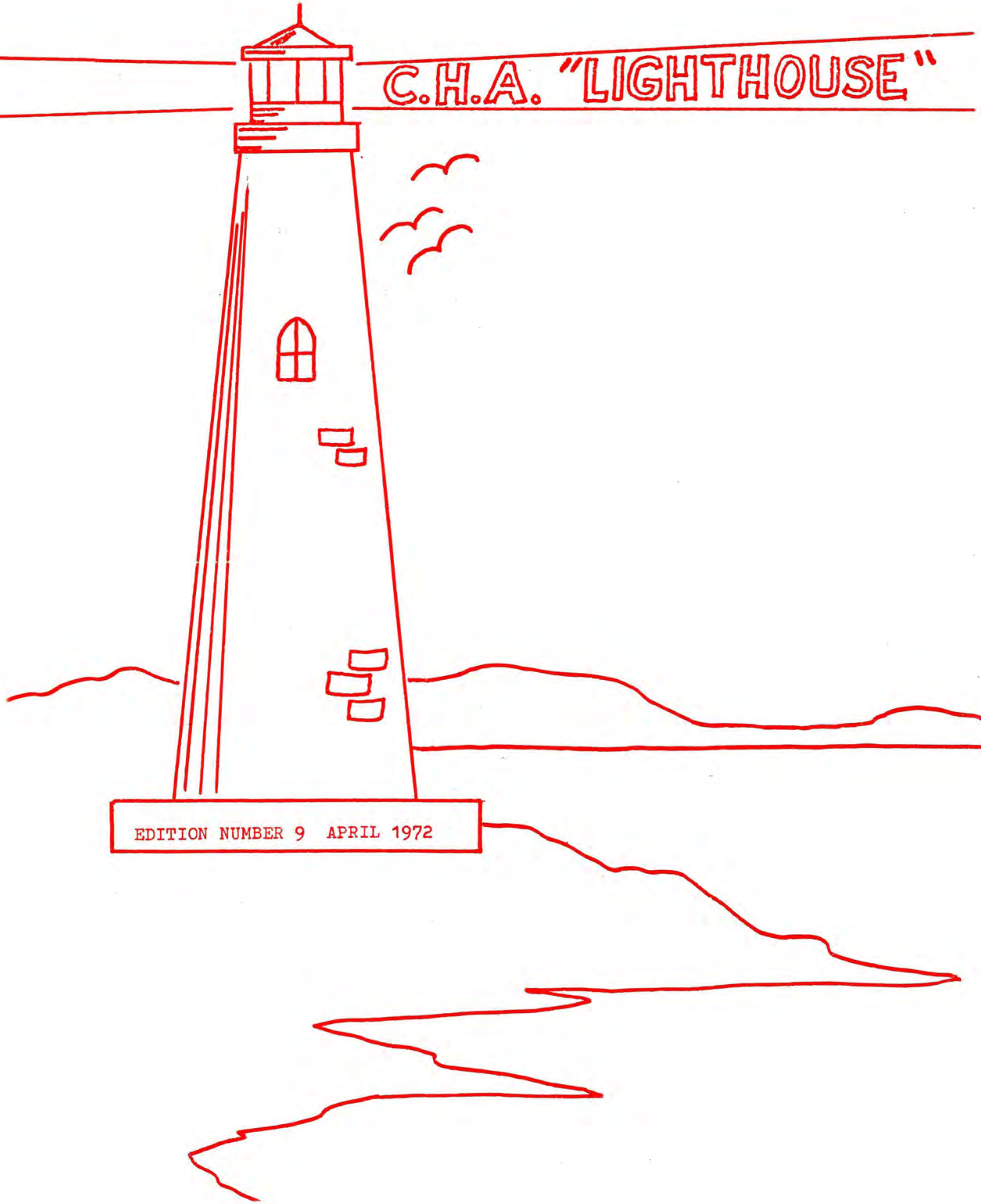

C.H.A. "LIGHTHOUSE"
EDITION NUMBER 9 APRIL 1972

The editors are pleased to announce that Mr. M. Eaton, of Atlantic Branch CHA, has been awarded the annual twenty-five dollar ($25) prize, as author of the best paper published in 'Lighthouse' in 1971. His article, "Satellite Navigation", was published in Edition Number 7.

A special thanks is extended to all contributors, who over the past year supported and helped improve the quality of 'Lighthouse'.

Your comments on Edition Number 9 are sincerely invited. Contributions should be made to:

Editors, CHA Lighthouse
c/o Mr. Earl Brown
Marine Sciences Branch
Dept. of the Environment
867 Lakeshore Road
P.O. Box 5050
Burlington, Ontario

The Association appreciates the support and encouragement of the Canadian Hydrographic Service.

Canadian Hydrographers Association

Marine Sciences Branch
Department of the Environment
512-1230 Government Street
Victoria, B.C.

24 February

Dear Fellow Member:

"LIGHTHOUSE", the official publication of the Canadian Hydrographers Association, continues to improve with each issue. For this we are all indebted to the Editor and his diligent associates from Central Branch. However, without your tangible support through the submission of articles, papers and regional news of significance, *"LIGHTHOUSE"* cannot continue to thrive.

Recently your Editor has expressed concern about the lack of regional news in this publication. *"LIGHTHOUSE"* is the appropriate medium for the reporting of newsworthy regional and local activities and I would encourage each of you to consider and submit items of interest to the Editor.

The National Executive Meeting will be held next week in Ottawa and I hope to be able to report on its activities in the next issue of *"LIGHTHOUSE"*.

Yours sincerely,

M. Bolton
National President

TWELFTH ANNUAL CANADIAN HYDROGRAPHIC CONFERENCE

As you are probably aware, the Twelfth Annual Canadian Hydrographic Conference will be held in Victoria in early 1973. Tentatively the scheduled dates for the Conference are Tuesday 27 February to Thursday 1 March. As a departure from past practices this Conference will be co-hosted by the Canadian Hydrographic Service and the Canadian Hydrographers Association.

As a tentative theme for the Conference *"Reading Between the Lines" - Hydrography in the seventies and challenges for the future* - has been suggested. This is a broad heading and leaves the field open for papers from all avenues of hydrography to be presented.

At this time the Conference Committee would solicit your suggestions regarding subject matter, possible papers and any other thoughts you may have which would contribute towards making the 1973 Conference a success. If you are considering submitting a paper, please forward the title and a provisional abstract to Mr. W.S. Huggett, Conference Chairman, 512 Federal Building, Victoria, B.C.

An official call for papers and more details regarding the Conference will be published in later edition of "LIGHTHOUSE".

Feb. 3, 1972

Dear Editor:

Thank you for sending me a copy of Edition No. 8 of the CHA "Lighthouse".

It has been read with interest since many of the articles dealt with people, vessels and equipment well known to us.

If it is possible we would like to ask your permission to obtain future copies of this publication.

Yours very truly,

Garth F.C. Weedon
P. Eng.
General Manager
Motorola maecan

Jan. 25, 1972

Dear Editor:

We have received a copy of Edition No. 8 of the CHA "Lighthouse" and find it most interesting reading. As this is the first copy received we have not been able to follow the correspondence between Mr. O'Connor of Victoria and Mr. Goldsteen in previous editions.

While we admit that the MRB2 Hydrodist (which has now been replaced by the MRB201 transistor/digital Hydrodist) was an awkward beast, we are amazed that we were not contacted by the Pacific Region. References are made to repeated repairs, checks, adjustments, etc. and yet the first we have heard of these problems in Victoria is via the "Lighthouse".

Tellurometer Canada Ltd., was established in order to assist users of our equipment and it is possible that a little consultation might have eliminated some headaches.

Yours very truly,

M.I. Mogg
General Manager
Tellurometer Canada Ltd.

Feb. 28, 1972

Dear Editor:

A few more comments on the Hydrodist controversy. Upon reading Messrs. Robichaud's and Anderson's report, I found that they reached 18.2 km under ideal conditions with the remote about 20 feet above water. Mr. DalBianco had his remote station on quite a high hill (several hundred feet) while obtaining about 12 km. I was only suggesting that one could normally expect a maximum range of 7500 m with the remote at an elevation of less than 20 feet.

The argument on horizontal control is perhaps confusing at times when listed under advantages in the various reports. What it really is supposed to mean is that one could start sounding almost immediately with a minimum of control, while a few (or just one) hydrographers extend the control further as required for the particular survey.

When mentioning the accuracy of sounding in a swell, I had a general depth of say less than 100 feet in mind, which surely would cause an appreciable error.

As far as the plotting is concerned, a fairer example would be to state that it took us 10 minutes to ink a quantity of 160-180 fixes averaging one inch spacing divided over 20-25 sounding lines. In other words, the scale of the survey (and therefore the mileage) is immaterial.

Finally, my colleagues and myself have used old car front seats on our hydrodist operations, to prevent the backseat driver syndrome to which Mr. O'Connor referred.

Yours truly,

G.H. Goldsteen

CURLING

The first annual H_2O Bonspeil run by CHA of Central Region was a complete success. The speil took place on January 8, 1972 with sixteen teams participating.

Prizes were donated by Computing Devices of Canada, Motorola, and Tellurometer Canada Ltd., along with wine and hams donated by local companies.

The winners of the one-day speil are as follows:

A EVENT

1st. K. Daechsel
2nd. R. Courtnage
3rd. P. Ward-Whate (CCIW)
4th. E. Thompson

B EVENT

1st. R. Lane (CCIW)
2nd. E. Brown
3rd. J. Simpson (CCIW)
4th. R. Chapil (CCIW)

TABLE OF CONTENTS

MARINE SCIENCES BRANCH CONTRIBUTION
TO THE
INTERNATIONAL FIELD YEAR FOR THE GREAT LAKES

"IFYGL, the International Field Year for the Great Lakes, has been established as a joint United States-Canadian contribution to the International Hydrologic Decade. A single lake and basin, Lake Ontario, has been chosen as the 'specimen' for this investigation, and the program's observational phase is now scheduled for calendar year 1972.

In simplest terms, IFYGL will take Lake Ontario, instrument it, and measure what goes in, what comes out, how lake waters (and their cargo of pollutants) circulate, and how chemical and biological characteristics of the lake change in response to those factors, and to seasonal variations.

A program of IFYGL's magnitude could not have been planned and cannot be implemented without the dedicated and continuing efforts of many experts in the various disciplines involved. The plan itself is steered by a committee composed of four leading scientists from the United States and four from Canada. Scientific activities include lake meteorology, terrestrial water balance, energy balance, water movement and chemistry and biology.

IFYGL participants include representatives of United States and Canadian universities, government agencies, and private industry." [1]

1. excerpts from NOAA magazine, January, 1971, OUR AILING INLAND SEAS.

Since the principle of the project IFYGL was accepted by Canadian and USA authorities, the Canada Centre for Inland Waters (CCIW), under the programme's Canadian coordinator, Mr. J. MacDowall, has been actively making preparations to ensure the success of this scientific study.

The Canadian Hydrographic Service, under its' coordinator, Mr. F.L. DeGrasse, is rapidly approaching the climax of its' participation as the towers for the DECCA LAMBDA 6f chain are raised around Lake Ontario.

At publication date, the positioning system set-up will be well in hand and the actual scientific work will be nearing the time when the other major input of Marine Sciences Branch will surface in the form of several well-equipped minor and major scientific platforms which will be used for the actual research programme. Other designated areas of responsibility of Marine Sciences Branch include:

1. Computer drawing of DECCA LAMBDA 6f plotting lattice by CHS Development Group, Central Region.

2. In co-operation with Computing Devices of Canada, carrying out reconnaissance and selection of sites suitable to DECCA LAMBDA chain, Hyperbolic mode.

3. Positioning of master, slaves, and monitor stations with geographic coordinates on 1927 North American Datum.

4. Responsibility for licencing chain and communication frequencies peculiar to the positioning system.

5. Completing land rental agreements for shore based stations.

6. Securing authorization from various municipalities for location of mobile office-living accommodations according to the pertinent by-laws.

7. In collaboration with Computing Devices of Canada, assisting with the phasing-in of the positioning system and to further evaluate the system along with obtaining a reasonably stable speed of propogation of radio waves by 'Fixed Error Calibration'.

8. Responsibility for mooring a maximum of 12 taut wire Reference Buoys.

9. Responsibility for acquiring and recommending specific mobile receivers and peripheral equipment.

10. CHS of Marine Sciences Branch will execute an offshore bathymetric survey of Lake Ontario over a six week period (See HAAPS description later).

11. Drawing and printing, by Ottawa compilation group at MSB Headquarters, five of the eight 1:80,000 plotting charts and one of the 1:400,000 plotting charts, each complete with lattices.

12. Tellemetering of water level data from four points in the Canadian sector of Lake Ontario to CCIW via Ottawa. This data will be available to participants upon request.

13. Investigate and advise on suitability of the selected positioning system.

14. Preparing survey status reports and an Official Technical Plan.

15. Coordinating operations between Computing Devices of Canada and various USA and Canadian agencies-users.

Since the Canadian Hydrographic Service's participation will involve many new developments which are of interest to Hydrographers, permission was granted to the Lighthouse to print excerpts from the Technical Plan which was submitted to the Joint IFYGL Management Team.

EXCERPTS FROM "NAVIGATION SYSTEM" TECHNICAL PLAN

THE IFYGL NAVIGATION SYSTEM

Introduction

Decca Lambda (6f) was specifically designed for hydrographic survey in offshore waters at distances ranging up to six hundred kilometers.

It is a continuous wave phase comparison system and has the capability to operate in the range/range or hyperbolic* mode in the 100 KHz frequency range.

* Decca (6f) in the phase-difference (hyperbolic) mode has been chosen for the IFYGL study, 1972.

Decca is a proven and well documented system of medium range capability presently being used throughout the world for a variety of purposes including charting, research, cable laying, Search and Rescue, etc.

The ultimate accuracy that can be achieved with radio positioning systems in offshore areas is highly dependent on a number of factors -- some of which the planner/user can control, viz., frequency, site selection, etc. However, the major contributor of the non-controllable factors is the effective Velocity of Propagation of electromagnetic radiation; refractivity of the atmosphere and conductivity of water rank high among the contributing agents affecting propagation.

By monitoring the chain pattern and Fixed Error Calibrations we hope to attain absolute accuracy of better quality than mathematically predicted.

Description of the Positioning System

Decca Lambda (6f) in the low-medium frequency range is a transportable electronic positioning system; it is not unlike a number of positioning systems in that it has the advantage of being usable in a three shore station configuration to generate intersecting hyperbolic patterns of phase differences, thus, enabling any number of survey vessels to operate simultaneously.

The system has the distinct feature to enable continuous positioning with the characteristics commonly referred to as The Three R's -- redundancy, reliability and range. Additionally, it has several other advantages that make it attractive to the marine surveyor: the absolute accuracy obtained is of sufficiently high order to permit its use for charting purposes, it can be interfaced to printers and plotters, a multi-user facility, the length of the baseline is not critical, it is not necessary to have any identification device.

Conversely there are a number of restrictions in that: specially constructed plotting sheets are required, the shore stations must be manned, careful site selection and accurate control is required, the system is vulnerable to skywave effect at dawn and dusk, it is subject to wave front retardation - Phase Lag due to the characteristics of the propagation media, viz., water surface, air and land, and high operating and maintenance costs.

Basically, the Decca (6f) chain consists of four shore based slave stations comprising a Master, two Slaves and a monitor station. The latter is required solely to measure the conditions, equipment drift, signal strength, etc.

The following is a tabulation of the system and chain parameters:

IFYGL LAKE ONTARIO

1971

SYSTEM & CHAIN PARAMETERS

The Decca chain will comprise a Master Station, a Red Slave and Green Slave Stations. The following approved frequencies will be transmitted for which licences are being processed by the Department of Communication.

Master	6f	-	84.730 khz
Red	8f	-	112.973 khz
Green	9f	-	127.095 khz

Velocity of propagation - 299,400 km/s

Comparison frequencies for each of the two lattice patterns and lane widths on the baseline.

Red - 24f (3x8f)	-	338.919 khz,	L.W. = 441.698 m
Green - 18f (2x9f)	-	254.190 khz,	L.W. = 588.929 m

Transmitter Locations	Lat. (N)	Long. (W)
Master (Eddystone)	44-03-28.818	78-00-28.550
Slave, Red (Grimsby)	43-11-24.314	79-35-58.053
Slave, Green (Wolfe I)	44-05-53.394	76-26-19.542
Monitor (Port Hope)	43-57-37.994	78-14-30.696

Baselines

Red to Master - 160,618.03 m.

Green to Master - 125,772.79 m.

Ancillary Equipment, Decca (6f)

The Marine Sciences Branch has placed an order for a number of mobile receivers and track plotters from Computing Devices of Canada Ltd. This equipment will be available to the user on or about April 1, 1972 and consists of the following:

a) Type C81 receiver for the larger vessels. This model is a sophisticated version of the survey type 80.

b) Type C81A receiver for the smaller craft - a modified version of the Decca Navigator MK 12.

c) Type 350T Track Plotters for use on the major ships or where required.

Additionally, Decca type MK 8A airborne receivers are available for purchase or rental from the company.

It should be noted that respective zones consisting of 24 lanes of Red and 18 lanes of Green are designated on the decometers alphabetically from A to J inclusive, this accounts for 10 zones. Lanes for the Red pattern are denoted 1-24 (24) while Green reads 30 through 48 (18). Each lane is further sub-divided into tenths and hundredths.

Site Locations, Shore Stations

Hereafter is a chartlet showing the location of Master, Red and Green Slave stations together with a symbolic phase-difference lattice.

The Canadian Hydrographic Service in cooperation with the leasing agency selected the sites while staff from CHS established horizontal control, on the 1927 North American Datum, for the electrical centers and receiving antenna for Monitor, which is near the shoreline and S.W. of Master.

Also CHS has negotiated Land Rental Agreements and secured licences for the Decca Chain and radio transceiver frequencies.

Permission to locate mobile homes to house the electronic equipment and personnel has been obtained from the respective municipalities.

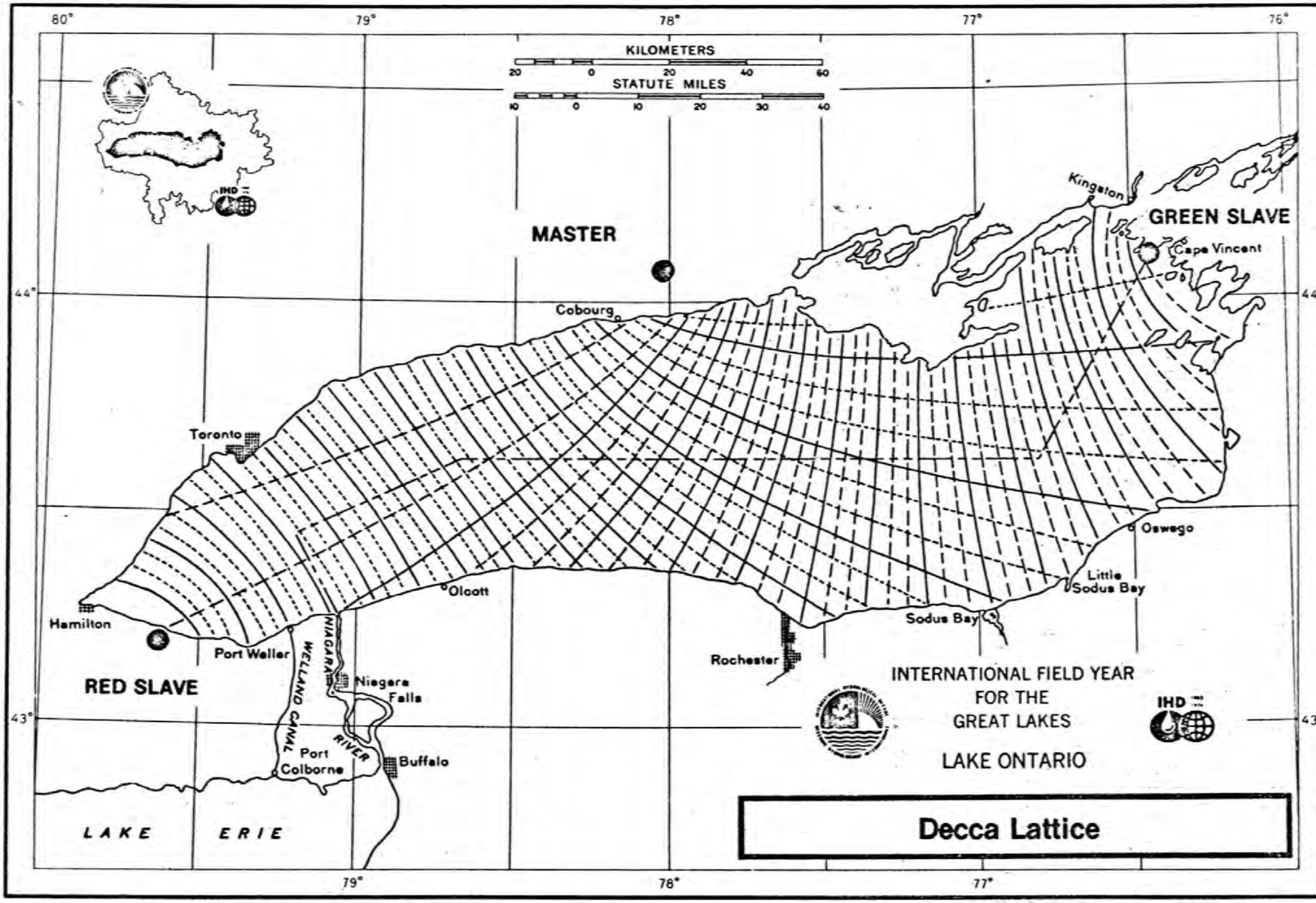
Fixed Error Calibrations

To make the best possible use of the system and obtain optimum results in absolute positioning accuracy, we plan to carry out a series of evaluations for fixed error at predetermined stations around the coastal areas of the Lake (see following sketch).

The Fixed Error Evaluation is necessary to determine the discrepancies caused by Phase Lag, etc. Resulting from this exercise, we will be able to publish a tabulation of corrections to be applied to the respective patterns.

Reconnaissance has been carried out to 'sight' and recover horizontal control points for the evaluation.

Target date for the exercise is late March or early April prior to commencement of the field year.


KILOMETERS
20 0 20 40 60
STATUTE MILES
10 0 10 20 30 40
80° 79° 78° 77° 76°
44° 43°
MASTER
GREEN SLAVE
RED SLAVE
Kingston
Cape Vincent
Cobourg
Toronto
Hamilton
Port Weller
WELLAND CANAL
NIAGARA RIVER
Niagara Falls
Port Colborne
Buffalo
Olcott
Rochester
Sodus Bay
Little Sodus Bay
Oswego
LAKE ERIE
INTERNATIONAL FIELD YEAR
FOR THE
GREAT LAKES
LAKE ONTARIO
IHD
Decca Lattice

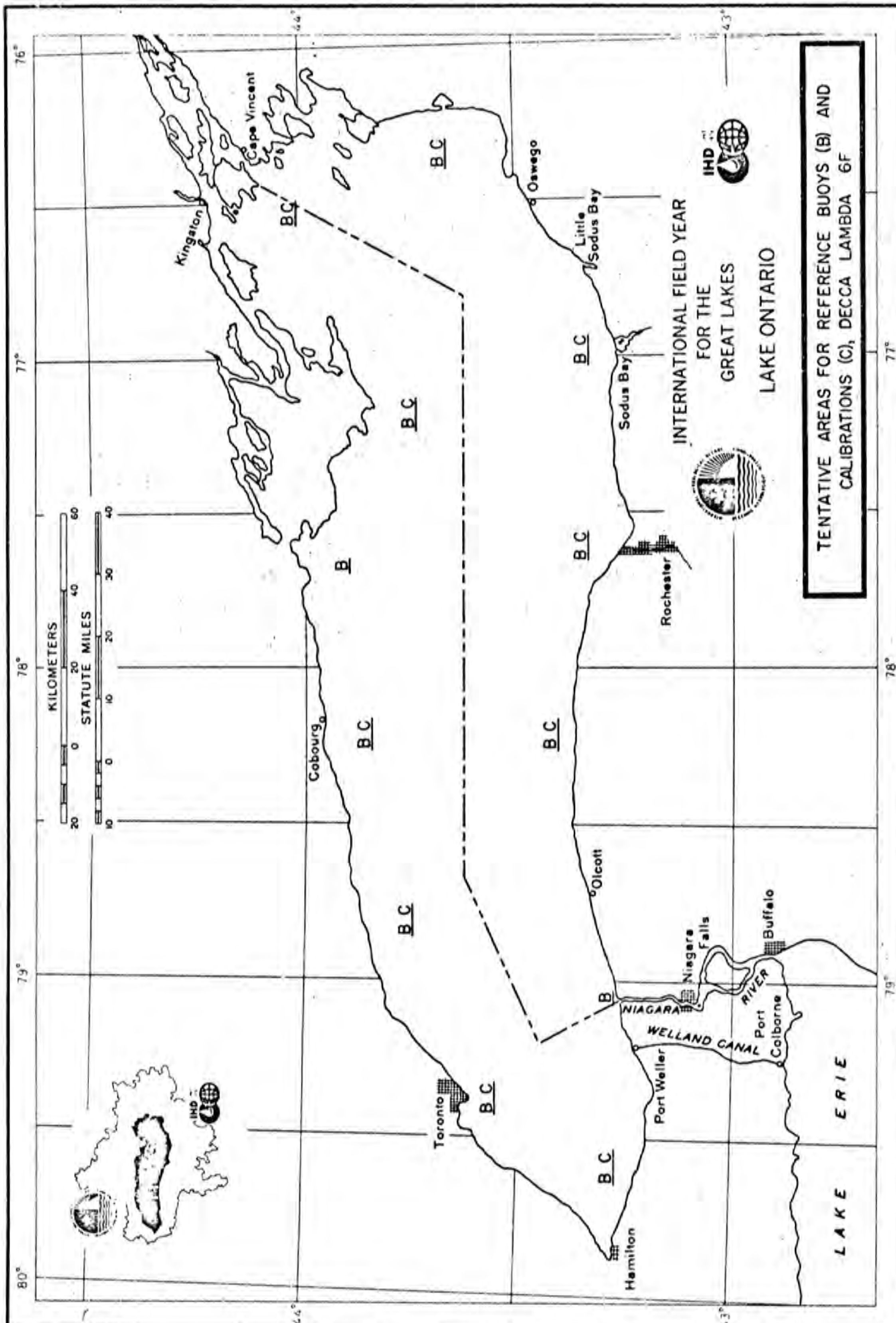
Reference Buoys

The Decca Lambda (6f) positioning system does not incorporate a Lane Identification capability normally common to the Decca Navigator (non-survey) and 12f systems - these systems are primarily used for greater ranges than required in Lake Ontario; it is therefore necessary to moor reference buoys around the periphery of the lake for purposes of establishing zone and lane count for the respective RED and GREEN patterns.

We have estimated that a total of twelve check points will be required to adequately cover the lake and provide a facility for setting, checking and re-setting the patterns. (see sketch).

Marine Sciences Branch has assumed responsibility for mooring the buoys by no later than mid-March and prior to Fixed Error Calibrations.

The buoys to be used are termed 'Winter Spar Buoys' and are fabricated from steel. Dimensions are 17 feet by 2½ feet in diameter. Five-eighths inch steel chain will secure the buoys to 500 lbs. concrete blocks. Two foot radar reflectors will be attached when the Lake is free of ice.



TENTATIVE AREAS FOR REFERENCE BUOYS (B) AND CALIBRATIONS (C), DECCA LAMBDA 6F

Plotting Sheets

The responsibility for constructing the Plotting Sheets is divided between the U.S. Lake Survey Centre at Detroit and the Canadian Hydrographic Service, while the Plotting Sheet Hyperbolic Lattices were computer drawn by the CHS Development Group at C.C.I.W.

Parameters for the manuscript are as follows:

1. Large Scale Plots

Natural Scale,	1:80,000
Projection,	Polyconic with UTM grid
Limits,	see attachment

2. Small Scale Plots

Natural Scale,	1:400,000
Projection,	Polyconic with UTM grid
Limits,	To fit USLS #2, CHS 2000 & 881 charts

3.* Medium Scale Plots (bathymetry only, CHS)

Natural Scale,	1:200,000
Projection,	Polyconic with UTM grid
Limits,	see attachment

(for Plotting Sheet Lay Out, No. 1 and 3, See Sketch)

Base Manuscripts

1:80,000

The scheme to cover the lake, and adjacent land areas at 1:80,000 had been previously determined. It was decided that CHS would compile sheets 1 to 5 inclusive and the USLS would compile sheets 6 to 8. Each agency will print its assigned sheets with the exception of sheet 5 which will be compiled by CHS and printed by USLS.

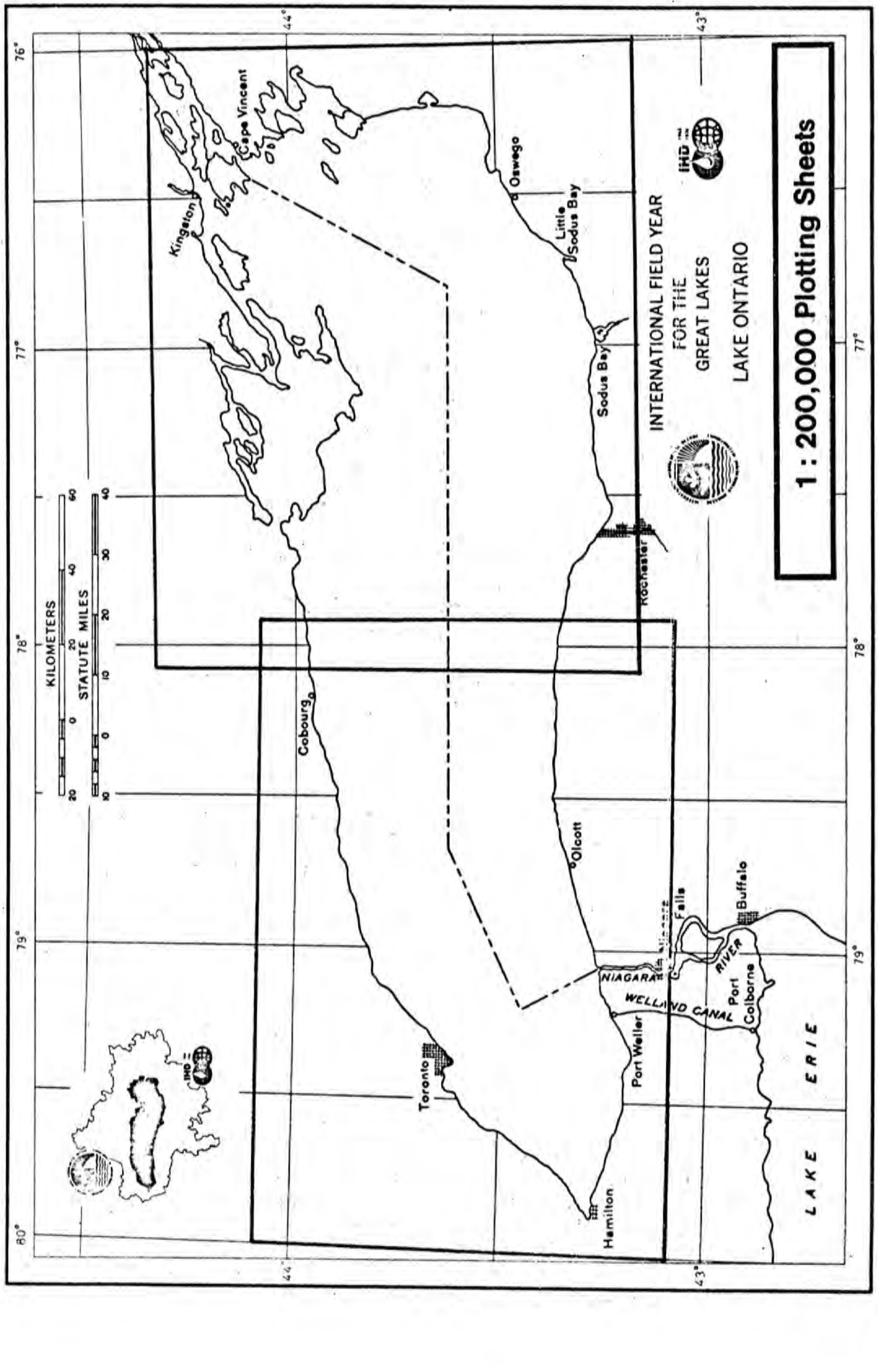
Projection:-

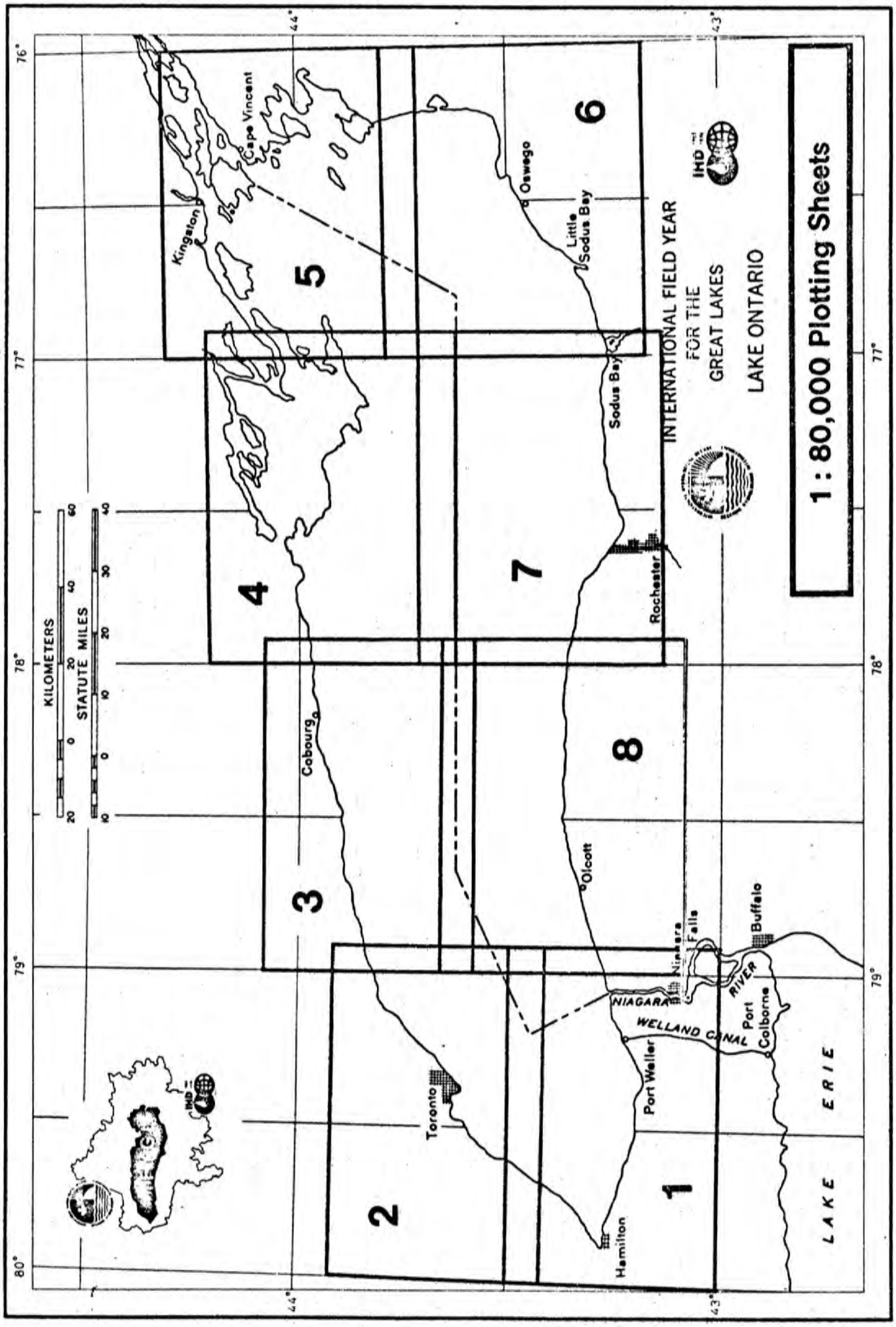
The sheets will have a UTM grid on a polyconic projection.

UTM Grid:-

Grid line interval every 10,000 metres with a sub-division along the grid lines at 1000 meter intervals. Labelling of the metric grid will be placed inside the neat lines.

* Primarily required for a bathymetric survey.


1 : 200,000 Plotting Sheets
INTERNATIONAL FIELD YEAR
FOR THE
GREAT LAKES
LAKE ONTARIO
IHD
KILOMETERS
20 0 20 40 60
STATUTE MILES
10 0 10 20 30 40
Kingston
Cape Vincent
Oswego
Little Sodus Bay
Sodus Bay
Rochester
Cobourg
Olcott
Toronto
Hamilton
Port Weller
NIAGARA
RIVER
Niagara Falls
Buffalo
WELLAND CANAL
Port Colborne
LAKE ERIE
76°
77°
78°
79°
80°
44°
43°


1 : 80,000 Plotting Sheets
INTERNATIONAL FIELD YEAR
FOR THE
GREAT LAKES
LAKE ONTARIO
KILOMETERS
STATUTE MILES
LAKE ERIE
Kingston
Cape Vincent
Oswego
Little Sodus Bay
Sodus Bay
Rochester
Cobourg
Olcott
Niagara Falls
Buffalo
NIAGARA RIVER
WELLAND CANAL
Port Weller
Port Colborne
Toronto
Hamilton
1
2
3
4
5
6
7
8
80°
79°
78°
77°
76°
44°
43°

Polyconic Projection:-

Intersection only to be drawn at a length of 2/10 inches at 5 minute intervals. Labelling will be placed outside the neat lines. The central meridians for the Polyconic Projections are as follows:

Sheets 1 and 2 -- 79°30'
Sheets 3 and 8 -- 78°30'
Sheets 4 and 7 -- 77°30'
Sheets 5 and 6 -- 76°30'

Hydrography:

The contours will be in metres at 10 meter intervals, with the index contours at 50 meter intervals. Shoreline will be from field sheets or published charts where applicable. Place names appearing on topographic maps will be retained as is, except for deletions in the water areas where names conflict with bathymetry. Aids to Navigation will not be shown. The contour interpretation used for CHS Chart 881 will be accepted for use on the 1:80,000 series with minor modifications where necessary.

Topography:

The line and type data shown in black, brown and blue on the Canadian Topographic Maps at 1:50,000 and the U.S. Geological Maps at 1:62,500 will be combined and shown in black on the plotting sheets. The contour labels shown on the maps will be retained and a conversion table added to the chart for conversion to meters above Mean Sea Level and meters above chart datum for Lake Ontario (IGLD). U.S. Lake Survey will supply CHS with positives of the topographic data for the U.S. Sheet 5. The topographic data will extend at least 5 miles from the shoreline and judgement exercised beyond this limit.

Type Style and Line Weights:

The bathymetric contours will be drawn with a line weight of 4/1000 and index contours (50 meter intervals) at 8/1000. Labelling will be the size used by CHS and a negative of the type will be supplied to USLS. Type for other notes will be supplied to USLS on request.

Overlap Areas:-

A print of the overlap areas between sheets will be exchanged as the sheets are completed.

Title Block, Notes and Diagrams:-

The title block will be determined by USLS and a copy supplied to CHS. A diagram showing an index of all plotting sheets will be included on the sheets, USLS to produce standard format and supply CHS.

The sheets bear a note of caution that they are not to be used for navigation other than by participants in IFYGL.

Bar scale for feet, meters, statute miles and yards. CHS to produce standard format and supply USLS.

Colours:-

Lattices	-	Red and Green
Line data and type	-	Black
Land tint	-	Screened Green

Paper:-

The sheets will be printed on the regular chart paper used by each agency and 36" x 48" size will be used for all sheets.

The target date for completion is January 1, 1972.

LANE WIDTHS FOR RED & GREEN ON THE BASELINES

Lane Width (Red) = $\frac{299400}{2x338.919}$ = 441.698 m

Lane Width (Green) = $\frac{299400}{2x254.190}$ = 588.929 m

ZONE WIDTHS ON THE BASELINES

------ WHERE RED = GREEN

RED	24f	24 x 441.698	= 10600.752 m = 1 Zone
			= 34779.4029 ft.
GREEN	18f	18 x 588.929	= 10600.722 m = 1 Zone
			= 34779.3045 ft.

A. AT 1:80,000 or 1 inch = 6666.6666 ft.

1 Zone (Red) is = 34779.4029 = 6666.6666 = 5.2169"
1 Zone (Green) is = 34779.3045 = 6666.6666 = 5.2169"

B. AT 1:200,000 or 1 inch - 16,666.6666 ft.

1 Zone (Red) is = 34779.4029 = 16,666.6666 - 2.0867"
1 Zone (Green) is = 34779.4029 = 16,666.6666 - 2.0867"

C. AT 1:400,000 or 1 inch - 33,333.3333 ft.

1 Zone (Red) is = 34779.4029 = 33,333.3333 - 1.0433"
1 Zone (Green) is = 34779.4029 = 33,333.3333 - 1.0433"

COMMUNICATIONS

During all operations, when utilizing the Decca Positioning system, it is imperative that the user have the capability to communicate directly with the MONITOR station for purposes of obtaining information on any irregularities to the transmitted patterns, signal strengths, etc. For the foregoing the assigned frequency must necessarily be guarded.

Also, a second frequency has been assigned for intership use together with back-up channels as per the following:

S.S.B. 6211 KHz	Monitor - Canadian Vessels Monitor - 'Researcher'*, USA for transmission to other US Vessels.
S.S.B. 4140.9 KHz	Intership, Canada and USA
S.S.B. 6214.9 KHz	Interstation, Decca Chain
122.7 KHz	Aircraft - major Canada and USA vessels
Telephone Link	Monitor - IFYGL Operation Room, C.C.I.W.
Telex	IFYGL Operations Room, C.C.I.W. IFYGL Rochester
DOT Coastal Stations	For emergencies, ships - CCIW and intership

N.B. It must be emphasized that the user shall not under any circumstances attempt to contact Master or the Slave stations. Licences for the above frequencies have been acquired from the Dept. of Communications.

* 'Researcher' or senior United States ship.

COMPUTER PROGRAMMES -- DATA PROCESSING

A number of computer programmes have been refined by the CHS Development Group at CCIW to assist the hydrographer in the areas of Fixed Error Calibrations, positioning of reference buoys and in the IFYGL charting programs.

These programmes were written primarily to enable the conversion of the Decca fix point to U.T.M. grid or geographic coordinates and the converse.

The computer programmes were written in FOCAL for the Digital Equipment Corp. PDP-8/I computer.

The following is a tabulation of the service available with a turn-around time, under ordinary circumstances, of one hour and field data required for Fixed Error Calibrations:

F030 UTM to Decca Conversions
F031 Decca to UTM Conversions
F032 Geographic to Decca Conversion
F033 Decca to Geographic Conversion

Calibration programmes are available for calibration by any of the following methods:

(1) By Range-bearing
2) By Theodolite
(3) By Resection

(1) <u>Required Input</u> - Position of observing and Reference station, observed angle, and observed distance in meters.

(2) <u>Required Output</u> - Positions of observation and reference stations, and observed angles.

(3) <u>Required Input</u> - Positions of observed stations as well as left and right angle.

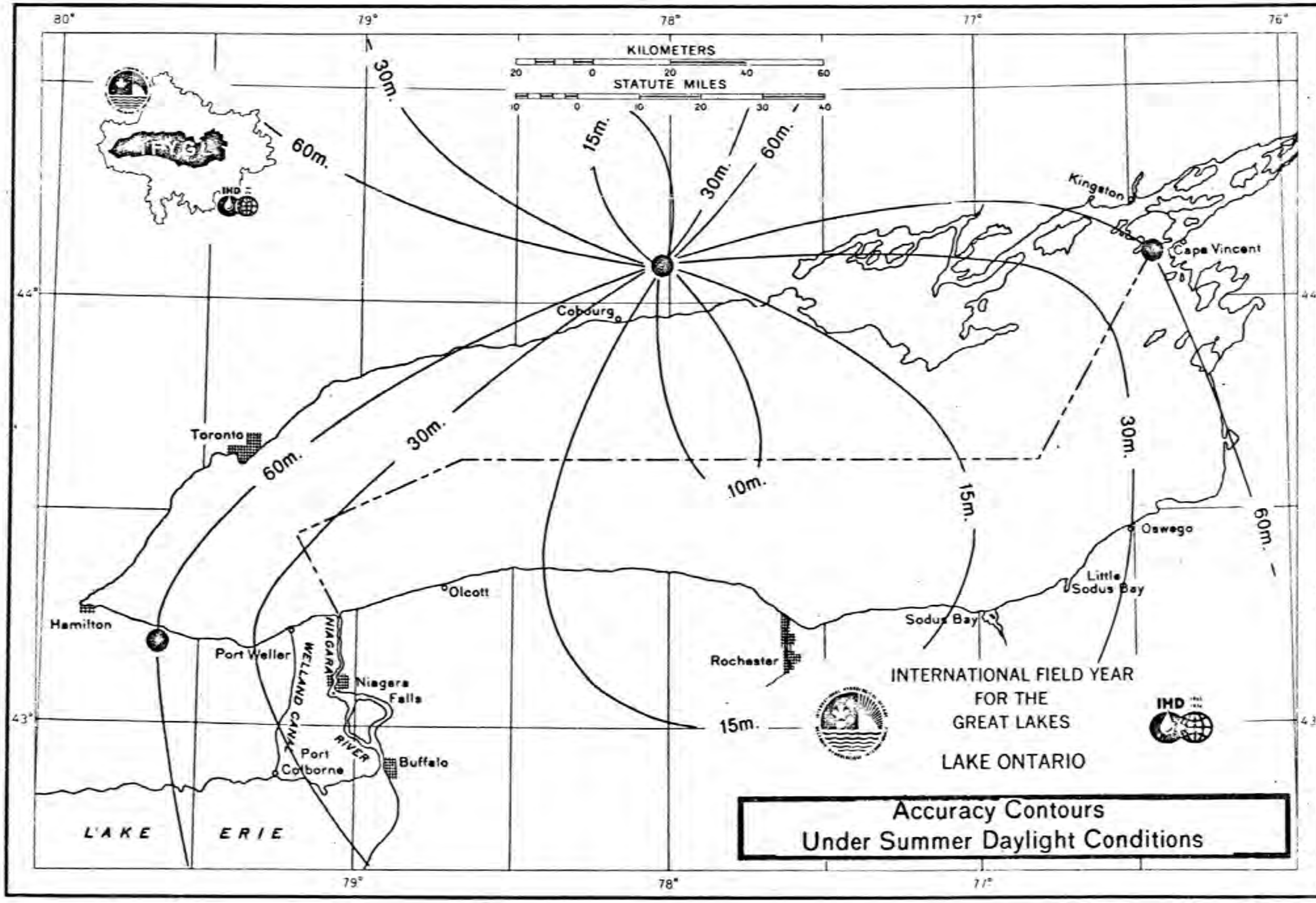
POSITIONING ACCURACY

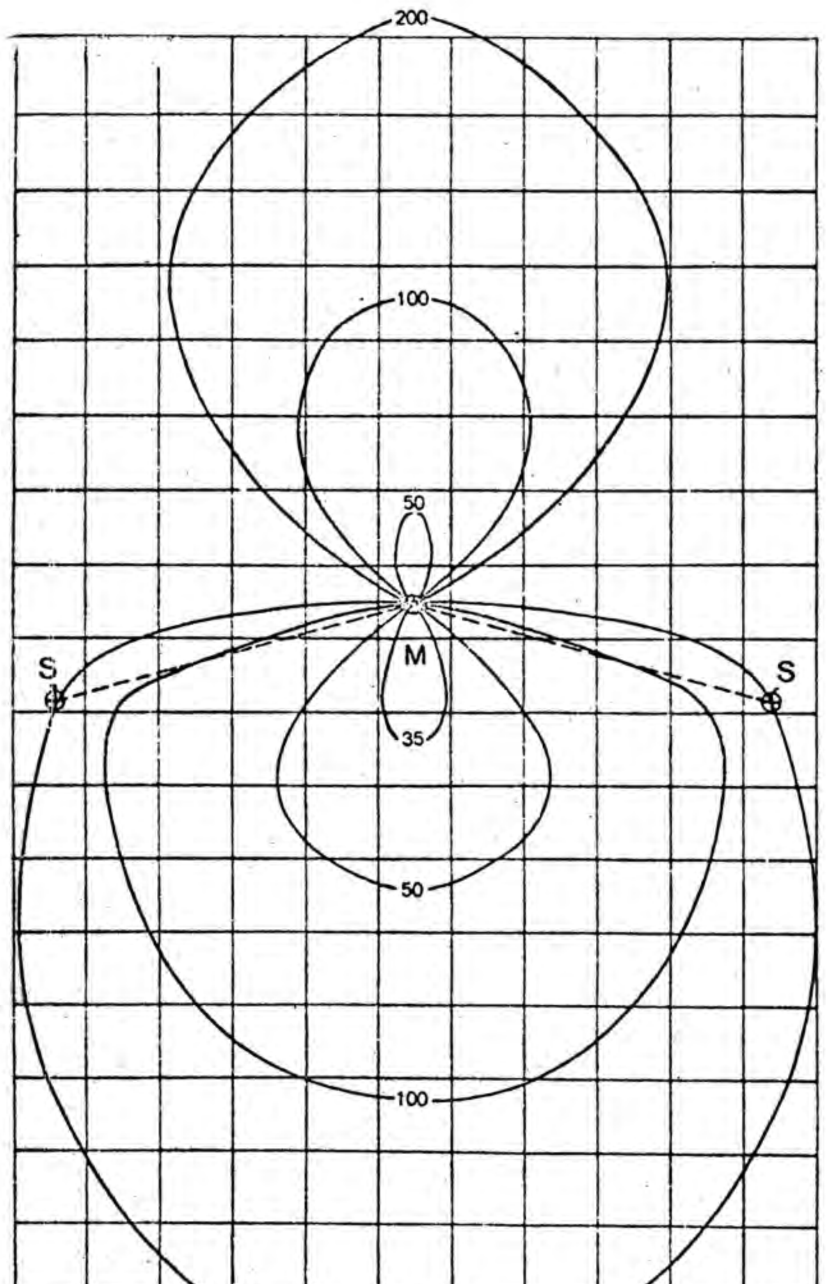
The results of a recent and comprehensive evaluation of Decca Survey as carried out by the MSB indicates an accuracy of ±20 meters for long line measurement over seawater. These tests were carried out at ranges varying from 100 to 500 n.m.

The relatively high accuracy of Decca Lambda can be partly attributed to the low ratio of ground wave to skywave.

At maximum ranges of 150 n.m., for Lake Ontario IFYGL project, skywave effect will not likely occur. However, should it occur at any time it is emphasized that the system must not be used as there are no known adjustments.

The attached Accuracy Contour Diagrams, Parts 1 and 11, are representative of the absolute positioning accuracy that can be expected during summer daylight hours for 60% of the time. However, with Fixed Error Calibrations, as proposed and application of the corrections as indicated much better results can be had -- possible 20-30 meters at the extremities of the lake.


KILOMETERS
STATUTE MILES
30m.
60m.
15m.
30m.
60m.
10m.
15m.
30m.
60m.
Toronto
Hamilton
Port Weller
WELLAND CANAL
NIAGARA
RIVER
Niagara Falls
Port Colborne
Buffalo
Olcott
Cobourg
Rochester
Sodus Bay
Little Sodus Bay
Oswego
Kingston
Cape Vincent
LAKE ERIE
INTERNATIONAL FIELD YEAR
FOR THE
GREAT LAKES
LAKE ONTARIO
Accuracy Contours
Under Summer Daylight Conditions



Baselines at 150°

Accuracy contours in feet for a standard deviation of 0.01 mean lane.

The squares have sides one-fifth of the baselines and enable ranges and areas covered to be quickly estimated.

M = master
S = slave

Type 350T Track Plotter

In navigation at sea, the process of plotting a Decca fix manually is generally fast and simple enough, but the use of a continuously recording automatic plotter has proved to be of considerable value for survey operations.

The Marine Automatic Plotter translates the decometer information into related movements of a roller-mounted chart (representing the vertical coordinate) and a plotting pen moving along the horizontal axis. Thus the hyperbolic Decca position-line patterns are presented upon the chart in the form of a rectilinear lattice, the pen indicates the position of a ship in terms of that lattice at any instant, and traces a continuous record of the track made good. If it is desired to follow a particular track or tracks, these may be drawn on the chart in advance and the ship steered so as to maintain the pen on the required line.

EXCERPTS FROM "BATHYMETRIC SURVEY" TECHNICAL PLAN

BATHYMETRIC SURVEY, LAKE ONTARIO

The Canadian Hydrographic Service, M.S.B., will carry out a bathymetric survey of the offshore areas of Lake Ontario as an integral part of the IFYGL study.

The results of this survey will enable the publication of a new navigational chart and the data will be made available to the concerned and participating scientific agencies.

C.S.S. 'LIMNOS' has been committed to the charting project for the periods as indicated:

A. June 12 - June 23
B. September 11 - September 22
C. October 23 - November 11

Estimated mileage to adequately delineate bottom contours and provide coverage of the offshore areas is 5500 n.m. To reach this objective in the time allotted will necessitate a 24-hour operation.

Specifically, the Lake will be surveyed at 1:200,000 with the data portrayed on a polyconic projection. Should it be necessary, areas of special interest can be surveyed at a scale of 1:80,000.

For charting purposes, the Lake will be divided into three zones, viz.:

(a) Less than 30m in depth
(b) More than 30m but less than 100m in depth
(c) More than 100m in depth (see sketch)

Zone (a) will require a large scale survey, therefore it is not intended to sound the zone at this time.

Zone (b) will be surveyed using a sounding line spacing of ¼" or 0.69 n.m.; the total mileage for this zone will be approximately 2,300 n.m.

Zone (c) will be surveyed using a sounding line spacing of ½" or 1.39 n.m. and the total mileage for this zone will be approximately 1,680 n.m.

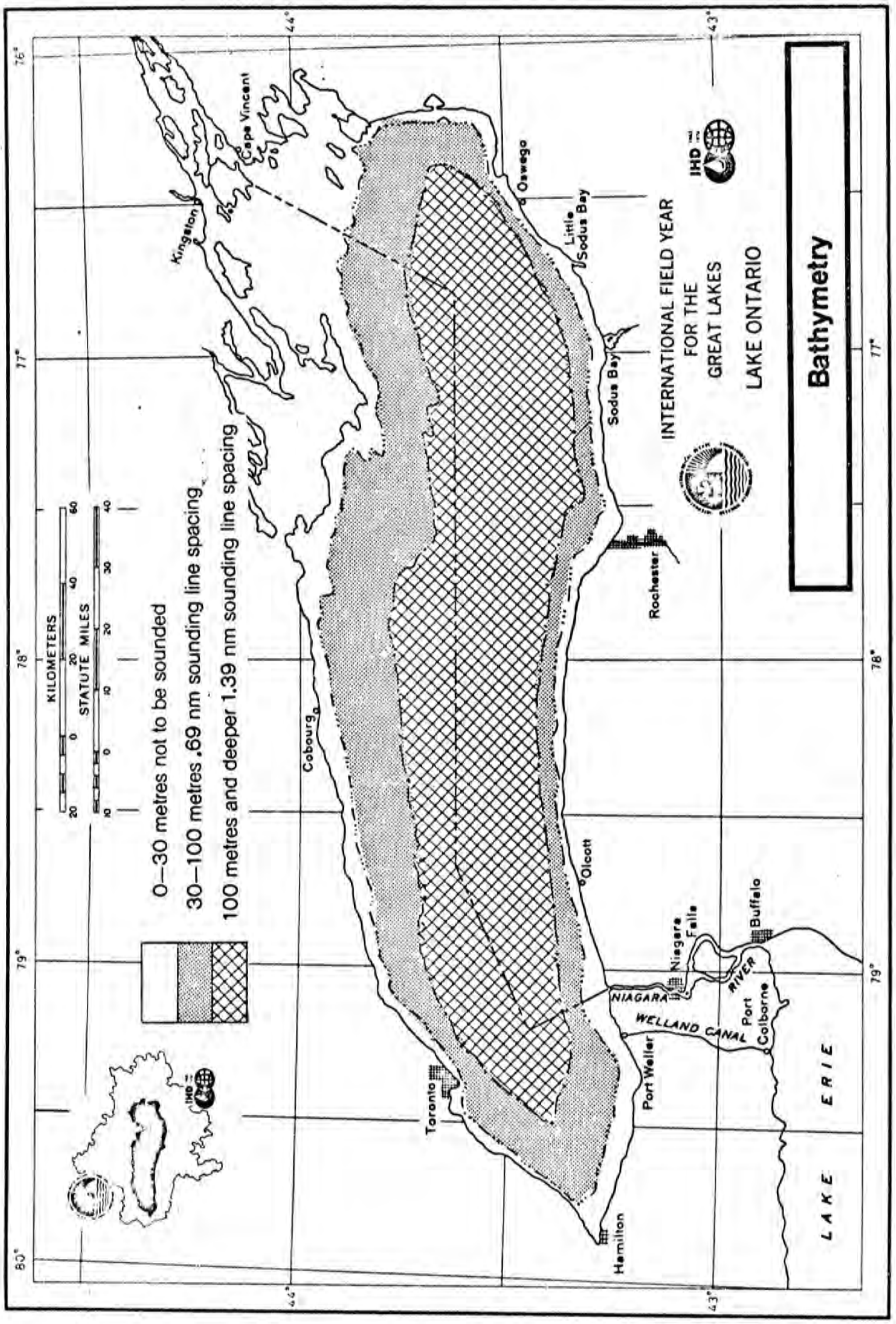
In general, the sounding lines will be N-S oriented and check sounding lines will run E-W.

In the eastern U.S. section of the Lake, the lines will run E-W with N-S check lines.

Additional lines will be run in areas of rapidly changing depth to give optimum contour accuracy. Sounding lines over the deep trench at the eastern end of the Lake will be run normal to the axis of the trench. Approximate mileage -- 500 n.m.

Acquisition and Data Processing of Bathymetry

The C.H.S. Development Group at C.C.I.W. will provide a service for the bathymetric survey in support of acquiring, recording and processing data pertaining to the chain pattern and bathymetry. The following description, block diagram and sample sheets are self-explanatory.


Bathymetry
LAKE ONTARIO
INTERNATIONAL FIELD YEAR
FOR THE
GREAT LAKES
IHD
0–30 metres not to be sounded
30–100 metres .69 nm sounding line spacing
100 metres and deeper 1.39 nm sounding line spacing
KILOMETERS
STATUTE MILES
Kingston
Cape Vincent
Oswego
Little Sodus Bay
Sodus Bay
Rochester
Cobourg
Olcott
Toronto
Hamilton
Port Weller
Niagara Falls
Buffalo
NIAGARA RIVER
WELLAND CANAL
Port Colborne
LAKE ERIE
76°
77°
78°
79°
80°
44°
43°

Description of the 'HAAPS' System

'HAAPS' which is the acronym for Hydrographic Acquisition and Processing System, was designed to record Hydrographic parameters in survey launches and small ships.

As the name implies, the system is made up of components to collect and process the data. The processing is not done on line, to increase flexibility of the system.

First the collecting or acquisition system is made up of four major components in addition to the echo sounder and Decca receiver (see flow chart, figure 1).

Echo Sounder - Standard Atlas Survey echo sounder operating with dual frequencies of 30 and 220 KHz.

Depth Digitizer - Connected to the echo sounder is a C-Tech Model DSS-101 digital depth indicator which provides a visual indication of depth in nixi tubes as well as output in 8241 BCD for external recording.

Decca Receiver - Standard receiver as supplied to users.

Decca Digitizer - Connected to the Decca receiver is a ComDev Marine Model LPD-401 digitizer display unit. This unit presents the Decca co-ordinates in digital form as well as output to the data coupler in BCD.

Data Coupler - The heart of the logging system is the ComDev Marine Digital Coupler type DC111, designed specifically for Hydrographic requirements. The unit has an internal fix number generator as well as digital clock. The coupler accepts data from the depth digitizer, Decca digitizer and manual input of administrative data. Data will be recorded on Eastern Standard Time and the Julian day will be used.

Magnetic Tape Unit - Each 40-digit line of data from the data coupler is recorded on the Kennedy Model 1600 tape recorder, once per second, at 200 bits per inch. A record gap is written at a selectable rate from 10 seconds to 2 minutes (see figure 2).

The processing system can be divided into two portions - hardware and software.

Hardware - A Digital Equipment Corporation PDP-8/E computer expanded to 8,192 words of memory, a high speed paper tape reader, and punch, a 7-track IBM compatible incremental magnetic tape unit, a ASR-33 teletype and a Calcomp Model 563, 70 cm wide drum plotter with 0.1 m increment.

Software - The software used to process the data has been written in the interpretive language FOCAL. The primary program called MGCONPLOT performs the following steps:

1) Reads one record of data into core buffer.
2) Selects the shallowest point for this record.
3) Calculates plotter co-ordinates for this point.
4) Depth data is corrected for water level above datum.
5) Position data is corrected for water level above datum.
6) Depths are plotted centered about their corresponding position.
7) Editing is performed to present overprinting.
8) A data tape of information plotted is generated along with hard copy of the teletype (See figure 3).

A sample plot of data, as plotted on the Calcomp plotter, is as shown in Figure 4.

All blocks of data, which are at this stage, stored on paper tape, will be combined and plotted on our Gerber 22 plotting table. This table has an active plotting area of 60 by 50 inches with a repeatable accuracy of 0.007 inch.

The data will be stored indefinitely in two forms - (1) the original collector tapes will be stored and (2) the edited paper tape data will be stored. Both will be available to any interested unit.

Hydrographic Acquisition and Processing System

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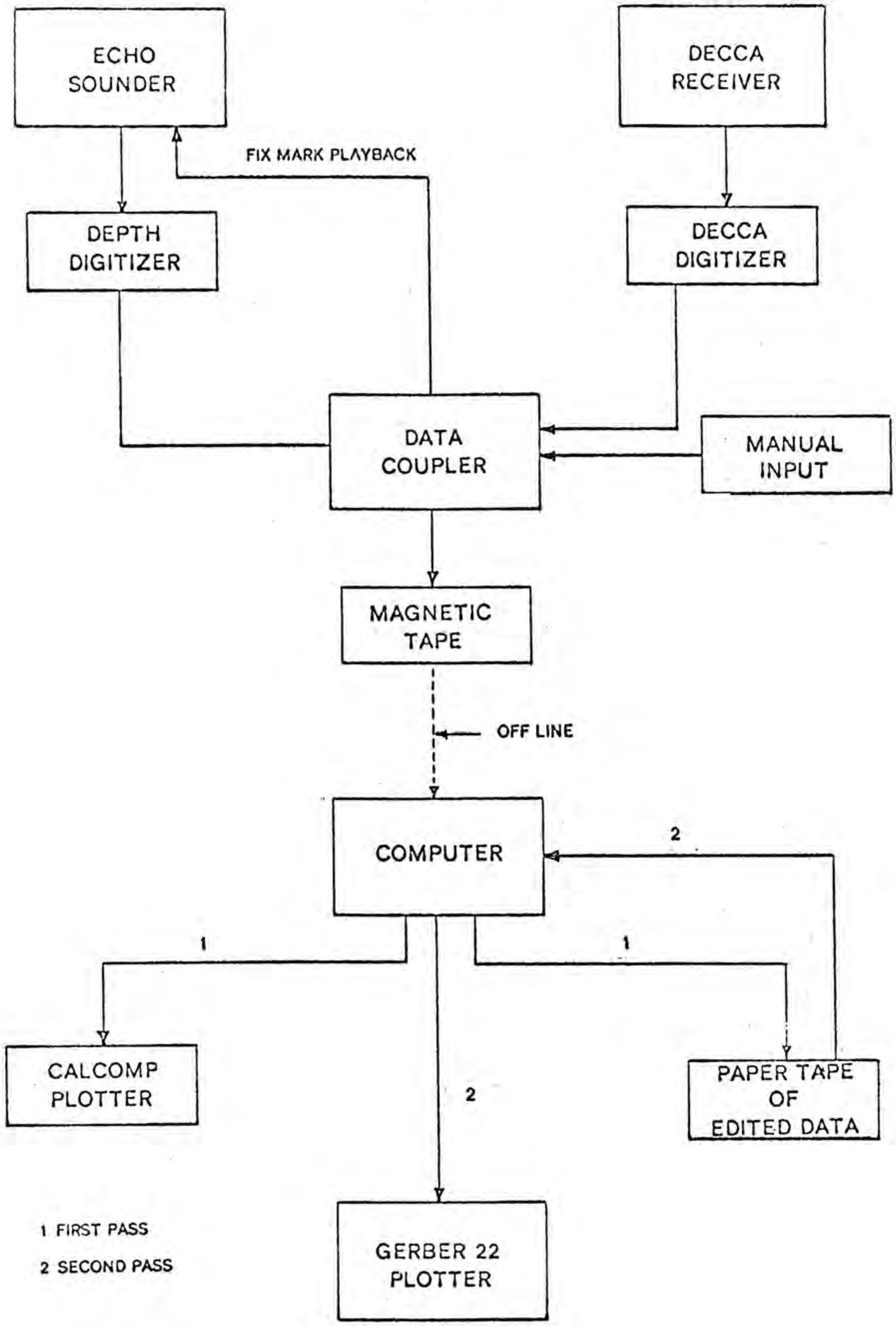


	TIME	RED	GREEN	DEPTH	SER. No.	ADMIN. DATA
=	93001=	8557=	10548=	149=	1682=	101244710
=	93002=	8557=	10542=	148=	1683=	101244710
=	93003=	8557=	10538=	145=	1684=	101244710
=	93004=	8558=	10529=	146=	1685=	101244710
=	93005=	8558=	10524=	148=	1686=	101244710
=	93006=	8558=	10521=	148=	1687=	101244710
=	93007=	8557=	10510=	148=	1688=	101244710
=	93008=	8557=	10505=	152=	1689=	101244710
=	93009=	8557=	10500=	154=	1690=	101244710
=	93010=	8556=	10494=	153=	1691=	101244710
=	93011=	8556=	10488=	152=	1692=	101244710
=	93012=	8556=	10481=	150=	1693=	101244710
=	93013=	8555=	10477=	150=	1694=	101244710
=	93014=	8554=	10472=	150=	1695=	101244710
=	93015=	8554=	10466=	153=	1696=	101244710
=	93016=	8553=	10462=	152=	1697=	101244710
=	93017=	8552=	10454=	152=	1698=	101244710
=	93018=	8551=	10453=	152=	1699=	101244710
=	93019=	8551=	10448=	153=	1700=	101244710
=	93020=	8550=	10441=	154=	1701=	101244710
=	93021=	8549=	10438=	155=	1702=	101244710
=	93022=	8549=	10429=	154=	1703=	101244710
=	93023=	8549=	10426=	153=	1704=	101244710
=	93024=	8548=	10420=	153=	1705=	101244710
=	93025=	8548=	10413=	155=	1706=	101244710
=	93026=	8548=	10408=	159=	1707=	101244710
=	93027=	8548=	10403=	159=	1708=	101244710
=	93028=	8547=	10395=	159=	1709=	101244710
=	93029=	8547=	10391=	159=	1710=	101244710
=	93030=	8546=	10385=	159=	1711=	101244710
=	93031=	8545=	10380=	159=	1712=	101244710
=	93032=	8544=	10375=	160=	1713=	101244710
=	93033=	8544=	10368=	159=	1714=	101244710
=	93034=	8543=	10364=	158=	1715=	101244710
=	93035=	8541=	10359=	156=	1716=	101244710
=	93036=	8541=	10355=	157=	1717=	101244710
=	93037=	8540=	10349=	160=	1718=	101244710
=	93038=	8539=	10344=	165=	1719=	101244710
=	93039=	8537=	10340=	166=	1720=	101244710
=	93040=	8536=	10335=	165=	1721=	101244710
=	93041=	8536=	10328=	163=	1722=	101244710?18.23 @ 08.10
*						

FIGURE 2
DATA AS RECORDED ON MAGNETIC TAPE

```
G
SKIP FROM :2030  TO :2035
ION :.10 :.15 :1650
TIDE :03 :1530
?18.23 0 25.20
*T FRMT(1)
=            0*G 7.1
```

	TIME	RED	GREEN	DEPTH (Feet)	Corrected depth (Fathoms & Feet)
=	83913=	84.11=	76.96=	120=	19
=	83931=	84.12=	76.06=	119=	19
=	83953=	84.12=	76.06=	116=	18
=	84029=	84.11=	73.13=	112=	18
=	84059=	84.14=	71.62=	110=	17
=	84127=	84.08=	70.22=	104=	16
=	84157=	84.11=	68.73=	100=	161
=	84227=	84.10=	67.20=	95=	152
=	84259=	84.13=	65.63=	85=	134
=	84329=	84.12=	64.12=	78=	123
=	84355=	84.10=	62.82=	70=	111
=	84427=	84.08=	61.25=	60=	93
=	84459=	84.12=	59.71=	53=	82
=	84531=	84.13=	58.09=	57=	9
=	84601=	84.13=	56.63=	59=	92
=	84631=	84.13=	55.15=	63=	10
=	84701=	84.08=	53.68=	65=	102
=	84731=	84.12=	52.15=	69=	11
=	84801=	84.09=	50.67=	72=	113
=	84807=	84.09=	50.67=	71=	112
=	84831=	84.09=	49.15=	73=	114
=	84903=	84.10=	47.58=	85=	134
=	84927=	84.10=	47.58=	80=	125
=	84957=	84.11=	44.89=	72=	113
=	85029=	84.11=	43.34=	65=	102
=	85059=	84.09=	41.90=	52=	81
=	85123=	84.10=	40.76=	39=	6
=	85151=	84.10=	39.48=	35=	52
=	85201=	84.07=	38.97=	35=	52
=	85229=	84.07=	38.97=	30=	43
=	85301=	84.14=	36.22=	14=	15
=	85331=	84.08=	34.84=	23=	32
=	85359=	84.08=	34.84=	20=	25
=	85425=	84.19=	32.49=	18=	23
=	85441=	84.06=	31.78=	15=	2
=	85501=	84.12=	30.88=	15=	2
=	85529=	84.12=	30.88=	13=	14
=	85547=	84.05=	28.82=	12=	13
=	85609=	84.10=	27.89=	11=	12
=	85631=	84.06=	27.37=	10=	11
=	85701=	84.09=	26.65=	10=	1?01.00 0 26.10
*					

FIGURE 3

HARD COPY OF PLOTTED DATA

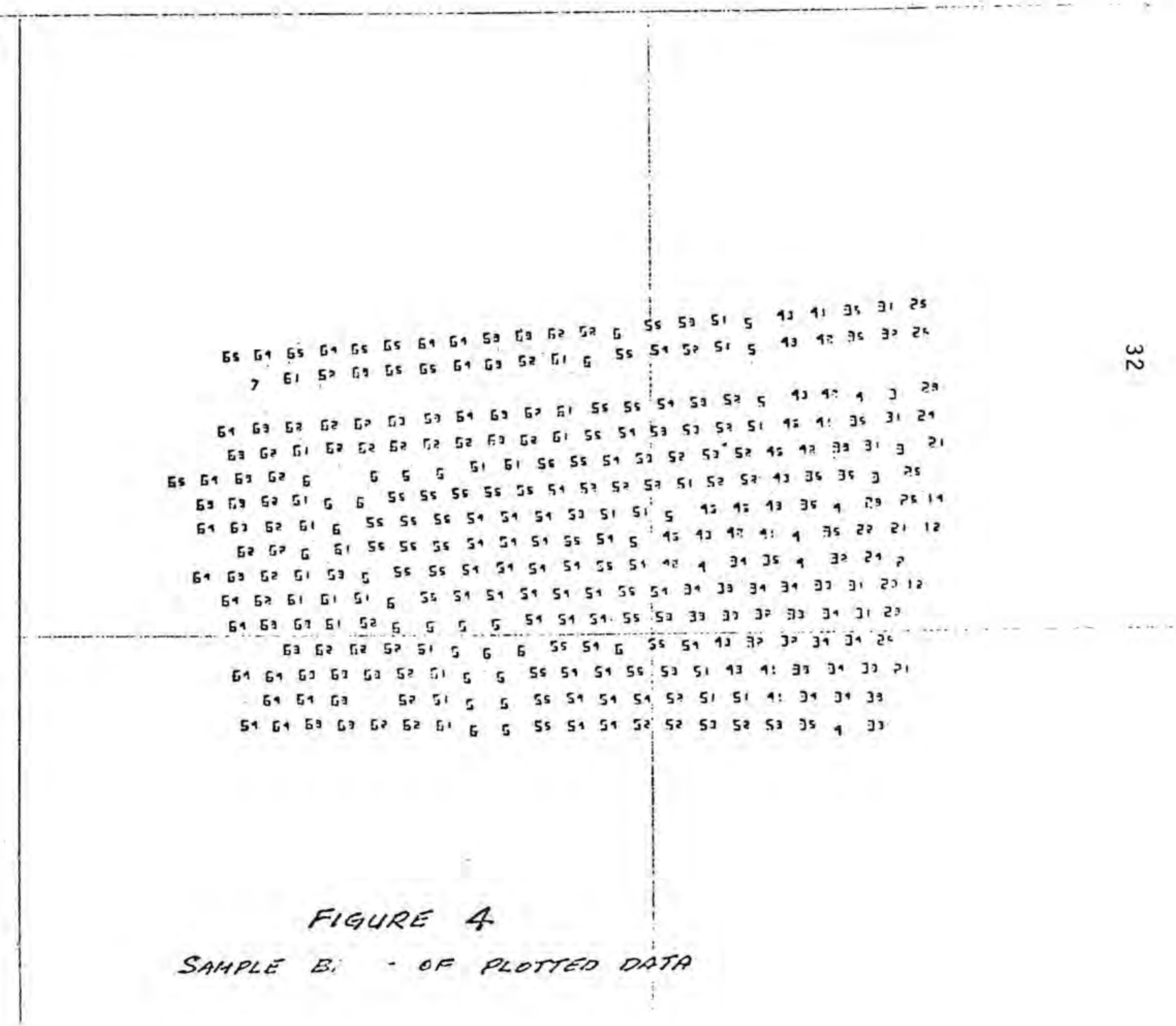


FIGURE 4

SAMPLE B - OF PLOTTED DATA

VESSELS

Vessels owned or chartered by the Government of Canada, participating in IFYGL and as follows:

CSS LIMNOS	Department of the Environment
MV MARTIN KARLSEN	Department of the Environment (Chartered)
MV LAC ERIE	Department of the Environment (Chartered)
CSL AQUA	Department of the Environment
CSL LE MOYNE	Department of the Environment
CSL STURDY	Department of the Environment
CCGS PORTE DAUPHINE	Ministry of Transport

Ontario Department of Lands and Forests:

VESSEL I:	COTTUS	(offshore work)
VESSEL II:	KEENOSAY	(nearshore work)

MINAMATA AND MERCURY

In stock crime movies, members of the ruling syndicate invariably outfit an upstart competitor with cement "shoes", escort him out to sea, and gleefully throw him overboard. This cinematic cliche is another testimony to man's ageless belief in the ocean as the perfect disposal unit. We have been tossing, shoveling, squirting, leaking, spilling, sinking, draining and dumping unwanted things into the ocean for centuries.

This carefree disposal, today, nears floodtide proportions. An industrial society's most prominent product is wastes, wastes that grow in volume, variety, and toxicity, and continually and more persistently threaten to engulf us in gross ugliness and alarming pestilence. As a solution to an ever increasing accumulation of wastes, the ocean is not only considered a handy dump, but an economical one, fully capable of diluting, neutralizing, and absorbing the flood of solid and liquid wastes to which it is subjected.

Minamata Bay is a rugged niche in the coast of Kyushu, a Japanese main island. A sweet abundance of fish and shellfish support the Bay's eleven fishing villages. Just inland lies Minamata City, where a large chemical plant employs many of the city's residents.

In 1953, 19 years ago, a mystifying nerve disease made its appearance at Kyushu. People of varying ages, sex, and physical well being were struck by the disease which left its victims helpless cripples in the throes of violent nervous disorders. Senses which no longer responded, limbs which suddenly collapsed, uncontrollable twitching, and rapid deterioration of mental ballast and cognizance, were well catalogued reactions of victims. The disease became known as 'Minamata Disease', and between 1953 and 1960, one hundred and five cases were reported.

Doctors were baffled by its cause, much less its cure. Medical teams from the United States diligently examined victims. Encephalitis, toxic metals, and thiamine deficiency were all considered as possible causes, but all were ultimately rejected. Researchers were reduced to isolating living habits common to the victims of Minamata Disease. Most lived in fishing villages rather than the city. Many had cats as pets, cats that were often afflicted with the same disorientation that seized their masters. Strangely, these cats, unbalanced in direction, would suicidally plunge into the sea.

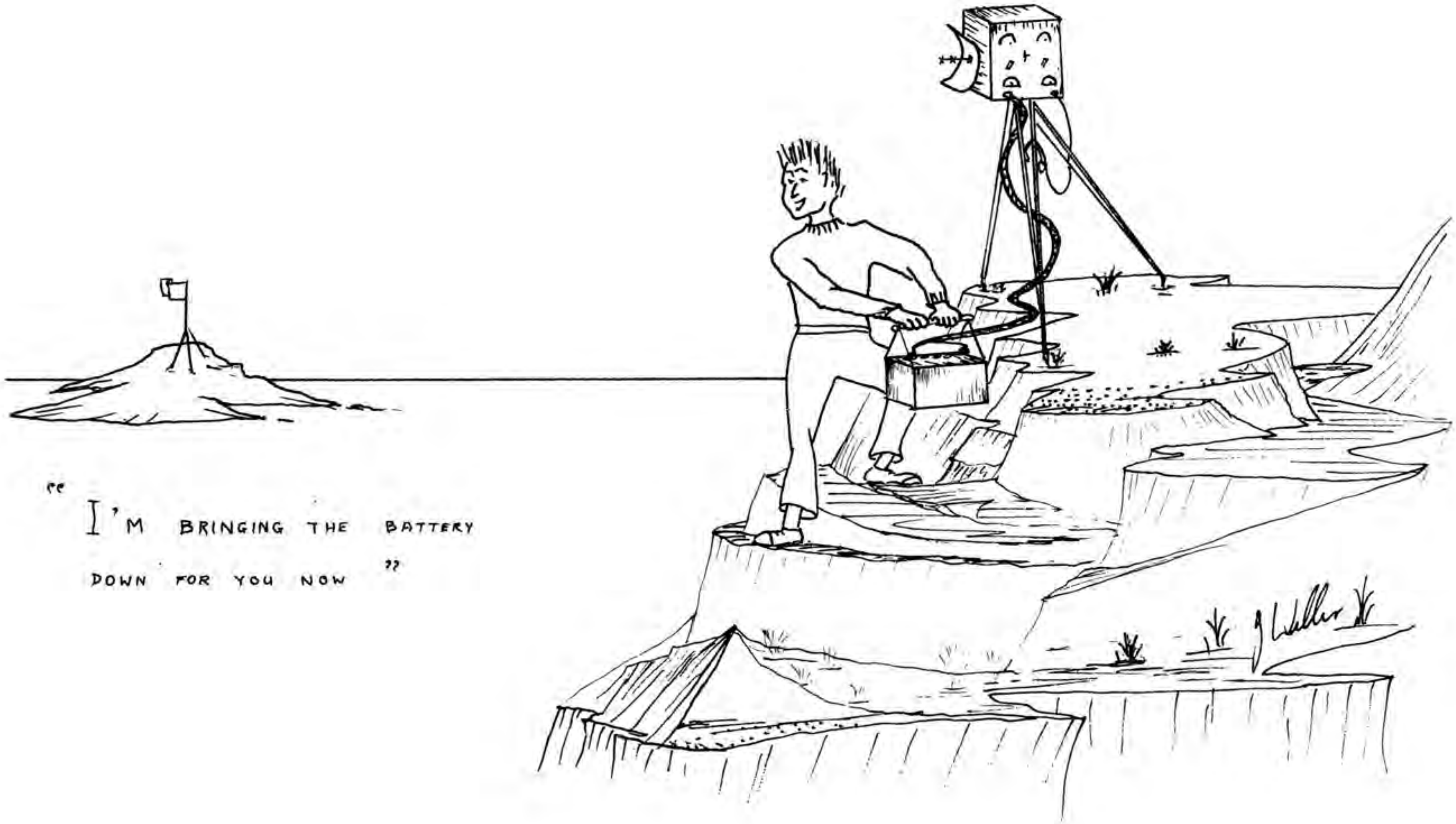
The cats and their masters had one thing in common. Both consumed seafood caught daily in the bay. Sample Minamata Bay shellfish were analysed for toxic content. Although quite healthy in their own right, the shellfish were found to contain high concentration of mercury. When these shellfish were fed to laboratory cats, the cats swiftly developed nervous disorders akin to Minamata Disease.

Mercury's toxicity derives from its ability to penetrate the blood-brain barrier, and disrupt the central nervous system. Where the Minamata shellfish were picking up their mercury temporarily perplexed investigators. Then it was noted that the large chemical plant at Minamata City had increased its production of vinyl chloride, used in phonograph records and plastics. After being processed, the vinyl chloride was washed to rid it of impurities, including residues of the catalyst, which contained mercuric chloride. The washing process left the plant with volumes of impure water, and the answer to the problem, typically enough, was to dump it into the bay.

Thus ended the mystery of Minamata Disease and, incidentally, the fishing industry; and the exposure to the world of a new concern -- mercury contamination.

It has been fourteen years since the causes of Minamata Disease became apparent, yet only in the last three years has mercury pollution of our waters been brought to the public attention.

Bruce Wright


"I'M BRINGING THE BATTERY
DOWN FOR YOU NOW"

REPORT ON VISIT TO DUTCH HYDROGRAPHIC OFFICES

During my winter vacation, which I spent in Holland, I visited the offices of the Royal Netherlands Navy Hydrographic Bureau and the Ministry of Transport, Roads and Waterways.

From my talks with several of the hydrographers of the Navy it appears that the methods and instruments used differ only in detail. Their standards of accuracy are similar to ours. In Holland itself, however, they are not so much involved anymore with horizontal and vertical control work, since these nets are very well developed. They just recover horizontal control points and set up their positioning systems. For tidal and controlled waterlevel information they just contact the nearest office responsible for the area to obtain the required information. Naturally in a country that size you sort of expect this.

In Dutch Guyana (its actual name was and is: Suriname), a group ran a horizontal control net along the coast there a few years ago. The problems they had were quite different from what we usually encounter. Practically all legs of the traverse had to be cut out of a dense jungle in order to obtain line of sight for theodolites and tellurometers. They used sturdy 10 foot towers as observation platforms and targets. Because of local conditions they were usually unable to use lines any longer than 1.5 Km which obviously does not allow speedy work as we know it. Lines 30 Km long are quite common in the CHS.

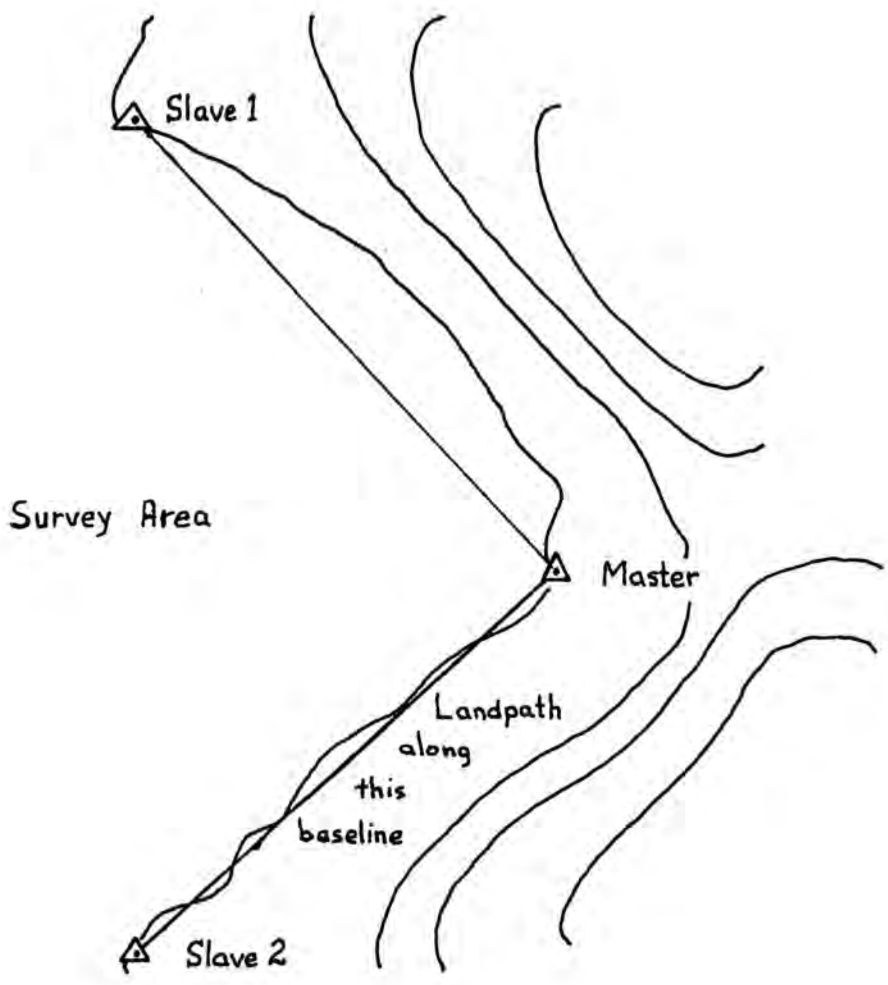
When Indonesia became independent in the late forties and again when all Dutch influence was eliminated in the mid-fifties, a large area of responsibility was lost by the Hydrographic Bureau. Now they only survey the Dutch coast and inland waters, former possessions in the Caribbean and any other area where a joint effort between 2 or more governments calls for their assistance.

All hydrographic data, either obtained by themselves or from other agencies and private firms, are processed by them in order that they can publish the necessary charts.

On their small craft charts they use more colours than we do to emphasize important information. These charts are published in book form, measuring about 14 x 21 inches, with about 5 sheets in each 'book'. Supplemental information is shown on the inside cover, just like ours.

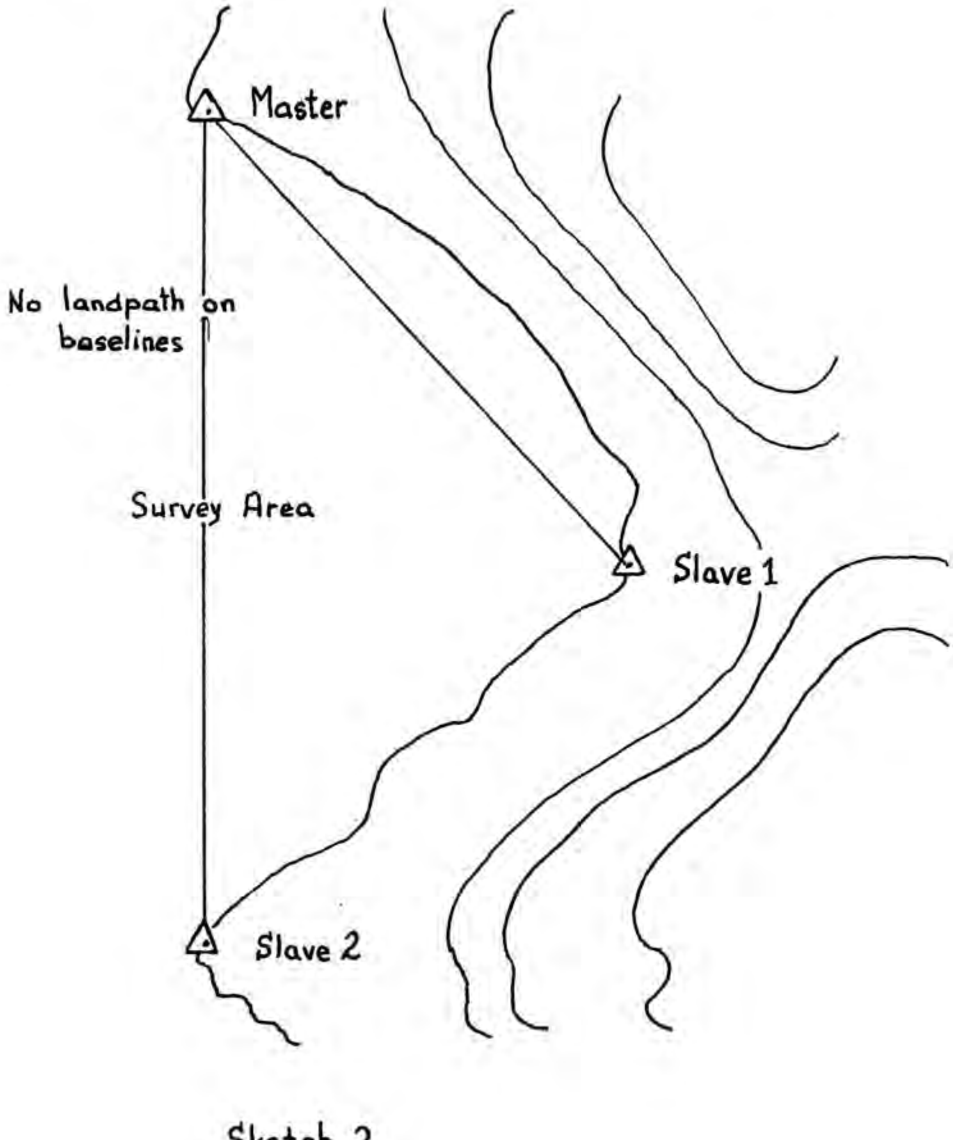
Because of a tight budget, it is virtually impossible for this office to have a development section like we have. They make quite a bit of use of computers, but rely on development from outside agencies. They are involved in designing and testing a Sea-Fix para-buoy just like we are.

One interesting development however is their modification to the standard hyperbolic patterns of Hi-Fix and Sea-Fix chains. We all know that it is important to have baselines over water for high and uniform conductivity, seawater being the best conductor on the surface of the earth. Because this is often not possible we are forever involved with inaccuracies because of a slower speed of propagation over land in general as compared to water (See sketch 1).



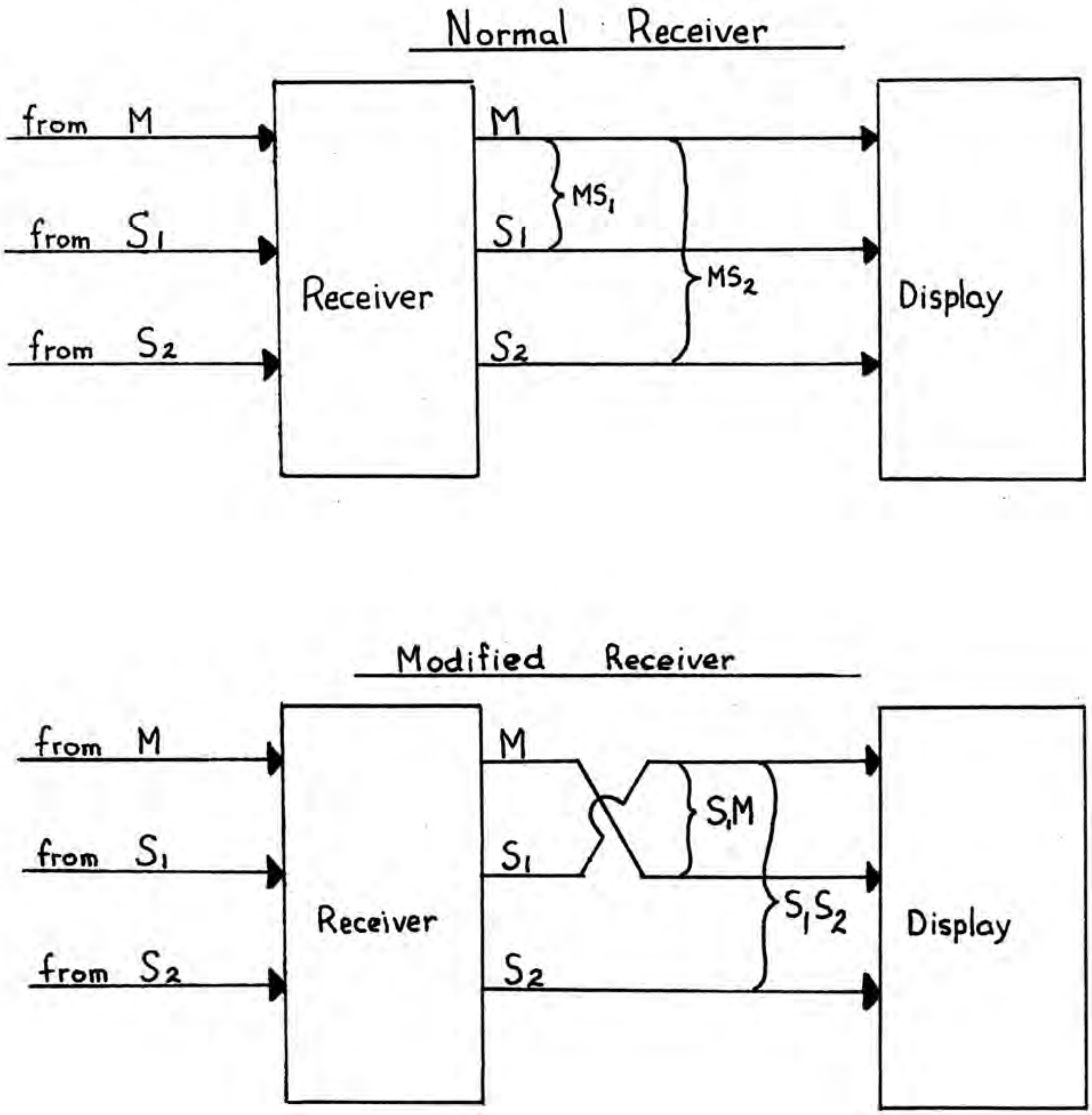
Sketch 1

However, if we were to switch the Master with Slave 1, we would obtain 2 baselines without landpath (See sketch 2).



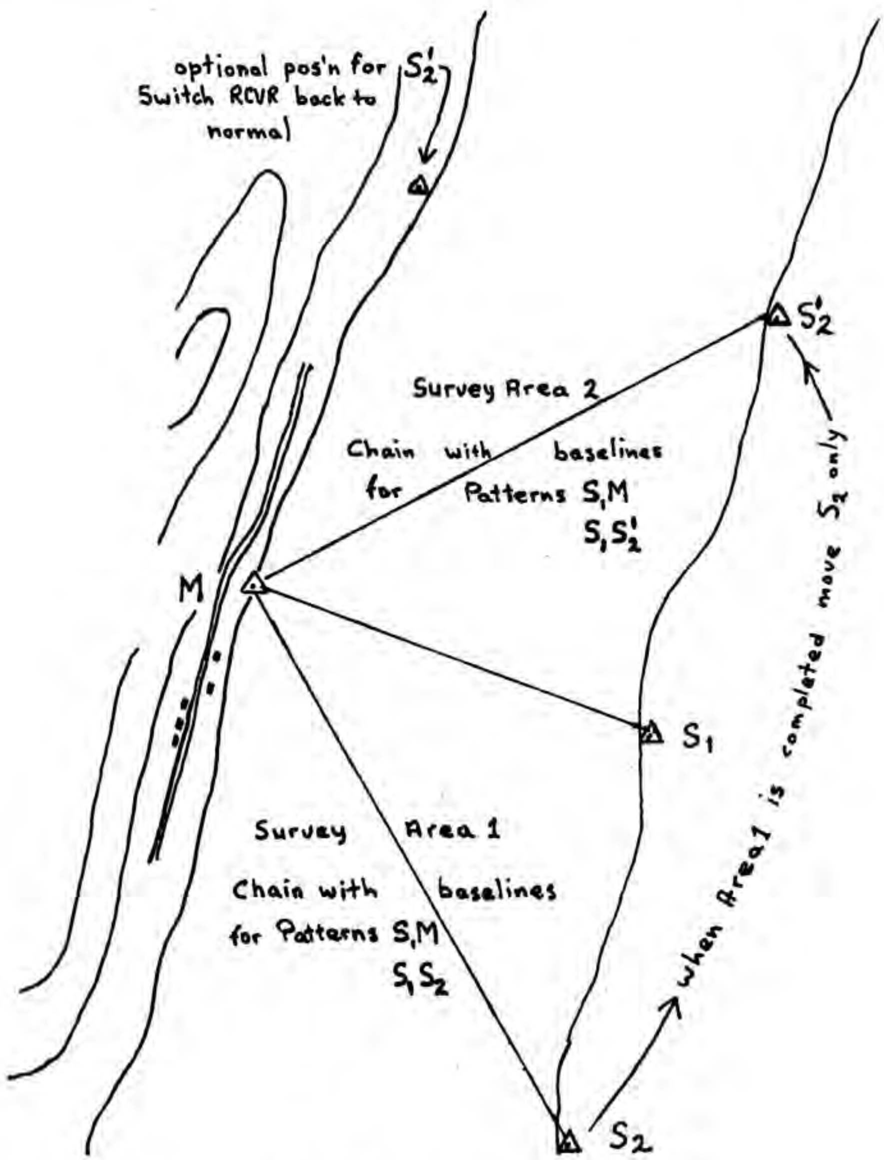
Sketch 2

Of course this chain does not give us much of an acceptable pattern lay-out. Suppose we were to modify the wiring in the Sea-Fix (=Mini-fix) receivers as shown in Sketch 3.



Sketch 3

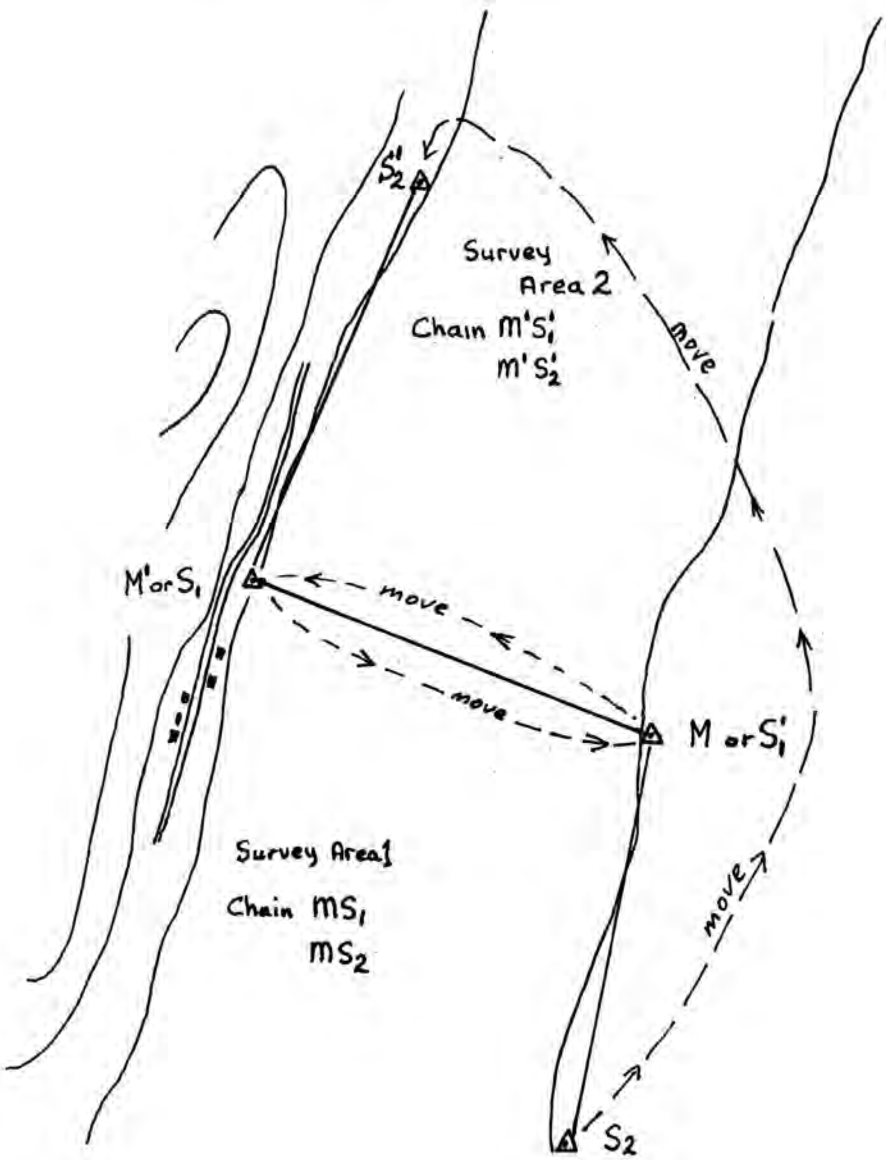
As can be seen in the modified receiver we lead S_1 signal now to the Master and the Master signal to S_1. We are actually matching the Master signal with S_1 signal to come up with a phase difference of the baseline S_1M. The same goes for S_2, where we will have a phase difference based on baseline S_1S_2. We are making Slave 2 the common station electrically and it is then 'acting Master'. In other words: Physically the transmitters are set up as in Sketch 2 although the hyperbolic pattern would be formed as if Slave 1 were the Master. The only alteration to be made is in the receivers on board the survey vessel and at the monitor. A simple rewiring that can be performed by our technicians.



Sketh 4

On Sketch 4 I have illustrated how a chain could be set up when using modified receivers. When moved, only one (1) site has to be relocated at S'_2. In the conventional set up with M at S_1 we would also only have to move one (1) site, however both chains would have landpath on a baseline.

With the modified deployment of the chain it is possible to relocate S_2 at its optional position (as shown on Sketch 4). We would then have to return to an un-modified chain with the disadvantage of landpath on one baseline, however only one (1) site is relocated. If we want a similar lay-out with a conventional chain for areas 1 and 2 with S_2 at its optional position, we would be in a situation where M, S_1, and S_2 all have to be relocated (see Sketch 5) with landpath on both chains.



Sketch 5

The Dutch Hydrographic Bureau has successfully worked with this modified hyperbolic pattern on the north coast of Holland both with Hi-Fix and Sea-Fix and with Sea-Fix on the southwest coast of "Bonaire" and between "Aruba" and "Paraguana". The former two are islands of the Netherlands Antilles and the latter is part of Venezuela.

When using Hi-Fix or Sea-Fix in the Range-Range mode it is also possible to modify the pattern. One would obtain a set of circles between say S_2 and M (=on board vessel) and rewire to give a hyperbolic pattern made up between S_1 and S_2 with S_1 as "acting Master". This combination will not improve the accuracy or coverage as compared to regular Range-Range. However, in most areas where Range-Range is going to be used it is better to have one hyperbolic pattern to use as a sounding pattern, in order that the bottom contours will be met at right angles. A report explaining the calibration procedures and mathematical equations required for this modified pattern will be made available shortly.

"Bureau Rijkswaterstaat" is a branch of the aforementioned Ministry. It is responsible for port conservancy and construction and carries out hydrographic surveys in these ports and their approaches.

The H.Q. for the "Europoort" program is located at the "Hook of Holland", about 15 n.m. west of Rotterdam, right on the shore and centrally located in the working area. A highly accurate positioning system is required for their work and they selected "Hi-Fix" in a hyperbolic mode, and "Cubic" in the Range-Range mode. They use a Hi-Fix frequency of about 2900 KHz (CHS 1700-1900 KHz), giving them a lanewidth on the baseline of about 51 metres (CHS 88-79 metres). Because of the permanency of the Hi-Fix chain location, it has been possible to obtain fixed errors throughout the working area. The narrower lanewidth and known fixed errors together with constant monitoring and calibration checks, of course, has given them a higher absolute position accuracy and a higher repeatability than we can expect to obtain in the C.H.S. with our relatively frequent chain moves. The Hi-Fix method is used on all their surveys at a natural scale of 1:2000 and smaller.

For their bottom profiling and precise placement of fill, stones and concrete blocks in construction they use the above mentioned "Cubic". This work is plotted on sheets having natural scales of 1:200 (i.e. 1 cm = 2 metres) I am not sure on the accuracy of "Cubic" but I believe it is in the order of 1 metre.

The survey launches are built of steel and are of the diesel powered displacement variety. Anything else probably would not stand up in the sea conditions encountered there. Navigational equipment include Radar, Gyro, VHF, and R/T, placed within easy reach of the coxswain. Behind him is the survey console consisting of the Hi-Fix and Atlas Deso 10 sounder equipment.

Most launches are equipped with small derricks to facilitate oceanographic work. When so used the Hi-Fix receiver aerial is mounted at the end of the boom to place it directly above the equipment which is lowered into the water, so that no allowance has to be made for a distance from position of ship (i.e. the antenna) to position of equipment lowered from boom.

The vessels used to dump fill and stones are equipped with many gadgets to aid the personnel in their work. One item I like to mention is their sonar. No technical specifications were available but it was explained to me that its transducer could be used in the vertical or horizontal mode and that it consisted of a "box" sector of, I believe, 60° inside which the bottom was scanned. This sector could be moved from straight ahead (with 30° on either side) to abeam on either side and its tilt in the vertical plane could be altered as well. The operator's panel (about 17 x 20 inches) was well laid out and equipped with a circular PP1. Unfortunately its performance could not be shown, because of the vessel's position relative to the dock and the proximity of the wharf face to the transducer.

One vessel, about the size of our 'LIMNOS' is engaged in hydrographic and geological surveys in the North Sea. Besides regular navigational aids it is equipped with Decca 12f, Hi-Fix and an Atlas Deso 10 sounder, coupled to a Decca Data logger, which stores X, Y, Z information and time on punchtape. They have used the Data logger for 3 years now. The first year the only real problem encountered with it was the fact that the switches were of inferior quality compared to the thumb-size of some of the personnel. They kept breaking off. Once these switches had been redesigned no more problems occurred and the logger has been used successfully since.

One unique piece of equipment was the so-called "SONIA SYSTEM" used for sub-bottom profiling, valuable for coastal engineering and geological research. It was developed by a private hydrographic firm and has been successfully used for about 12 years. However, the company is very secretive about it and one can only rent it. The rent includes an operator/technician. There is no theoretical limit for maximum depth. So far it has only been used in waters of up to 4000 metres deep. In shallow waters of about 10 metres and less multiple reflections may mask deeper reflections. In these cases the transducer and hydrophone are towed along the seabed to prevent this. Unfortunately I was unable to see it in operation.

The entire visit was an enlightening experience and I enjoyed it very much.

This article was presented as a talk at the Canada Centre for Inland Waters, accompanied by a movie showing "the Europoort" project as undertaken by the "Rijkswaterstaat". For interested parties, this movie is now available free of charge from the Royal Netherlands Embassy, 275 Slater Street, Ottawa, Ontario.

Title of the 16mm movie is: "GATEWAY FOR GIANTS".

G. H. Goldsteen

STRICTLY PERSONAL

by Sydney Harris

I rarely go to meetings of any sort, but I was roped into attending one not long ago. As the proceedings were grinding to a halt, a man in the audience stood up and began haranguing the group on what it should be doing and wasn't.

"Who is that chap?" I whispered to the person next to me. "Oh, he's always doing that," was the reply. "Just a jerk who's always trying to stir up trouble."

I listened carefully to him, and he was undoubtedly a jerk, with a bad case of halitosis of the personality. But he also happened to be right; he was the only person in the room who came to grips with the real problem that all the others were politely evading.

And I thought sadly how characteristic this was of most organizations. The decent, pleasant, attractive people go along with the tide, for a number of reasons, including their reluctance to be abrasive; while only a person supremely unaware of his obnoxious personality was willing to buck the tide and bring up some unpleasant truths.

We have yet to learn that "intolerable" people are often the ones we should tolerate the most; they are usually the only ones blunt or insensitive enough to remind us that the emperor is indeed naked.

"An idea," Don Marquis once said, "isn't responsible for who believes in it." But we equate ideas, or criticism, with the sorts of people who propound or oppose them. If the Communists are for something, we tend to be automatically against it, even if it is a sound idea. But the source of an idea has no relationship to its validity.

Indeed, most of us would be ashamed and embarrassed to get up at a meeting and tell people directly that they are pussy-footing around the problem. It takes a particularly hard-shelled and unself-conscious personality to oppose the general drift of a meeting; the rest of us merely grumble privately after we get home.

Since we voluntarily abdicate our right of candid criticism, we have an obligation to tolerate, and listen attentively, to the jerks who are often doing our dirty work for us.

The above article is reprinted from the February 6 edition of the Montreal Sunday Express.

ATLANTIC OCEANOGRAPHIC LABORATORY

BEDFORD INSTITUTE

DARTMOUTH, NOVA SCOTIA

RADIO WAVES AND SOUND WAVES
FOR
POSITIONING AT SEA

BY

R.M. EATON

Part of a panel discussion at the annual meeting of
The Association of Nova Scotia Land Surveyors, Dartmouth,
Nova Scotia, November 1971.

INTRODUCTION

Until a few years ago the surveyor who had to work at sea did his best to behave as though he was still on land. Within sight of shore he fixed by resection, using a sextant, which has mirrors, so that he could site two objects simultaneously. If he had to go beyond the horizon he extended a network of taut-moored buoys to seaward, fixing them by sextant triangulation and taut-wire distance measurement. Taut-wire was the hydrographer's chain; a huge reel held hundreds of miles of single-strand piano wire. One end was anchored to the seabed close inshore where he could fix by the land, and then the wire was paid out astern over a measuring sheave as the ship steamed down the line of buoys. These floating control points were used for the detailed survey, allowing a slightly different position depending on which way the tide was running, until a storm blew them away or an irate fisherman got his nets tangled in them.

Then, in the mid-1950's, the radio-navigation methods originally developed in World War II to guide bombers and invasion barges over hundreds of miles became sufficiently refined to give survey accuracy, rather than just hitting the right beach. At about the same time our interest in the seabed began to go beyond just being sure it was deep enough for navigation; we began to think of resource surveys and scientific studies. In 1957, the Canadian Hydrographic Service began to survey the whole of the Gulf of St. Lawrence, using a Decca Survey chain. This year there are probably a dozen geophysical survey vessels on our continental shelf, all using radio and acoustic waves to find out where they are. "*Baffin*", for instance, was mapping bathymetry and the earth's gravity and magnetic fields on the Flemish Cap, 350 nautical miles east of Newfoundland.

Now 350 miles is a long line to measure in one hop. A land surveyor might ask why we make things so difficult for ourselves; why don't we extend our control seaward from the coastline in an orderly manner, using towers or seabed markers? Well, the only place I know where there are enough towers to do this is the Gulf of Mexico, and since a tower which is to stay in place for even a short time will cost millions of dollars, we will have to wait for the oil companies to put them up for us. Seabed markers are being used more and more, but because the sea is opaque to light waves and radio waves, the only method we have of 'seeing' the beacon on the bottom is by sound, which travels very well in water. Unfortunately, there is a snag. The sea is not a uniform mass of water, the same from top to bottom; it is strongly layered, being generally warmer at the top than at the bottom. Consequently, sound waves are strongly refracted. They are bent towards the colder water, and so if you are trying to 'see' a seabed marker at some distance, your interrogating sound waves will be refracted downwards and may hit the seabed before they get anywhere near the marker (Fig. 7). The range at which seabed beacons can be detected in the relatively shallow waters of the continental shelf is no more than a mile or two; much less in early summer when water layering is strongly developed.

Another method of acoustic navigation uses Doppler sonar to look at the seabed and measure how fast you are moving over it. The echoes returned from objects which you are steaming towards will be higher pitched than the transmitted signal, due to the same Doppler effect that makes the pitch of a train's whistle high as it approaches a station and then drop sharply as it passes through. Accurate Doppler-shift measurements, tied into the ship's gyro, give ship's velocity over the seabed.

PRINCIPLES OF MEASUREMENT

The basis of all these methods, except Doppler sonar, is to measure ranges from the ship to two or more beacons in known positions. This is done by transmitting a radio wave or sound wave which triggers the beacon into responding, and timing how long the response takes to get back to the transmitter. Knowing the velocities of radio waves over the earth's surface (about 299,650 km/sec), and of sound waves in water (about 1500 m/sec), you find that range equals roughly 150 km/msec return travel time for a radio wave, and 0.75 m/msec for a sound wave. Note that very high timing precision is needed for radio wave ranging. Note also that the velocities I quoted are approximate; for precise work you must take care to estimate them as closely as possible. The residual error from a careful estimate of radio wave velocity is about 20 metres at 200 to 500 km range.

The simplest method of time measurement is to transmit short bursts, or 'pulses', of waves, and to arrange that the leading edge of the pulse transmitted from the ship's 'Master' transmitter starts a clock count, and the leading edge of the return pulse from the 'slave' beacon stops it. Unfortunately, it is physically impossible to transmit an absolutely sharp, wall-sided pulse.

In addition, distortion during propagation through the atmosphere and during processing by electronic circuitry alters the shape of a signal, so that the return pulse from the slave is not quite the same shape as the one transmitted by the master. Consequently it is difficult to identify the leading edge of the pulse exactly, and this 'pulse-matching' method gives a fuzzy sort of time count. For a radio wave it is correct to about 1 usec, the equivalent of ±150 metres, and this is the best resolution of a radio-navigation system such as Loran-A. However, the situation is much better in acoustic ranging; the timing accuracy is only about ± 6 msec, but due to the much lower velocity of sound in water this is the equivalent of ±2 metres.

(Note that the timing accuracy by no means represents the over-all system accuracy. Timing contributes just one of several range errors, and the geometry of the ranging position lines amplifies all these in the fix error.)

A great improvement in radio-ranging is achieved by identifying one particular cycle of the radio wave within the pulse, and making the measurements on that. Loran-C, a long range radio navigation system using 'cycle-matching', has a timing accuracy of about ± 0.05 usec, equivalent to ±6 metres. Figure 1 illustrates cycle-matching time measurement on the master and slave pulses diagrammatically.

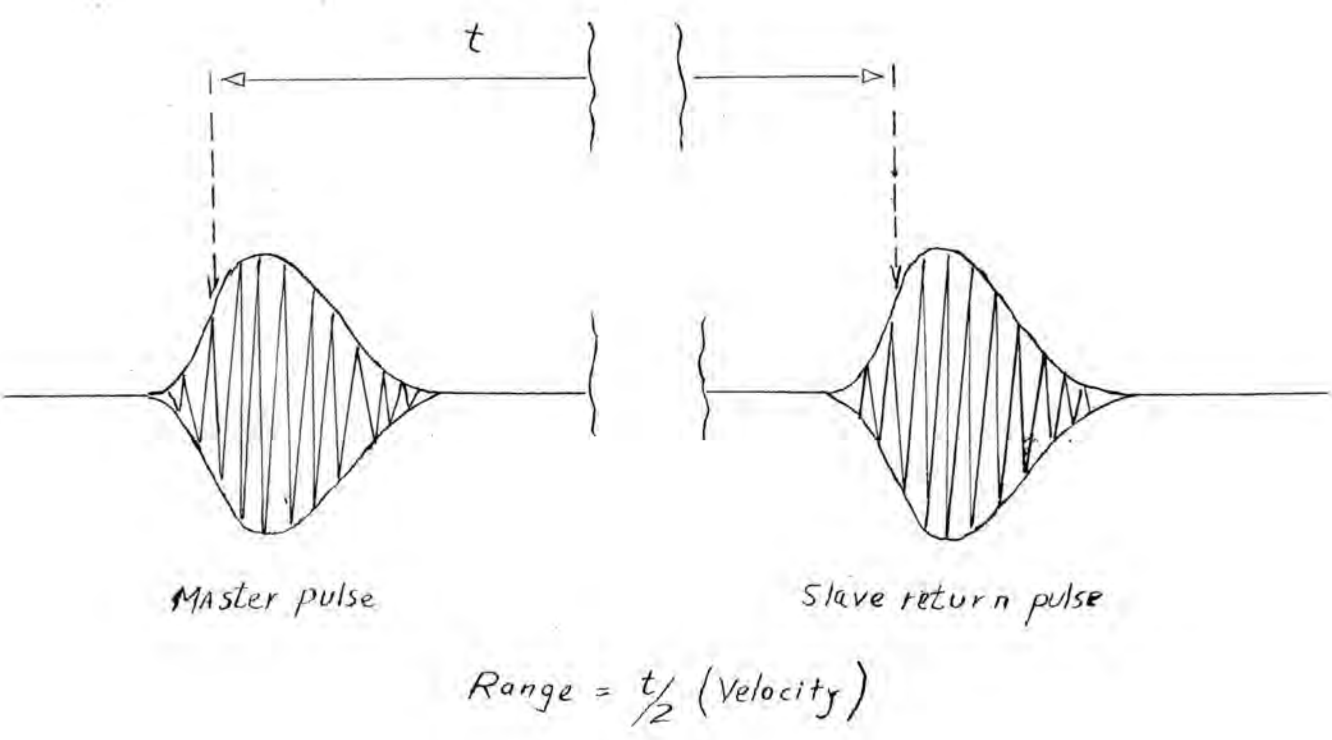


FIGURE 1: Cycle Matching

Cycle-matching is technically difficult to accomplish, and a simpler and more reliable method is used by the Decca Navigator systems. Both master and slave transmit continuously, instead of in pulses, and the slave is 'phase-locked' to the master so that it always re-transmits at the same point of the cycle that it receives from the master (the same principle is used in the Tellurometer). If the vessel carrying the master transmitter is initially at a range from the slave equal to a whole number of wave-lengths, the signal it receives from the slave will be in phase with its own transmission, i.e. the peaks and troughs of each signal will coincide exactly. As the range increases, the two signals will move out of phase (Fig. 2), until eventually, when the range has changed by half a wavelength (or one 'lane'), they will be in phase again. A phasemeter measures the fraction of a cycle (lane) between the signals at the master, with a resolution of about 6 meters. The difficulty now is that although the phasemeter measures exactly where the ship is within a lane, it does not say how many whole lanes there are between the ship and the slave. To establish this 'lane count' the ship must start from a known position, such as a buoy, a seabed beacon, or a series of satellite fixes. Once the correct whole lanes are set in the Decca will thereafter keep track of lanes gained or lost.

Unfortunately for Decca, a radio-wave reflecting layer, absent during the day, appears high up in the sky at sunset (Fig. 6). At long range the indirect travel-path via the reflecting layer often delivers more signal strength than the direct path over the earth's surface, and since the two path-lengths are different the two waves 'interfere' and the range measurement is lost. When this happens, the ship must return to the known position for a fresh start. Loran-C also suffers from 'skywave' interference, but its signal is chopped up into pulses, and since groundwave travels a shorter path and so arrives earlier than skywave, the first part of the pulse will consist of groundwave alone. A range measurement made on this part will be free from skywave.

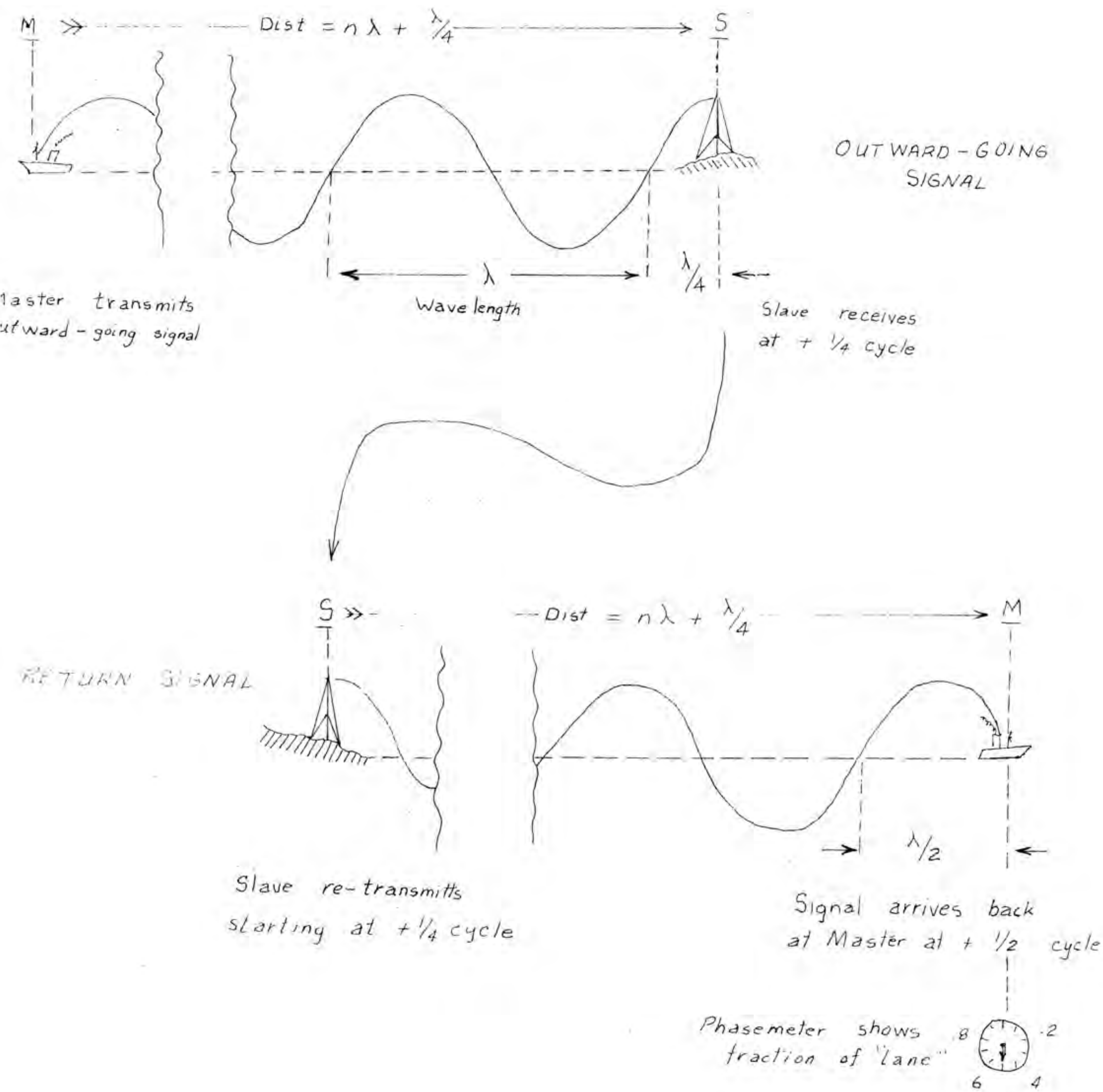


FIGURE 2: Phase Comparison

RANGE-RANGE AND HYPERBOLIC OPTIONS

So far all I have described is the measurement of one range. The information you want is the position of the survey ship and this is determined by the intersection of two range circles, as shown in Figure 3. (More than two shore stations are sledom used because of the high cost of radio transmitters.) Acoustic positioning is similar in principle, but many seabed beacons are used, to extend the range. Note how strongly accuracy depends on the angle of cut of the position lines; along the inter-slave baseline, for instance, there is no fix at all. Note also that no slave can serve more than one master, so that the ranging method is restricted to a single user. (Current developments are modifying this restriction.)

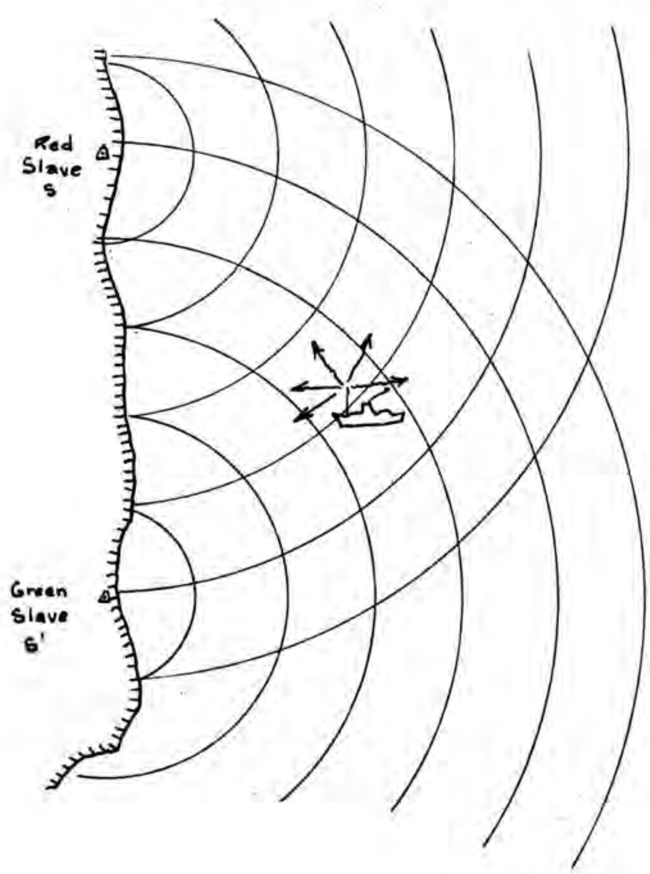


FIGURE 3: Range-Range Positioning
(from Bigelow, 1965)

However, there is a second option. If you take the master transmitter off the ship and put it ashore between the two slaves, and carry a passive time-difference receiver in the ship, you can measure the time difference between the arrival of the master signal and the slave signal. (The master transmission triggers the slaves to transmit, as before.) The time difference can be converted to a distance-difference. A line along which the distance-difference has a given value happens to be a hyperbola; Figure 4 shows how hyperbolas for distance differences of 0 and 40 Km are constructed. A second distance-difference between the master and a second slave produces a second hyperbola, and the intersection with the first hyperbola gives

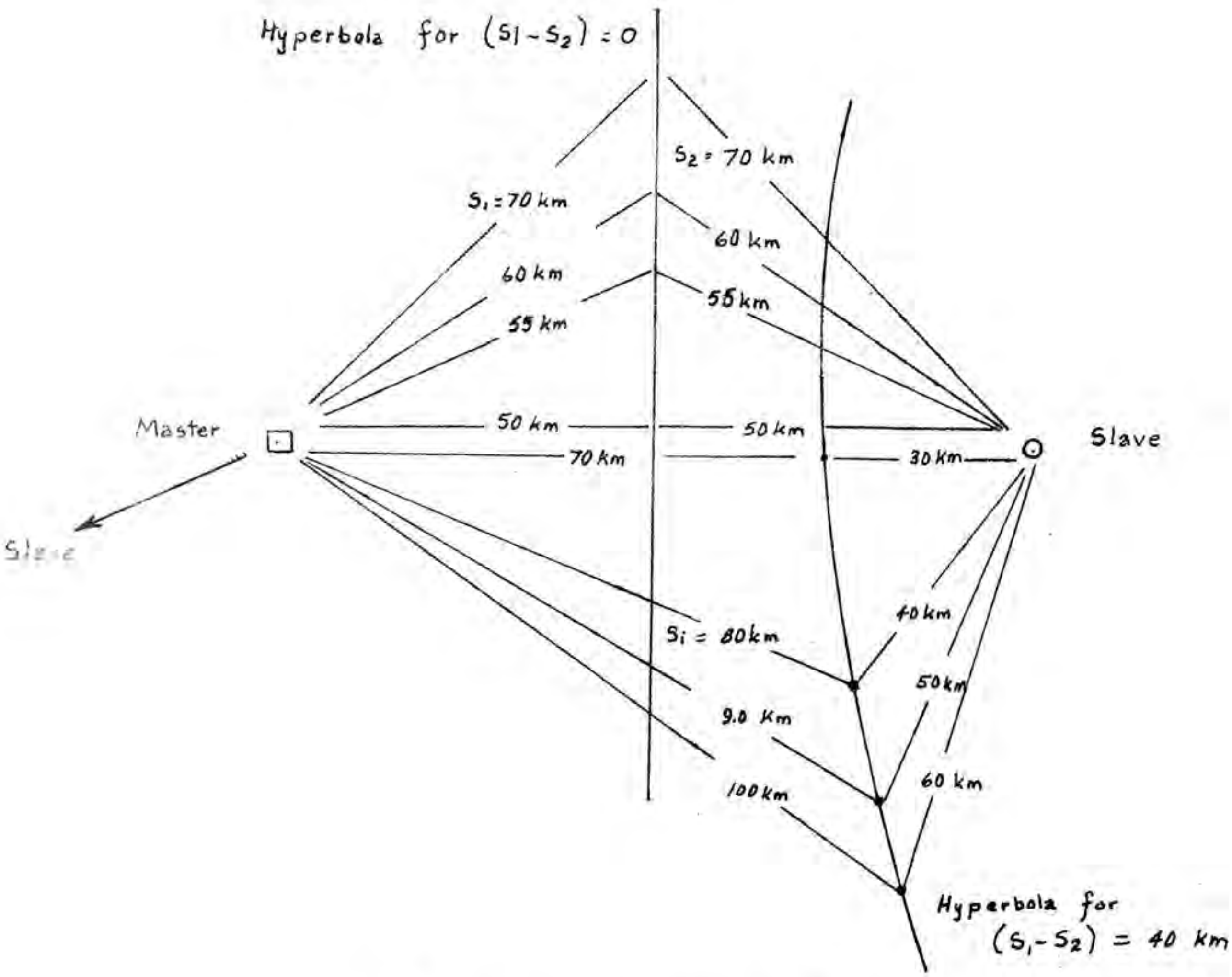


FIGURE 4: Construction of Hyperbolas

the ship's position, as shown on Figure 5. Note that the 'lanes' of a hyperbolic lattice widen as they leave the baseline, magnifying the effect of position-line error. In addition, the angle of cut is generally weaker than in a range-range lattice. However, any number of users can operate passive receivers simultaneously, which is useful. This is the option used for the main Decca Chains operated by M.O.T. for commercial shipping; it is also used for inshore hydrographic surveys, when several shallow draught launches are deployed on the same survey.

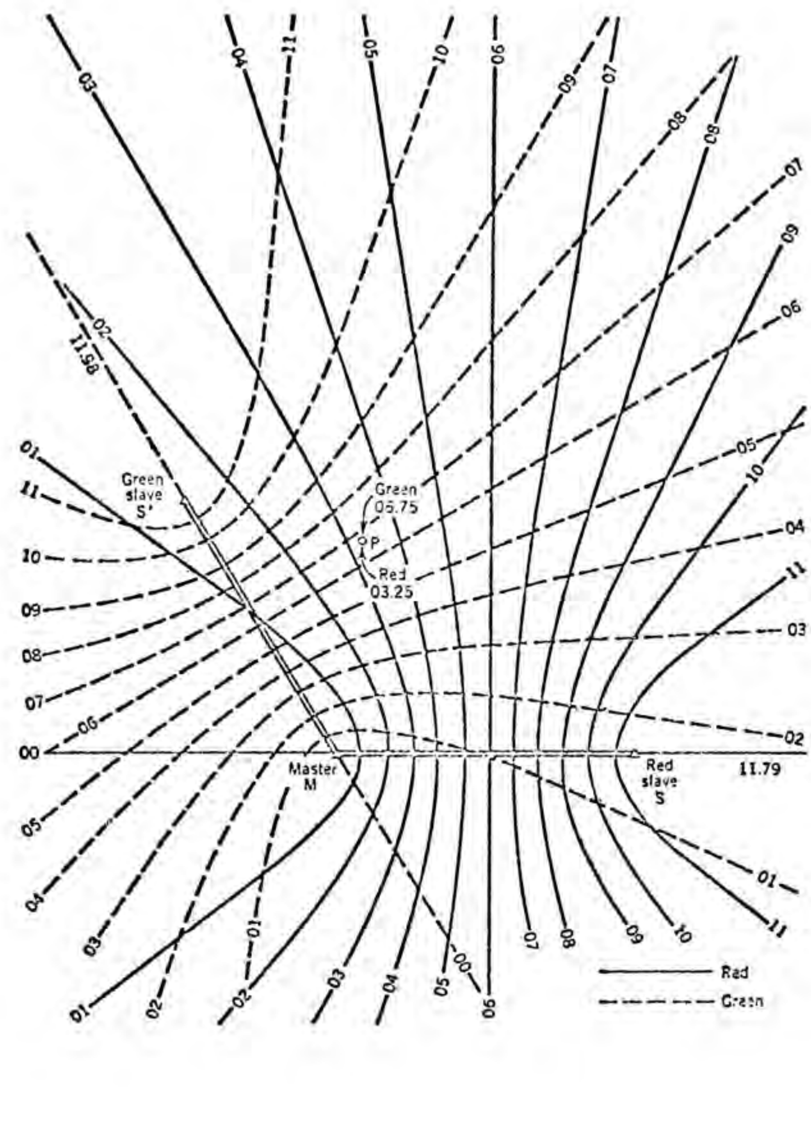


FIGURE 5: Hyperbolic Positioning (from Bigelow, 1965)

PROPAGATION PECULIARITIES

You may have looked out to sea from the water's edge one time and seen a ship quite clearly, but 'hull-down', with only her masts and upperworks visible. Looking back from seaward, a hydrographic surveyor balancing in a launch 12 miles offshore will just see the top of a 70-foot high lighthouse.

Radio waves at radar and tellurometer frequencies (UHF up) behave much like light waves. However, at lower frequencies they tend more to follow the curvature of the earth's surface (Figure 6). And so if the survey area extends beyond the horizon visible from a shore station, you have to bring down the frequency of the radio system in order to get a radio wave that will hug the earth's surface.

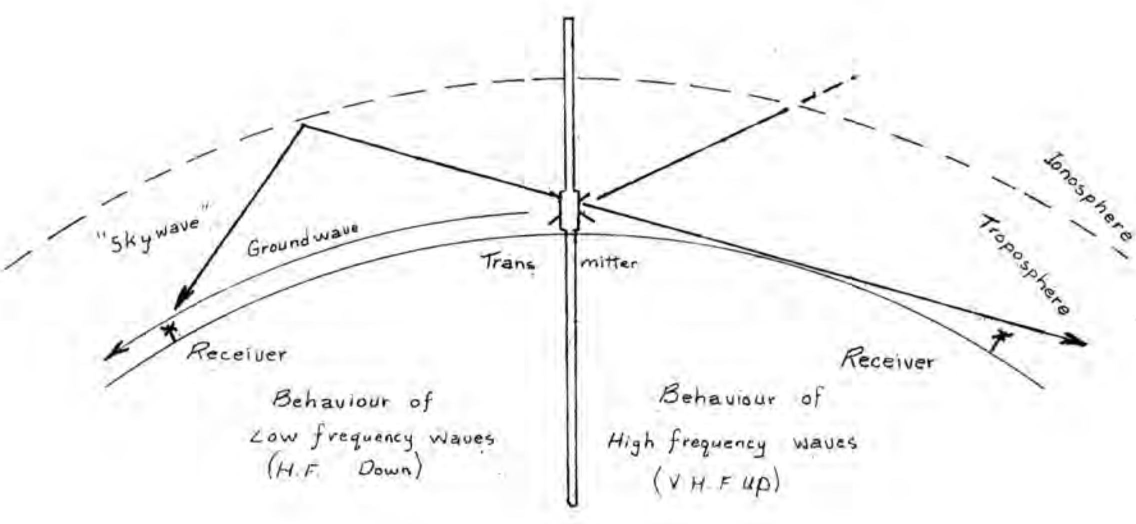


FIGURE 6: Radio-Wave Paths
(after Wells, 1970)

Immediately there are two consequences:

1. More power is required to propagate lower frequency waves, and a bigger antenna is needed. So up goes the size of the transmitter station, and up goes the cost.

2. The wavelength increases, in inverse proportion to frequency, and since the error in a position line is to some extent a constant fraction of lane width, up goes the size of the error.

Sound waves are greatly affected by the characteristics of the water they travel through. Velocity, which is the parameter you need to know in order to convert sound-wave travel-times into distances, changes markedly with water temperature. It must always be measured on the spot, since the ocean is a dynamic system (too dynamic for those with weak stomachs) and its temperature is always changing. Temperature also changes from one depth to the next, as shown in Figure 7. Refraction on passing through the water layers bends all but vertical sound rays, and this means a slight correction must be calculated to find the true slant range. Much more serious than this, it imposes a maximum operating range for the acoustic system.

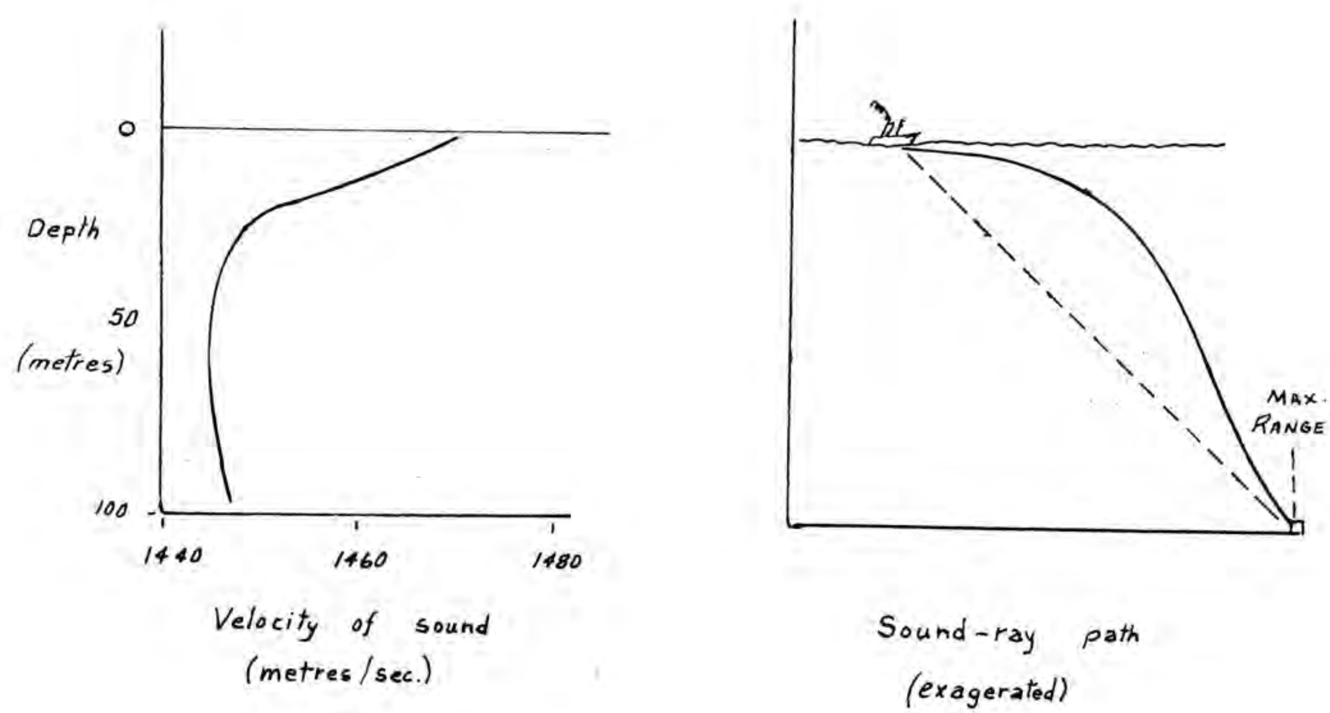


FIGURE 7: Sound-Wave Path

THE BEWILDERING CHOICE

The survey requirements, such as where you want to go; what accuracy you require; whether you can afford to close down at night; etc., impose certain limitations on the choice of positioning system. But there will usually be a number of approaches to any particular problem, sometimes with radical differences between them. For example, a geophysical outfit prospecting around Sable Island might decide to use Decca, with reference buoys for lane identification; or it might sacrifice accuracy for flexibility and opt for an integrated system involving satellite navigation and Doppler sonar.

Table 1 lists some of the alternatives. The detail shown has deliberately been kept to a minimum so as to give an over-all picture, and should not be interpreted too exactly; for instance, an integrated satellite Doppler sonar system would cost much more than \$8K+\$12K because a large computer would have to be programmed to tie the two together. Costs are rough estimates, intended to allow comparison between systems.

Comments on some representative systems follow.

Inshore: Hydrodist

When you are close to shore you can behave like a land surveyor. You can put a Hydrodist (modified Tellurometer) Master in the boat, and the Remote ashore on a control point, along with a theodolite. Then you can fix by bearing and distance. As an alternative, particularly useful on the shores of Nova Scotia in summer when you can seldom see very far through a theodolite, you can double up the Hydrodist, with two masters on board, and two remotes ashore, and fix range-range.

Hydrodist is in the ultra-high frequency range (just above television), with wavelengths measured in tens of centimetres. It is limited to line-of-sight, because radio waves at that frequency travel in straight lines and do not follow the earth's curvature. As soon as you get out of sight of land you must look for an alternative.

TABLE 1

Continental Shelf Survey Systems
(Broad-Brush Treatment)

System	Transmitter Size	Frequency	Range	Method	Fix Accuracy	Approx. Cost per month
SHORE BASED:						
RPS (radar) Hydrodist (Tellurometer) etc.	100 lb.	10,000 MHz	Line of sight	Range-range or Range-bearing	5 m	$ 6K
Hi-Fix Raydist Toran Lorac etc.	300 lb.	2 MHz	200 km	Range-range or Hyperbolic	40 m	$10K
Decca	10 ton	100 kHz	500 km	Range-range	120 m	$50K
Loran-C	-	100 kHz	2000 km	Range-range	160 m	$15K
SEABED:						
Acoustic Beacons	500 lb.	10 kHz	2-10 km, worldwide	Range-range	30 m	$10K
Doppler sonar	-	150 kHz	Continental shelf	Velocity Measurement	300 m/hr	$ 8K
CELESTIAL:						
Sextant Fix	-	-	Worldwide	Position lines (if sky clear, 8-hourly).	3 km	$ 3K
Navigation Satellite	-	400 MHz	Worldwide	Computer Solution (2-hourly)	500 m	$12K

Coastal: Hi-Fix

If you come down in frequency to 2 MHz (wavelength 150 metres), and increase in power from a battery to a thermo-electric generator and in antenna size from a short stub to a 10-metre mast, you can get out to 200 km or more offshore before the signal gets too weak to be reliable. The maximum range of Hi-Fix over water has not been determined, but it is used regularly out to 150 km. We have been using Hi-Fix for eight years in hydrographic surveys by ship and launch in open seas, and by helicopter and hovercraft in the Arctic. It has proved reliable and convenient, and has become the mainstay of coastal surveys; the ship operates in deep water while the launches work on shoals and along the coastline, all on one hyperbolic chain. At present it is being used by the survey ship "*Kapuskasing*" for surveys of Newfoundland and Northumberland Strait.

Setting up a Hi-Fix chain is not just a matter of erecting a mast and switching on. The patterns must be correctly zeroed by talking the slaves on from a receiver situated at a known point, and calibration is then carried out over the survey area, usually by shooting up a receiver in a survey launch by theodolite from shore control.

Since Hi-Fix uses phase-comparison, it can resolve the fraction of a lane in the distance to the slave, but cannot measure the number of whole lanes. Once the total lane-count has been established, by an independent fix, such as a theodolite intersection, a number of taut-moored reference buoys must be laid, and Hi-Fix lane reading of each found by steaming the ship close by. These buoys can then be used to re-establish the correct whole-lane reading after a transmission interruption.

Offshore: Lambda Decca

Hi-Fix will not cover all of the Gulf of St. Lawrence, and certainly not the Grand Banks, which extend more than 500 km from Newfoundland. So once again you must come down in frequency and up in power and antenna size. Decca Lambda has a small hut of equipment, and a 50-metre mast, and it takes three or four days to set up a station, plus another day to calibrate. Since the survey is now out on the high seas, and with luck there are no dangerous shoals, we can safely do all the work from a ship. We normally operate Lambda in range-range configuration, with the "*Baffin*". She has been working on the Grand Banks and in the Gulf of St. Lawrence for several years. Last summer she took a trip to the Beaufort Sea, where she used the hyperbolic Lambda chain which the Polar Continental Shelf Project sets up anually for air, sea, and ground operations over the Arctic Ocean and the Archipelago of the Queen Elizabeth Islands.

Lambda Decca is the twin brother of the Navigational Decca Chains, which cover most of the Atlantic coast and Gulf of St. Lawrence from Cape Bonavista to Fundy to Father Point. Apart from ship and aircraft navigation, Decca is used to control aerial photography and aeromagnetometer flight lines.

Decca is another phase comparison system and has the same ambiguity over lanes that occurs with Hi-Fix. Lambda Decca has a lower frequency 'lane identification' pattern that can be transmitted on command, but this is not reliable at long range or under bad atmospheric conditions, and so once again we lay buoys. The lane identification system of the navigational Decca chains is reliable.

Anywhere on the Oceans: Acoustic Navigation

Because of its short range, navigation by interrogating seabed beacons will probably be limited to marking points on the seabed of particular interest, or to surveying small areas in great detail. The techniques are relatively new, and we are working on them at Bedford Institute.

"Integrated Systems"

The principle is analagous to a bearing and distance traverse tied into control points at intervals. At sea, the ship's gyro provides bearings, and distance is found from the ship's speed, measured either by an inertial system (if you are very rich indeed, like the U.S. Navy) or by Doppler sonar. Navigation satellite fixes provide the control for adjusting the accumulated error in course and speed measurement. A large computer keeps track of the data and produces up-to-the-minute position on demand. One such system is being operated on the Scotian shelf now.

BIBLIOGRAPHY

Unfortunately, there is no comprehensive, up-to-date reference on offshore surveying. But the following will help:

'American Practical Navigator', Bowditch, 1962. U.S. Navy Oceanographic Office. An encyclopedia on ship's navigation, with useful chapters on principles.

'Navigation Lecture Notes', D.E. Wells. Canadian Hydrographic Service Technical Note, 1970. A comprehensible introduction, full of useful information.

'Radio Aids to Maritime Navigation and Hydrography'. International Hydrographic Bureau Special Publication No. 39, 1965. Useful reference.

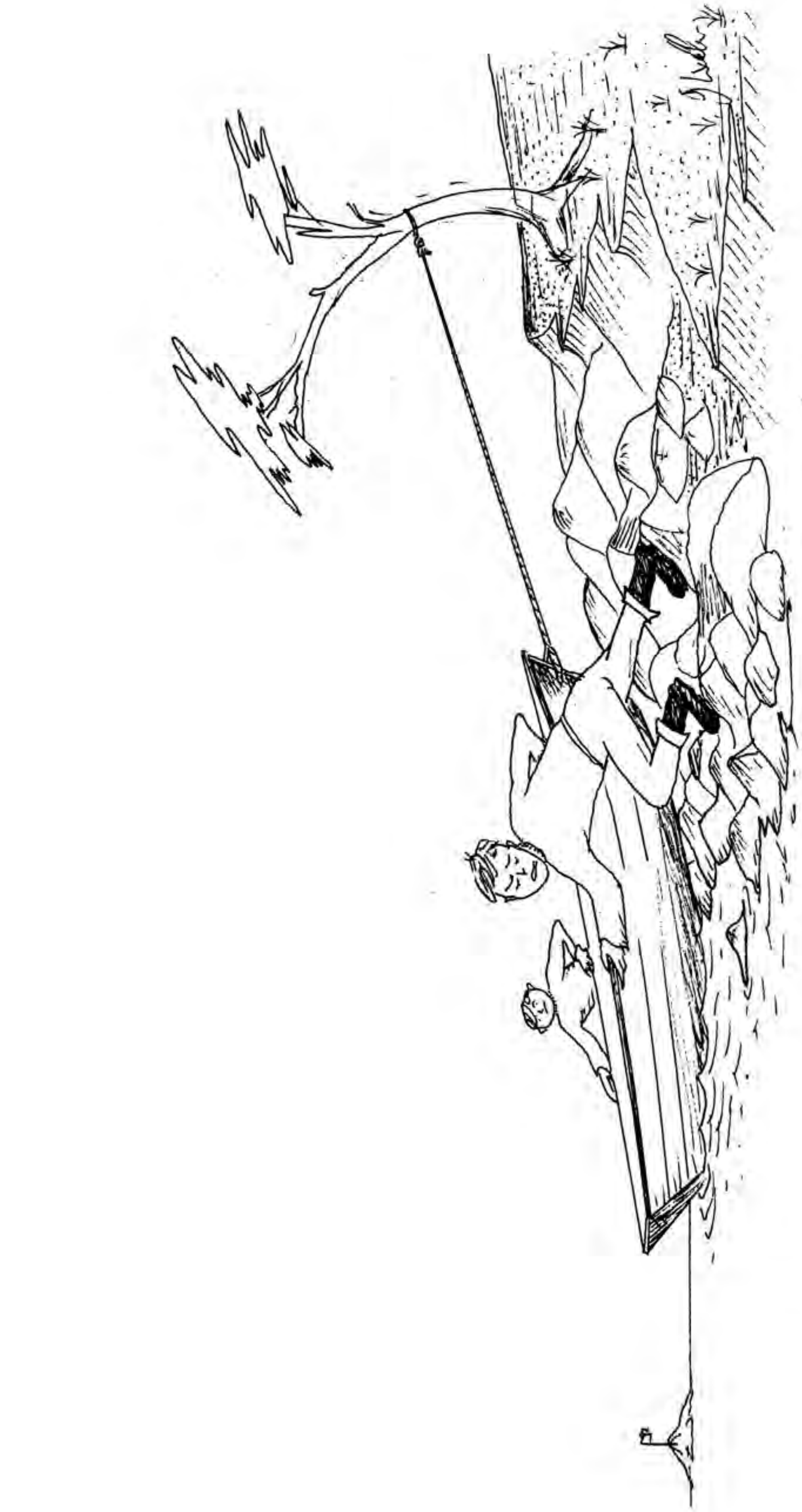
'The Position Finder', H.P.L. Engineering, 49 Cleopatra Drive, Ottawa 12, Ontario, 1970. Some interesting introductory articles, plus manufacturer's detailed specifications for many navigation systems.

'Navigation at Bedford Institute', Ross, Wells, Douglas, and Eaton. AOL Report 1970-2 obtainable from Bedford Institute. Gives performance data for systems used by the Institute.

'Electronic Surveying: Accuracy of Electronic Positioning Systems'. H.W. Bigelow, Supplement to the International Hydrographic Review, Vol. 6, September 1965.

'The Use of Hi-Fix Hyperbolic', R.M. Eaton, Canadian Hydrographic Service Technical Note, 1966. A detailed field man's guide.

'The Navy Navigation Satellite System', T.A. Stansell Navigation, Fall 1968. Reprinted in International Hydrographic Review, January 1970. Standard reference on Satnav.



"MUST BE ON A ROCK"

— PUSH HARDER, KEN

HYDRODIST IN CENTRAL REGION

The hydrodist system is one of the most tempermental beasts ever concocted by our alleged genii of the flitting electron. Bonaparte would never have taken it on his campaigns because he was a man of immediate action. Hindenburg would have tinkered with it, and Caesar would have used it. But at that time the Roman Senate was not issuing patents to upstart heretics of the ole reliable candle, and so Plessey had to wait a few years before the sun was to shine.

If memory serves me correctly, the first MRB-2 system arrived at Central Region in 1966, and was shuffled from Charlie Leadman to Don Snodgrass to Earl Brown on Georgian Bay. Tests at that time revealed a range of about 25% of the claimed value. The range-range equipment, with the "push button, flick of a finger" rotary antennae, was mounted into a spanking new Bertram, and off we went into the wild blue aqua to once again witness the blessings of mother science. Suffice to say, it took two competent hydrographers, each equipped with four hands, a "mal de mer" proof gut, and the persistence of a Resolute Bay cattle breeder, to come up with anything roughly approaching optimism. However, it was discovered that the system did measure.

As a result of experimentation in 1967 and 1968 by Ernie Robichaud and Neil Anderson, it was concluded that a range-bearing method was the only feasible way of operating the system from a launch. So, up went the ground plane antennae; on came the left-right indicators; the T-1A hit a new high in popularity; and we are arcing away at those ill-defined masses of moisture.

In 1969, 1970 and 1971 the hydrodist systems received considerable use on a number of parties in Central Region. The electronic staff had expanded to such a degree that nothing, not even the local hound dog, was immune to "debugging". Buster Waldock fashioned a digitizer which was to be the fore-runner of the present C-Tech item. - We really made strides -. On the St. Lawrence Survey, the system was used to run incremental arcs as small as 10 metres; it was employed in everything from a Boston Whaler to the Bertram submarine class; it was worked out to 20,000 metres (one set out of four gave this effective working range, believe it or not); and with the assistance of a little device for measuring R.F. output, it was possible to match master to remote for improved efficiency.

Thus the Region <u>has</u> manifested some success from a system rarely described beyond "dubious". So - for the skeptics, the hesitaters, the bearers of misgivings -- take heart boys -- the most accurate positioning system available is not <u>really</u> a lost cause. Like the man says, "it's all in your mind!"

Bruce Wright

EXCERPTS FROM SEMINAR PRESENTATION AT THE CANADA CENTRE FOR INLAND WATERS

by: G.E. Wade
Hydrographer-in-Charge
Polar Continental Shelf Project

Our interest in the Arctic is not recent. Artifacts along the coasts of Baffin and Ellesmere Island bear witness to the landings of Icelandic peoples as far back as the 10th century.

The story of Arctic exploration and discovery is a fascinating epic of courage and determination to overcome all sorts of hardships and difficulties. Our purposes for these northern excursions included the search for the Northwest Passage (which incidentally took over 300 years to find), mineral wealth (which was first sparked by Martin Frobisher's report of gold on Hall's Island), the competitive race for the Pole (won by Peary in 1909), and finally the search for new territorial possessions. In more recent times we have expanded our interests into the realms of the sciences Geology, Oceanography, Meteorology, Ecology and Pollution to name a few.

Canada was ceded the Archipelago in 1880 by Britain, but made very little effort either to assert her sovereignty or expand her knowledge of this "Frozen North" for nearly thirty years. The first official Canadian expedition was in 1903 by Low, of Geological Survey of Canada. His interests were mainly scientific. Bernier in 1909 was the first to actually try to establish our claims followed by Stefausson in 1913 and finally by the Eastern Arctic Patrol, which was R.C.M.P. in 1922. Since that time our interests have run hot and cold depending on what other nations were doing.

There has been some contention as to our claims to the Archipelago and the Norwegians were the last to concede our rights to the Sverdrup Islands in 1930.

Arctic discoveries were first made by using small ships operating in open leads or from camps set up along the coastline. However, the 20th Century has seen remarkable changes in methods of travel.

Remote operational sites have been established with regular supply routes; air travel makes the accessibility to these out-of-the-way places relatively economical and the physical discomforts have been practically eliminated.

Drift patterns such as those of the "Fram" and "Maud" are being duplicated by the establishing of research camps on ice islands such as 1918 drift station of Stoykerson the Russian camp set up near the North Pole in May 1937, and the American's ice island T-3 or Fletcher's Island.

Various other proposals have been suggested, such as the freezing of a well-equipped scientific ship in the pack ice for a test period of three years; the setting up of a research centre on Prince Patrick Island; the establishing of meteorological stations in a circular pattern around the North Pole, and more recently in setting up ice camps on the Polar pack ice with logistical support from land-based camps such as Tuktoyaktuk using long-range aircraft.

A number of these have been accomplished. A scientific research station -- in fact a very elaborate and well-equipped station -- has been set up at Point Barrow, Alaska; the met. stations have been organized at Thule, Eureka and Resolute (1947), Mould Bay and Isachsen (1948) and finally Alert (1950). These were originally a joint venture by Canadian and American governments but the Americans have been nearly completely phased out of this field in Canadian territory.

In 1957-1958, which was the Internation Geophysical Year, polar research was conducted by a group of thirteen countries of whom Canada was one. The amount of scientific data collected, the questions left unanswered, the increased activities of American and Russian groups in Polar regions, and finally a widely publicized Russian article written by a leading Russian polar expert, which sharply criticized Canadian participation in, and lack of knowledge of Arctic Investigations in the Canadian Basin, especially in the region of the Canadian Archipelago, roused officials in Ottawa to look into the situation.

As a result, the Advisory Committee on Northern Development submitted a brief in January of 1958, recommending that "A Canadian expedition be mounted in order to obtain scientific data and to demonstrate Canadian interests. The initial proposal was for a group which would be responsible for "a long-term programme of research ... to extend over several years and ... be additional to the normal government scientific programme." The activities of this programme included physical oceanography and hydrography over the Continental Shelf, seismic, gravity and magnetic observations, and such other scientific studies as seem desirable and could be incorporated.

As a result of this submission the Polar Continental Shelf Project was established on April 5, 1958 by a Cabinet Directive as a continuing activity of the then Department of Mines and Technical Surveys, with no date for its completion. The project is a separate activity of the Department and has been headed since its inception by Doctor E. Fred Roots, a most capable and distinguished scientist.

Polar Shelf has no security classification and results of the Project are made available to interested parties through maps and reports published by the Department and articles in Scientific Journals.

Investigations cover all of the Arctic Continental Shelf to seaward of the Canadian Arctic Islands and Mainland, from the Danish Border (60°W Longitude) to the American border (141°W Longitude) together with the relevant islands, the straits and sounds between the islands for an undefined distance within the Archipelago, and also such areas beyond the Continental Shelf, within the Arctic Ocean Basin as may, from time to time, warrant study.

During the nearly 14 years of operation, Polar Continental Shelf Project has become a very unique branch of the Department of Energy, Mines and Resources in Canadian Arctic Exploration. It operates throughout the winter and summer servicing over 60 different projects as well as involving large groups of scientists with supporting technical staffs of up to 300 men. Our activity extends across the entire Canadian Arctic from Greenland to Alaska and from the Arctic Circle to the North Pole, an area in excess of 1,500,000 square miles.

Activities of the Shelf Project are rapidly becoming more varied and complex as its reputation grows and more and more demands are made on its facilities by environmentalists, research scientists, geologists and others not yet involved in Canada's Arctic, but whose interests lie or may in future lie in this area.

Until one becomes involved in an operation such as Polar Shelf, it is impossible to imagine the number and complexity of the problems to behandled and overcome in supplying logistic support to scientific groups spread all over the Arctic, supplying them with delicate, highly sensitive instruments and getting them to their destination intact; the establishing of remote supply centres such as Tuktoyaktuk and Resolute; setting up systems of fuel caches at convenient air strips and camp sites; arranging tight flying schedules around the clock; the number of outside agencies who are involved, the signing of large numbers of contracts with private agencies well in advance of the actual operation to ensure that sufficient transportation and necessary supplies are available and on the spot when they are needed.

The Shelf organization has done all of these things in a thorough and dependable fashion. It amazed me to note the promptness of response to requests from remote camp sites for equipment, supplies, and on occasion, emergency transportation. These things I have experienced myself in nearly every part of Canada and believe me, service on Shelf projects compares very favourable with any I have received anywhere.

The principal activities of the Project then are coordination of individual programs and logistics - the provision of facilities, supplies and transportation to the various camp sites of scientists, surveyors or whatever. Its activities are not restricted to Canadian participation but have been closely linked with those of American Study groups. We have had representatives from other countries visit our camps and, in some cases, take part in an actual operation. This will happen again this coming year when two Danish representatives will be joining me and the Hydrographic Operation in Kennedy Channel for about two weeks.

The largest group from outside Canada to take part in Arctic research has been the A.I.D.J.E.X. The word AIDJEX is, of course, an abbreviation for Arctic Ice Dynamics Joint Experiment. It consists of research groups whose interests lie in related interactions of Arctic ice - its motion relative to the atmosphere and the ocean, the different types of ice and how they react to these influences. This type of study is essential for effective forecasting of ice conditions, understanding surface/atmosphere heat exchange variations and their relation to atmospheric circulation in general.

The Canadian Hydrographic Service has been involved in Polar Shelf activities since its inception and has played an important role in planning operations, supplying a good part of the muscle of its logistics programs, in obtaining bathymetry, and in the design and testing under field conditions of various types of instrumentation. Some of these operations required considerable patience and intestinal fortitude as well as the ability to improvise when breakdowns occurred. Believe me, these breakdowns did occur and on more occasions than most of us care to remember. To date, we have had five hydrographers assigned to Polar Shelf as Camp Commanders. Each oceanographic ice camp is commanded by a senior hydrographer with supporting hydrographic staff.

I have wanted to see more of the north since my first field season in the Yukon, followed by a summer survey in the Frobisher Bay area. One does not cover much in two years or so but there is a certain feeling which goes with being associated with the Arctic which is difficult to describe. I know there are some who would not care to go on a Northern operation. This is understandable, but I know of no one who has been there who is not anxious to let you know about it. Most people are keen to brag about it openly and get quite a charge at seeing themselves in movies or pictures taken during the survey.

However, one must have certain characteristics in his makeup to be suitable for work in remote, isolated areas. Unfortunately we do not all have these traits, which makes it imperative that personnel selected for Arctic Surveys by chosen with great care. The success or failure of the entire operation depends on this selection and the willingness of every member to pull his weight so far as the work load is concerned.

Fortunately this seems to have been the case in most of our surveys to date. My own group was very compatible and results of last year's operation were among the best on record. After all it is those with whom you are obliged to work, see every day and night throughout the entire operation, and on whose cooperation and support you must depend who make the job either a pleasant one or a damned miserable experience. The memories of such relationships have a strong bearing on your reaction to being reassigned to the project. My own memories are very reassuring and I have a strong feeling of kinship towards those who were on our establishment. It is a good feeling and one which I hope they in turn feel toward me.

This has been anything but a scientific treatise on Polar Shelf. It was not my intention that it be one. The main purpose has been to give you a broad general outline how Polar Continental Shelf Project came about, what it is doing and possibly some insight as to its future.

E.S.P.

E.S.P. is an "in" thing -- be in -- amaze your friends at coffee breaks - cocktail parties - or even appraisal boards!

Count out the six cards. Have your straight man select a number from 1 to 63, and have him give you the cards on which this number appears.

Ask him to concentrate on his number and astound him by reading his mind.

For example: Number selected 42
This appears on cards 2,3 and 5

You add the number which appears on the top left corner -- in this example $2 + 8 + 32 = 42$

Readers are invited to develop the mathematical formula for this trick and submit them for printing in the next issue of Lighthouse.

1

1	3	5	7	9	11	13	15
17	19	21	23	25	27	29	31
33	35	37	39	41	43	45	47
49	51	53	55	57	59	61	63

2

2	3	6	7	10	11	14	15
18	19	22	23	26	27	30	31
34	35	38	39	42	43	46	47
50	51	54	55	58	59	62	63

3

8	9	10	11	12	13	14	15
24	25	26	27	28	29	30	31
40	41	42	43	44	45	46	47
56	57	58	59	60	61	62	63

4

4	5	6	7	12	13	14	15
20	21	22	23	28	29	30	31
36	37	38	39	44	45	46	47
52	53	54	55	60	61	62	63

5

32	33	34	35	36	37	38	39
40	41	42	43	44	45	46	47
48	49	50	51	52	53	54	55
56	57	58	59	60	61	62	63

6

16	17	18	19	20	21	22	23
24	25	26	27	28	29	30	31
48	49	50	51	52	53	54	55
56	57	58	59	60	61	62	63

GUIDELINES FOR THE TIDES, CURRENTS & WATER LEVELS UNIT CENTRAL REGION, MSB

N.G. Freeman

INTRODUCTION

The prime responsibility of this unit is to provide hydrodynamic support, specifically tidal, current, and water level, for hydrographic surveys and navigational requirements, while maintaining a strong scientific expertise. Such goals can be realised only through a well defined programme of data acquisition and analysis instrumentation development and maintenance, information dissection and dissemination, and hydrodynamic research and investigation.

Within the branch the regional needs, priorities, and programmes must be determined by the regional sector, allowing for significant input and feedback by headquarters, whose function it is to define national requirements, and by other regional units. As pointed out in the 1970 Task Force Report[1], "A continuing two-way flow of information with the regions", is essential. Regionally, all hydrodynamic requirements should be channeled through the unit, thus insuring a well coordinated regional programme. Within the unit it is essential that the coordinated functions are established bearing in mind the necessary distinction between staff and line responsibilities. In general, a regional autonomy in conjunction with a significant interaction, both external and internal, must be achieved.

1 *Task Force Report: Tides, Water Levels and Tidal Current Activities, Marine Sciences Branch, May 1970, Ottawa.*

HYDROGRAPHIC SUPPORT

In consultation with the Assistant Regional Hydrographer and Hydrographers-in-Charge, certain requirements must be reviewed and implemented for the various hydrographic surveys prior to the field season. Lake Ontario, Playgreen Lake, Lake-of-the-Woods, Little Current, James Bay, Lower St. Lawrence and the Polar Continental Shelf require this type of preparation for the 1972 field season.

(a) Water Level Regime:

The location of permanent gauging and the requirement for complementary temporary gauging, and for predictive analysis must be determined. Reconnaissance surveys into new areas, including in situ measurements, are necessary for the evaluation of instrumentation spacing and sampling intervals, and the applicability of water level transfers. In addition, permission from such groups as the Water Survey of Canada and the Department of Public Works to use their permanent gauging facilities, must be obtained. Also water level printouts, in support of the surveys, must be requisitioned from headquarters.

(b) Current Regime:

The type, location, quantity, and frequency of sampling of current measuring devices employed by the hydrographic party, must be determined. A literature search and/or reconnaissance survey of a new area would be useful in ascertaining the current structure likely to be encountered by the hydrographer.

(c) Vertical Control:

Present bench mark descriptions, locations and elevations must be provided for the survey areas, and the need for additional bench marks determined. At the termination of the field season, the leveling notes should be checked by the unit for accurate vertical control.

(d) Sounding Datum Calculations:

Long term, time series (of the order of ten years) must be analysed and the statistical mean of the yearly lowest daily mean used to obtain the low water datum (i.e. sounding datum). Horizontal datums must be computed for large bodies of water, and sloping or stepped datums for rivers. These computations, fully documented, will be forwarded to Tides and Water Levels, Ottawa, for inclusion in chart datum calculations.

(e) Submission of Field Data:

Temporary Gauge Data Forms (TWL502) and Record Comparison Forms, bench mark descriptions and photographs, along with monthly temporary gauge records, both water level and current, should be forwarded to the unit, as soon as they become available. These items will be compiled, checked and sent to Tides and Water Levels, Ottawa, in time for inclusion in their regular publications.

(f) Field Sheet Checking:

The sounding datums and hydrodynamic information entered on the Field Sheets by the hydrographic survey should be checked by the unit prior to acceptance by the Regional Hydrographer.

(g) Instrumentation Acquisition and Calibration:

Temporary Water level and current gauging should be requested through this unit and returned to same for maintenance and recalibration.

As hydrographic support is our main operational area, the mechanisms for expediting this function must be established immediately - well in advance of the field season. This will be the prime responsibility of the Tidal Officer (rotating hydrographer) as his field background is ideally suited for such a purpose.

NAVIGATIONAL STUDIES

As our prime concern is the mariner, certain studies in the interest of safe navigation must be undertaken by the unit. These investigations would include such items as water level hydrographs, current hodographs for channels and narrows, harbour entrance currents and silting, tidal streams, and wave climatologies.

Studies will be formulated upon completion of a thorough literature search and extensive discussion with experienced personnel in both government agencies and in private industry. Once this is accomplished, it can be ascertained whether the study should be carried out in conjunction with hydrographic field parties, the unit's own field group, or an external organization. Regardless, it will be up to the unit to compile and forward the data to headquarters along with the recommendations for its inclusion in Charts, Notices to Mariners, Canadian Pilots, and such special publications as Current Atlases. In addition, feasibility studies can be conducted into the hydrodynamic implications of proposed shipping routes (eg. an Arctic oil route - U.S.S. Manhattan), channel dredging, and harbour construction.

A few explicit examples of proposed navigational studies might prove more elucidating. In the Lower St. Lawrence between Quebec City and Les Escoumins, a major hydraulic and tidal current study is to be undertaken to evaluate the flow regime and its effect on discharge, shipping, and harbour installations. A preliminary report and plan of attack is required early in 1972 and a complete programme by January 1972, leading to a large scale field operation commencing in 1973 or 1974. In Nares Strait in the Arctic, a tidal study encompassing both horizontal and vertical movement of water, is required in support of hydrographic surveying and outside scientific studies. In 1972, a definition of the problem and a reconnaissance survey are planned, while in 1973, a field testing of the winterized instrumentation is to be undertaken, and in 1974, a full programme of measurement and analysis is to be carried out. A current study of the Little Current area on Georgian Bay should be conducted, as soon as possible, to complement W.D. Forrester's current study in this area, and to enable current hodographs to be incorporated in the published navigational material.

It should be pointed out that these navigational studies differ from the research investigations to be discussed later, in that they are an integral part of our operational function, that is to supply the mariner with the most up-to-date hydrodynamic information.

SCIENTIFIC EXPERTISE

As the unit must be readily conversant with hydrodynamic, hydrologic, hydraulic, and hydrographic concepts, a continual updating of its scientific knowledge must be striven for. An essential step in this direction, and one that can not be overemphasized, is the regular review of published material. Attendance at in-house seminars, branch workshops, and specialized university courses is also essential, as is active participation in national and international conferences and committees. The preparation and conduct of in-house training programmes will also enhance the unit's scientific knowledge.

An expansive scientific expertise is required in the areas of computer programming, fluid flow instrumentation, data abstraction and analysis, statistical analysis, vertical and horizontal positioning, hydraulic and hydrological analysis, water level, tidal and current analysis, and meteorological analysis. This type of experience could be gained by secondment to Tides and Water Levels, Ottawa, or east and west coast units. An exchange of personnel would also have the additional advantage of increasing joint cooperation, and reducing the likelihood of duplication of scientific investigations.

Finally, unit personnel should take an active role in national and international conferences and committees. Dr. A.E. Collin, the Director of Marine Sciences Branch, strongly supports the submission of papers. It is only through an increased exposure to the scientific community that the unit will become a recognized authority on the subject of tides, currents and water levels.

DATA ACQUISITION AND ANALYSIS

Large volumes of field data, from temporary water level and current gauges, installed by the region, must be documented and processed at the close of the field season. The necessary data reduction and statistical tools must be developed to handle this mass of data. In addition, numerical analyses routines must be written in support of our applied research function.

A data reduction system for the water level strip chart records can be formulated by employing the D-Mac pencil follower and magnetic tape output, presently in our Research and Development Group. However, a mechanical roll advance, computer interfacial programming, data output programming (in T.W.L. format), a simple data editing, data averaging, extreme data determinations, and frequency of occurrence routines must be devised to make the system operational. This digitizing system must be flexible enough to accept analog records from continuous current, wind speed, and wind direction recorders. In addition, other abstraction systems must be developed to handle the already digitized paper and magnetic tape records (Data processing techniques are well developed at headquarters and these should be scrutinized prior to evolving our own procedures).

Standard computer programmes for the numerical and statistical analysis of digitized data must be written, or obtained, and if necessary modified to meet the unit's particular needs. Some common routines might be: data histogram analysis, complex demodulation analysis, correlation analysis, regression analysis, autospectra analysis, cross-spectra analysis and tidal constituent analysis.

The above mentioned considerations not only apply to the unit's research function, but equally as well, to our operational processing; for instance in the Lower St. Lawrence, the sounding reduction predictions require the analysis of short term water level records to determine the regression coefficients for the extrapolation curve.

INSTRUMENTATION DEVELOPMENT AND MAINTENANCE

The development of temporary hydrodynamic gauging and ancillary equipment should be undertaken by the unit. The Task Force report states that, "The development and operation of special gauges now being carried out in Mr. Dohler's section should be assigned to the various regions as soon as they develop the required capability and interest." The phasing in of a complete instrumentation function, which would include evaluation, purchase, modification, calibration, and maintenance of all regional hydrodynamic gauging, must be accomplished over an extended period of time (Our regional Research & Development Group, and Electronics shop, as well as headquarters instrumentation group, can be called on to give assistance in this area).

Additional temporary gauges, presently the Ottboro water level gauge and the Ott current meter, must be obtained by the unit. The former, a simple to operate pneumatic system, is a continuous recording device, while the latter, an electro-mechanical system, requires manual recording. To adequately serve the purpose of long period time series studies, a continuous recording device either magnetic tape or punch paper tape, as well as a directional vane must be affixed to the Ott instrument (Westinghouse demonstrated a two channel cassette recorder in their recent presentation at C.C.I.W.)

New equipment must be developed for specialized functions. Winterized instrumentation must be produced for the Nares Strait survey (Assisting Mr. Duncan Finlayson, Defence Research Board in installing current instrumentation in the Lincoln Sea in April 1972 is a possible way of "getting our feet wet" in this area). Telemetered water level gauging, either land line or radio link, should be obtained and modified for use with the on-board recording system, Haaps, with the sounding reduction predictions in the Lower St. Lawrence, and with remote sensing in Lake-of-the-Woods. The possibility of a small on-board computer performing the zonal predictions in the Lower St. Lawrence must also be investigated. To study the two-dimensionality of surface currents, drogues must be developed (Dr. C.R. Murthy of Inland Waters Branch could be consulted as to drogue design and application).

Finally, field instructions for present and new equipment must be drawn up, and an inventory of all permanent gauging must be written.

INFORMATION DISSECTION AND DISSEMINATION

Various forms of environmental data must be compiled, dissected and plotted, in easily discernable format, to provide an instant causal reference for changes in water level and current regimes. Collected field data must be disseminated to headquarters and other interested parties.

The dissection of water level, surface current, water surface temperature, river discharge, precipitation, evaporation, runoff, ice observation, snow cover, wind speed and direction, atmospheric temperature and pressure, and Great Lakes control regulation data will enable the unit to determine a priori, the meteorological, water level and surface current regimes in the field survey areas. This type of water inventory must be continually updated by the unit. Ultimately, a storage and retrieval system for bench mark, sounding datum, water level, tidal, current, and meteorological data, should be developed within the region.

HYDRODYNAMIC RESEARCH AND INVESTIGATION

In November 1968, the Dominion Hydrographer asserted that "Specialized tidal investigations related to a specific navigational requirement or undertaken in support of hydrographic projects are an integral part of the hydrographic activity". In the Task Force Report, the committee recommended that, "The responsibility for scientific research on tides and currents should be assigned to the various regions as soon as they develop the required capability and interest". With the appointment of a Regional Tidal Officer and the setting up of a Tides, Currents and Water Levels unit, such an interest and capability is evolving in Central Region.

In Central Region, it would appear that the temporal and spatial scales of the physical processes of interest are of a different order of magnitude than those of interest to headquarters who carry out considerable applied research; namely, the direct regional involvement in hydrographic surveys and navigational studies dictates a natural scale, as determined by the duration and coverage area of the individual survey. The questions that must be answered here, at least as far as hydrography is concerned, are how frequently should the water level data be sampled and how close, geographically, should the water level instruments be placed, in order to insure accurate sounding reductions. Thus our research into the meteorological effects on water level fluctuations will take the form of small scale, spatial and temporal correlations of water level variations with wind and atmospheric pressure systems. This empirical research must also be supplemented by theoretical modelling, both analytical and numerical, in order to comprehend the dynamics behind such processes, and to better predict their occurrence (Dr. Murthy of Oceanographic Research Division is presently being consulted on these aspects, especially as they relate to the Sarnia Storm Surge - qualitatively a ten mile spatial scale is indicate here). This type of scale determination must also be investigated in relation to other physical processes, such as astronomical effects on water level variations, fluctuating currents, and hydrological budgets, to name just a few.

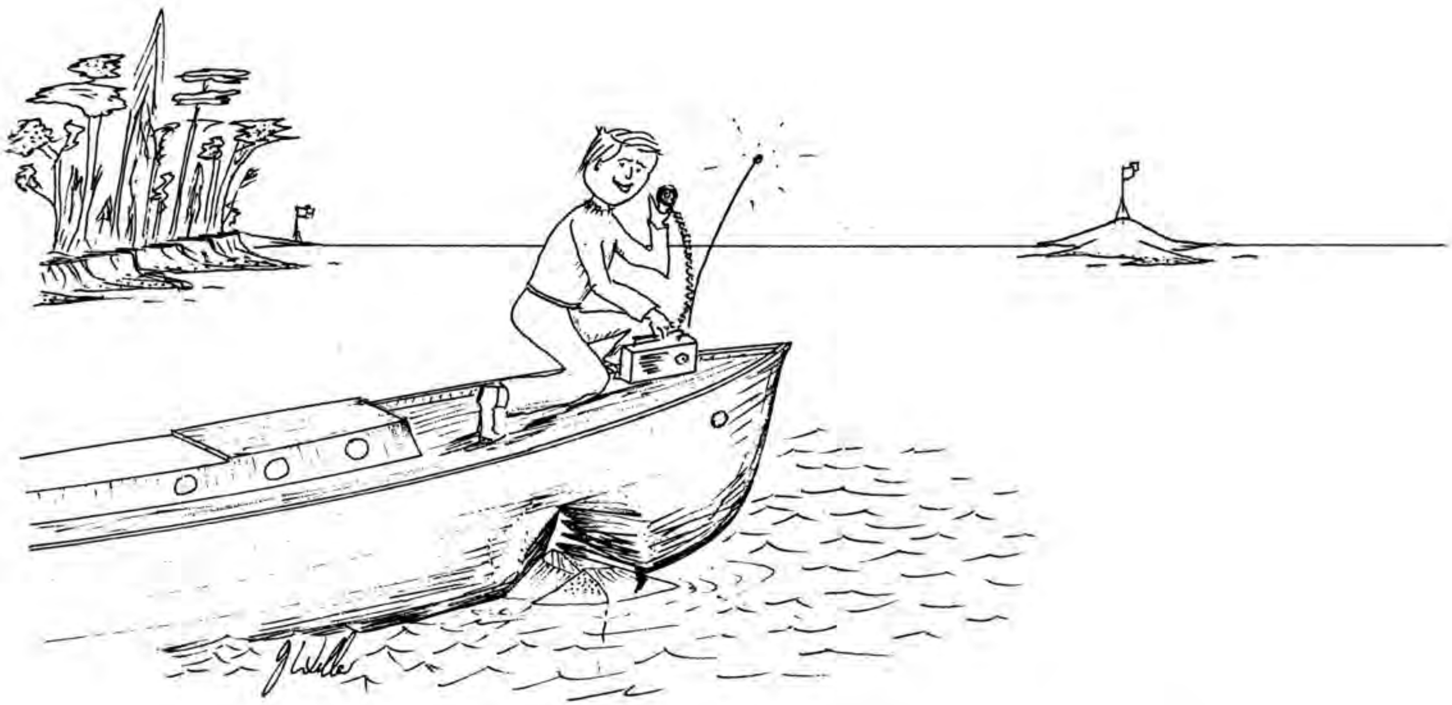
At the recent hydrographic debriefing session, it was continually indicated, especially in the Little Current, Lake Winnipeg and Lake-of-the-Woods surveys that variations in local winds altered the onshore water level, over small reaches, by as much as a foot within a few hours. These small scale hydrodynamic processes must be investigated, at least qualitatively, prior to the 1972 field season. In addition, empirical and theoretical research on such localized phenomenon as the effect of intervening islands on wind set-up, the hydraulic currents due to set-up imbalance, the hydraulic gradients as rivers empty into lakes, storm surge resurgence, and natural seiching, etc., must be undertaken. This type of research will better enable our unit to define the water level and current environment to be encountered by the hydrographer on the Great Lakes. In our tidal reaches, namely, the St. Lawrence River, where a hydrographic survey is presently being conducted, we are required to predict water level variations, including meteorological perturbations on the normal astronomical fluctuations.

In order to successfully backup other Central Region operations, a wider breadth of applied hydrodynamic research must be undertaken. In support of our Shore Properties Study unit, research is presently being carried out into the effects of water level variations on shoreline erosion. Generally, the higher the water level the greater the kinetic energy of breaking surface waves on the onshore bluff. In support of our ships and launches section, surface wave research could be conducted, to assist in stability modifications to boats, or improvements in harbour mooring systems, or to damp out high frequency oscillations in sounding records. In instrumentation design, fluid drag studies are required on sensing heads, that are placed in strong current regimes. Finally, in support of our charting function, a research study could be launched in the Lower St. Lawrence, simultaneous with the navigational study, to investigate the frequency of occurrence, the spatial distribution, and the rate of propagation of submarine sand dunes, with a view to understanding and predicting the river's ever changing bathymetry.

Other areas of hydrodynamic research and investigation will no doubt evolve as new problems are encountered in the field. However, it is mandatory to the viability of this new unit that an on-going programme of scientific research and study be carried out, viz., only through a direct involvement in research will the scientific competence of the unit remain commensurate with the state of the art and enable it to answer scientific requests intelligently.

CONCLUSIONS

While this dissertation does not cover every aspect of the unit organization, it does outline the main areas of influence, along with numerous examples of the functions to be performed. However, by outlining such specifics this document automatically dates itself, as it should, for the concepts outlined herein are ever changing, and an awareness of the responsibilities ever increasing.



"SIR ... WE'VE FOUND THAT ROCK!"

CANADIAN HYDROGRAPHERS' ASSOCIATION

APPLICATION FOR MEMBERSHIP

I hereby make application for admission to the Canadian Hydrographers' Association and if accepted, I agree to abide by the Constitution and Bylaws of the Association.

SURNAME AND CHRISTIAN NAMES:

MAILING ADDRESS:

DATE OF BIRTH:

PRESENT OCCUPATION:

NUMBER OF YEARS AND TYPE OF EXPERIENCE RELATED TO HYDROGRAPHY:

FORMAL EDUCATION:

COURSES IN HYDROGRAPHY:

Signature