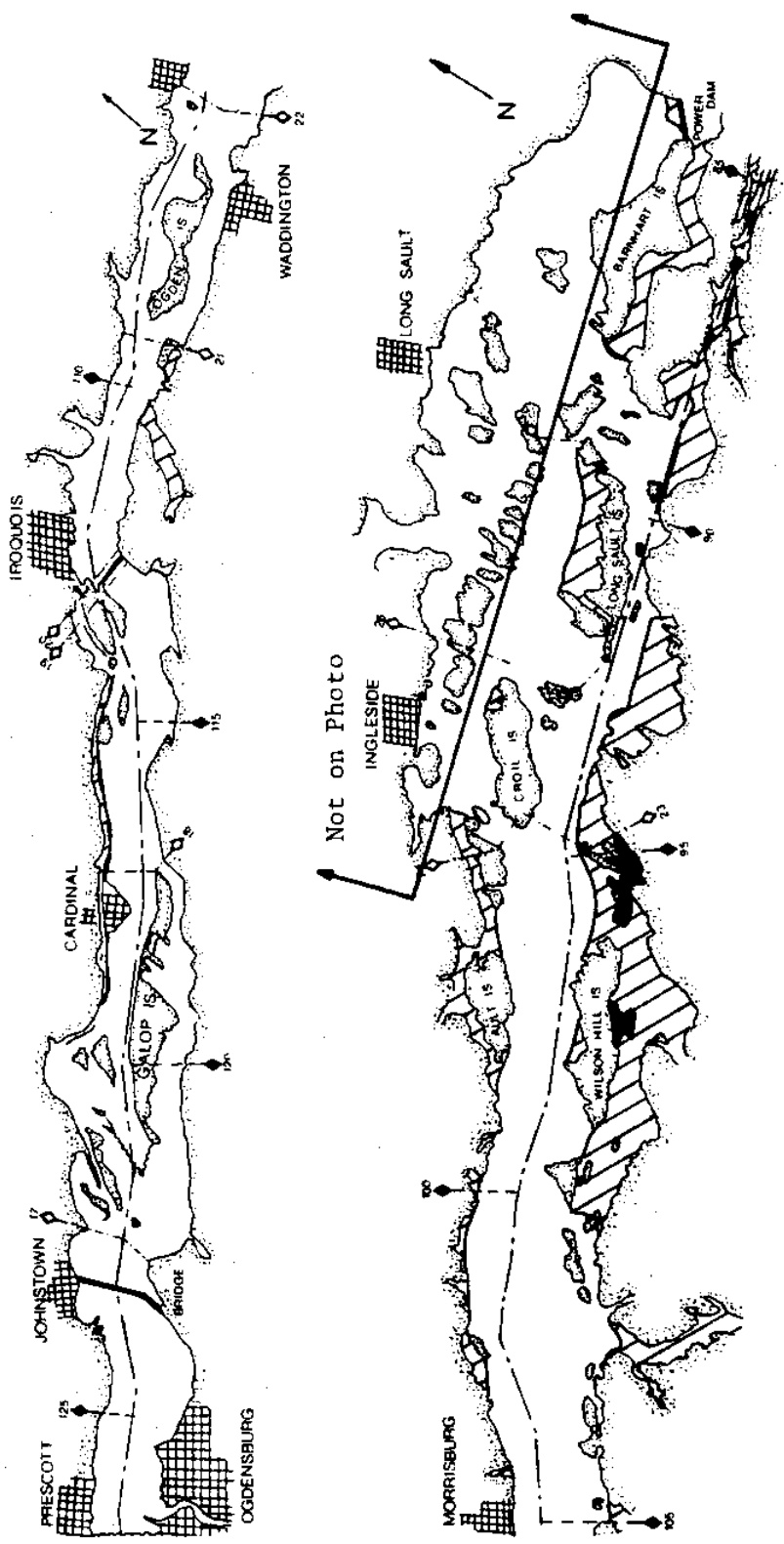


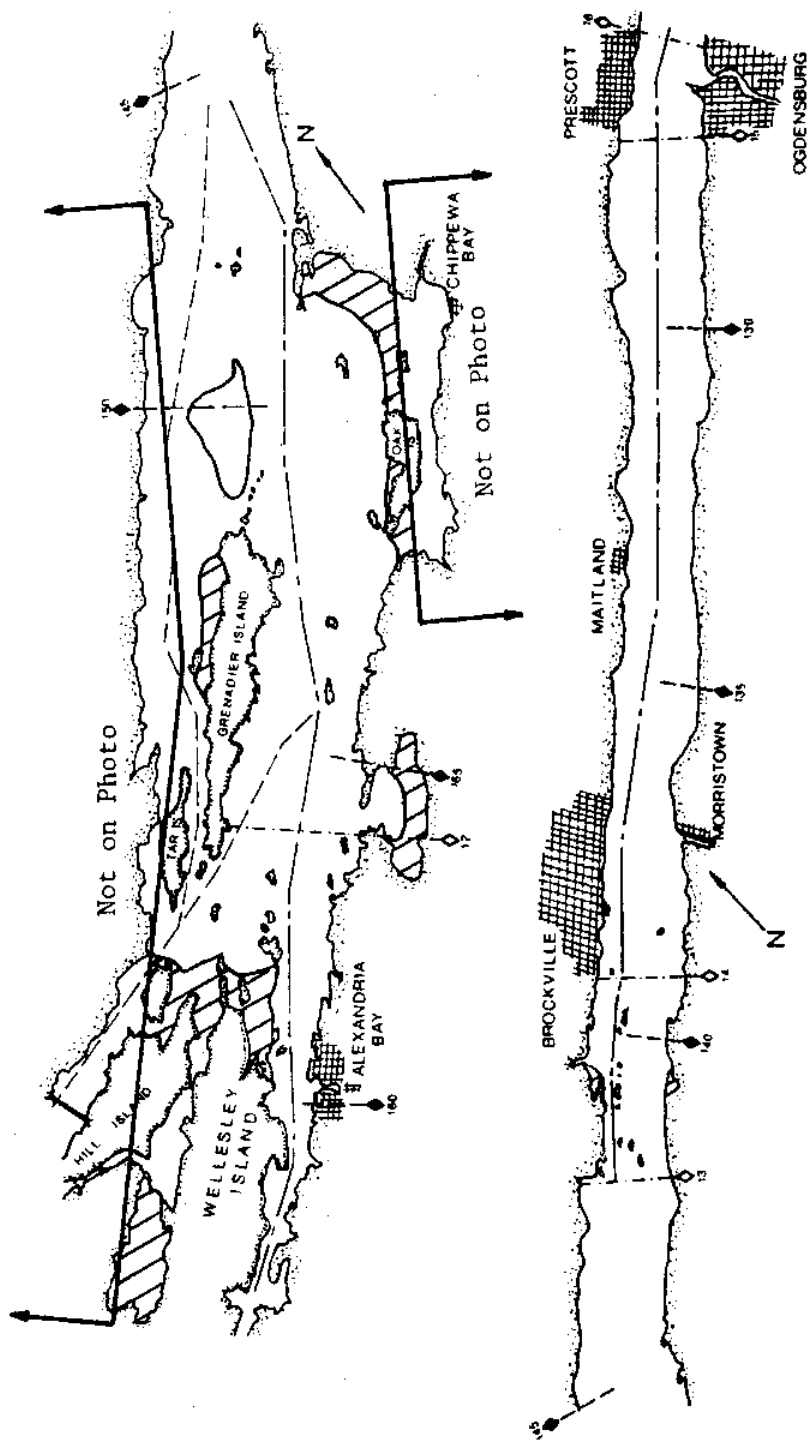
DATE Mar. 26, 1976



DATE Mar. 26, 1976

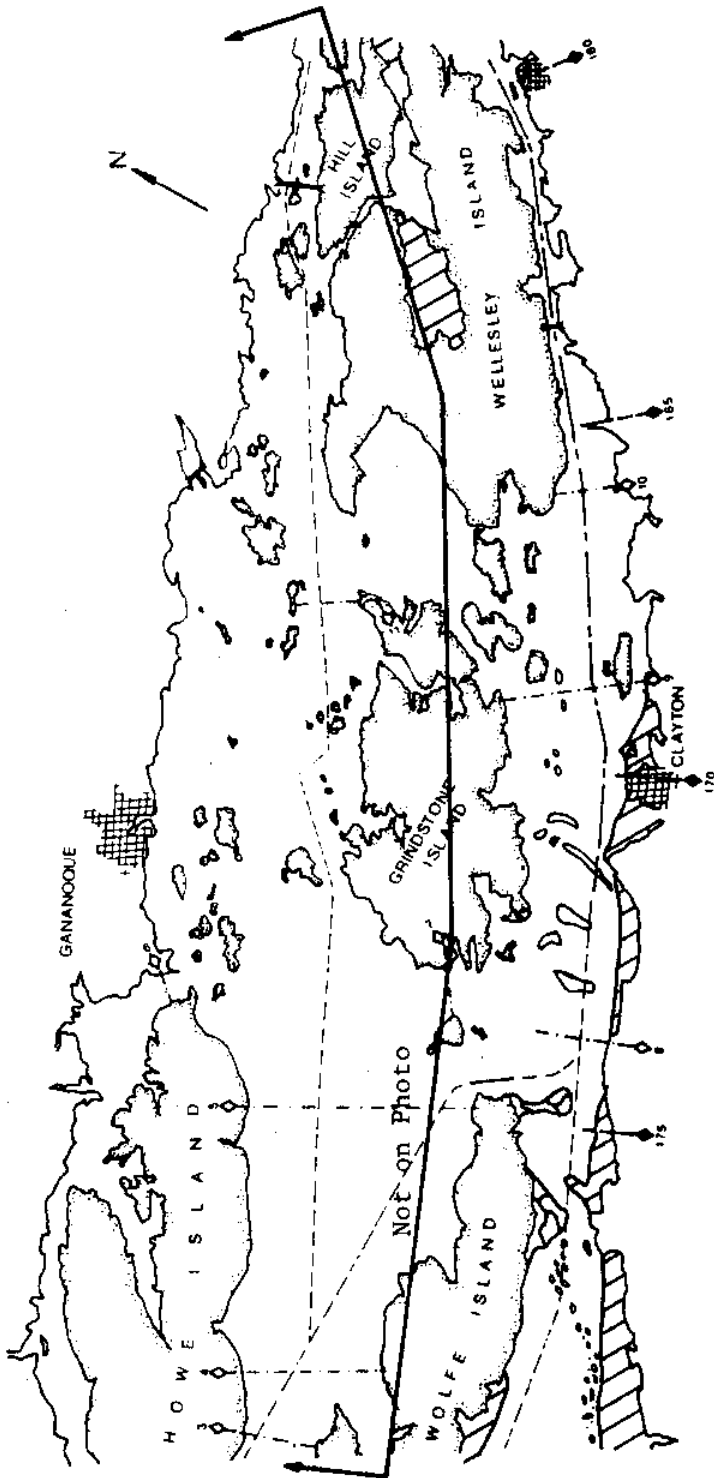






0 Scale of Miles 5

DATE Mar. 30, 1976



0 Scale of Miles 5

DATE Mar. 30, 1976

