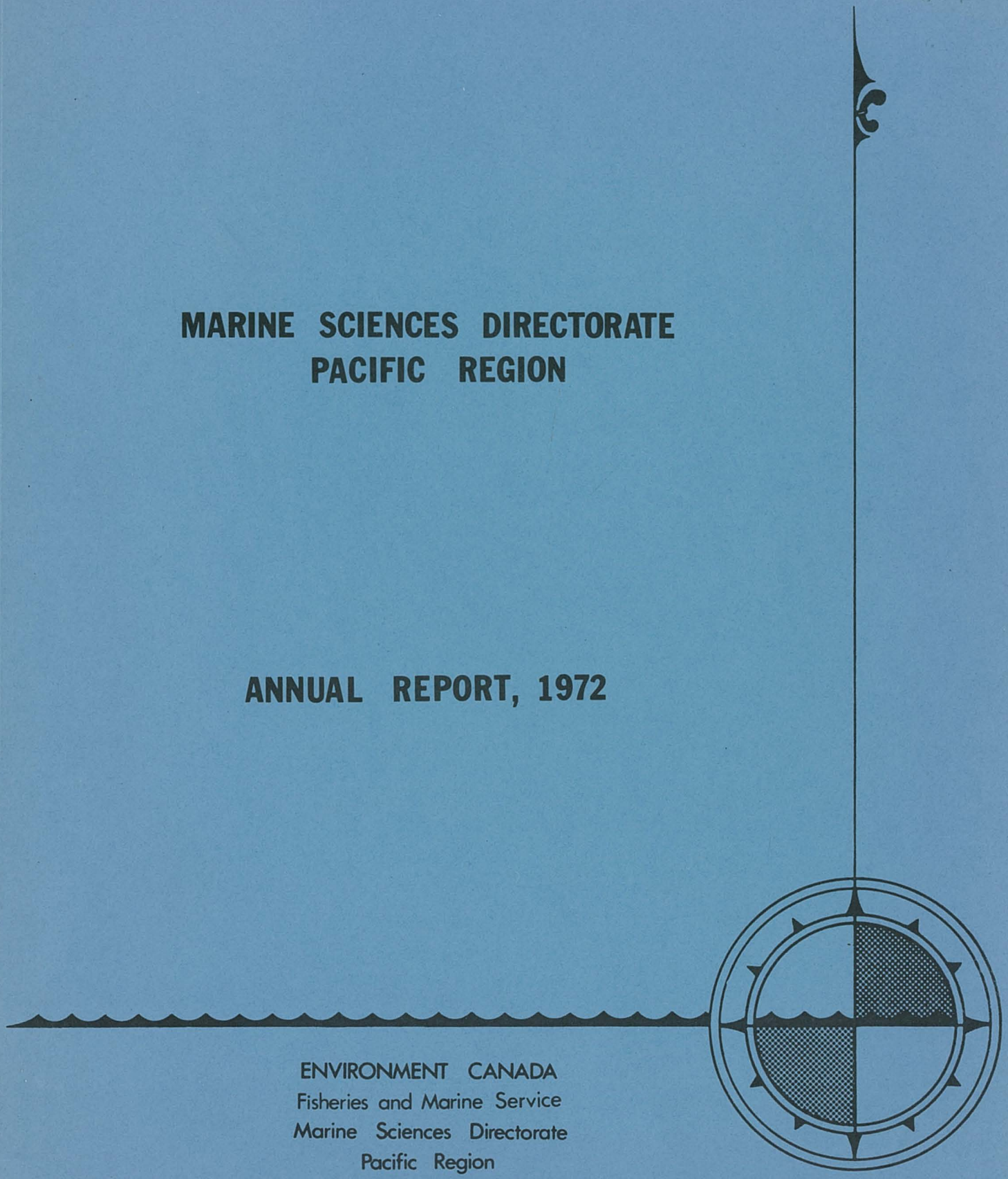
MARINE SCIENCES DIRECTORATE
PACIFIC REGION

ANNUAL REPORT, 1972

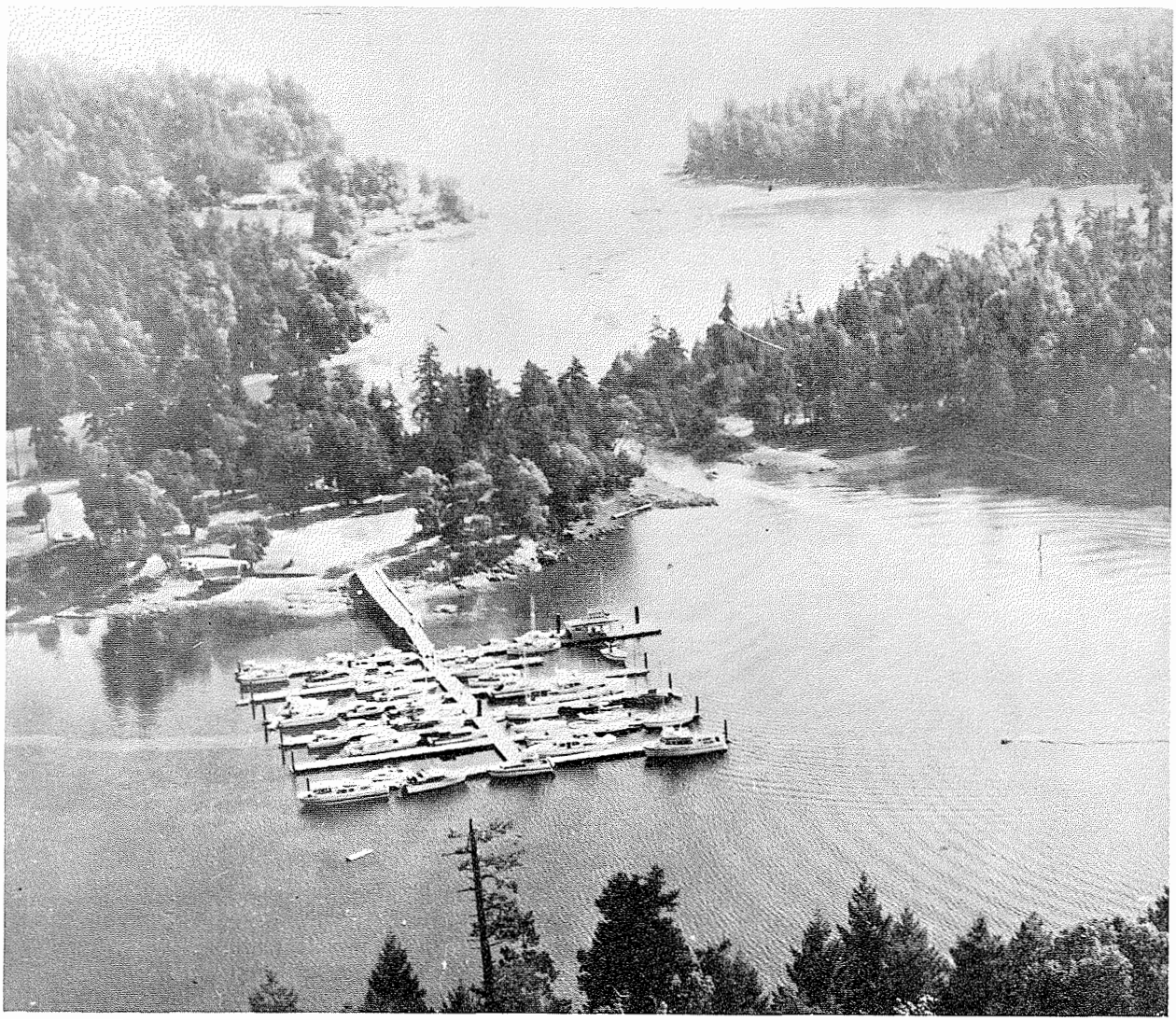


ENVIRONMENT CANADA
Fisheries and Marine Service
Marine Sciences Directorate
Pacific Region
1230 Government St.
Victoria, B.C.

MARINE SCIENCES DIRECTORATE

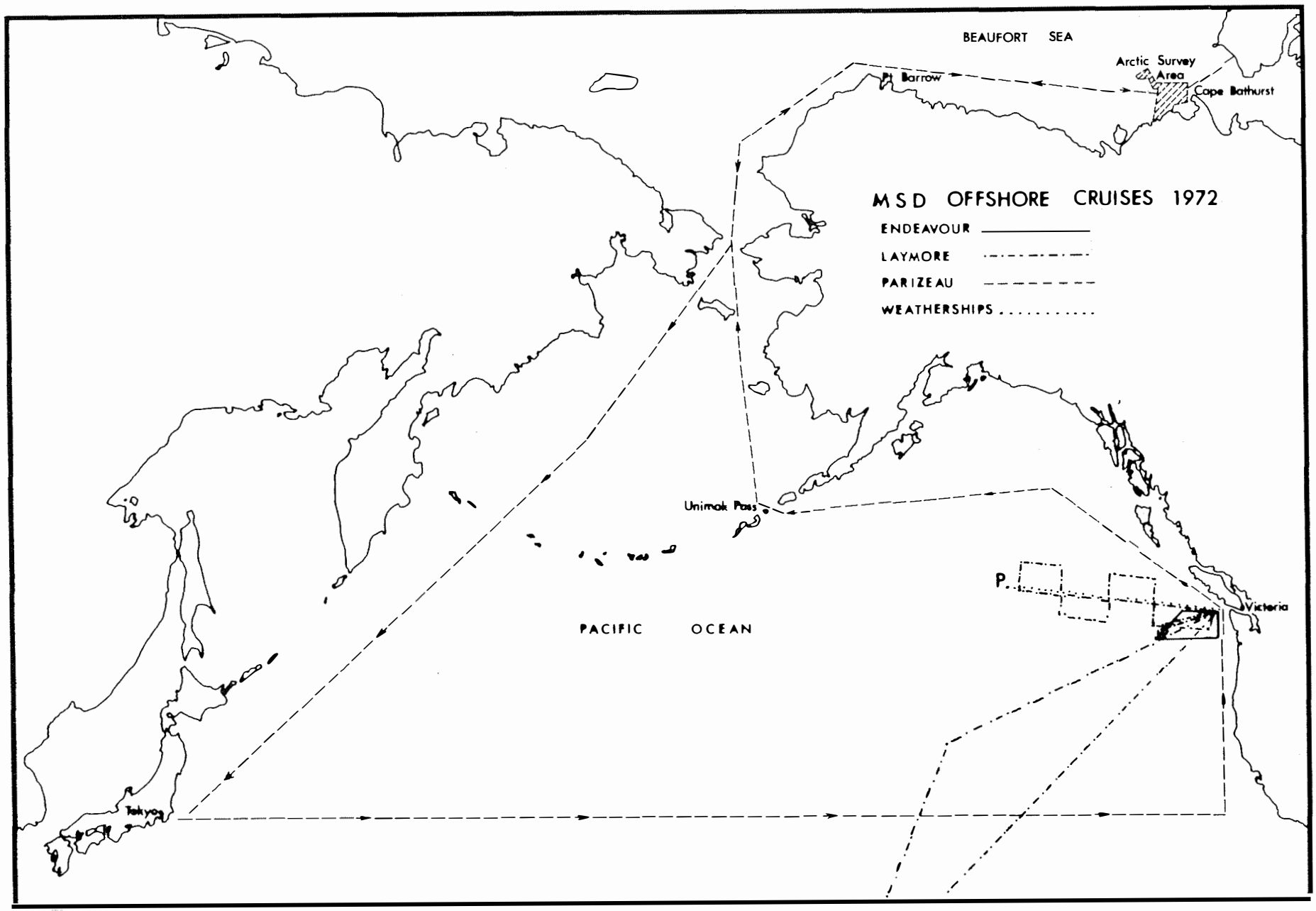
PACIFIC REGION

ANNUAL REPORT 1972



Telegraph Harbour in the Strait of Georgia's Gulf Islands is one of the hundreds of small anchorages on the British Columbia coast which are feeling the pressure of the pleasure boating boom.

Victoria, March 1973.


BEAUFORT SEA
Arctic Survey Area
Pt Barrow
Cape Bathurst
MSD OFFSHORE CRUISES 1972
ENDEAVOUR
LAYMORE
PARIZEAU
WEATHERSHIPS
Unimak Pass
P.
Victoria
PACIFIC OCEAN
Tokyo

For the Marine Sciences Directorate, Pacific Region, 1972 was a year which may in retrospect appear as a calm between storms. The intensive reorganization which occurred in 1971 had comparatively mild sequels in 1972, and although the future promises much more extensive reorganization and relocation of the work and personnel of the Region, these impending changes had little effect on the work carried out during the year. As is to be expected in the Department of the Environment, there were many ad hoc tasks demanded of us, but these did not prevent substantial progress being made in ongoing programs.

In 1972 the Hydrographic Division made good progress in the continuing survey program for the B.C. coast. The main portion of the Strait of Georgia has now been completed, as has a new survey of Massett Harbour and approaches in the northern area.

Hydrographic and geophysical surveys in the Beaufort sea were conducted from CSS PARIZEAU, which again spent the summer in the Arctic. Further data were collected for the delineation of the underwater pingo-like features of this area.

A new charter vessel, the RADIUM EXPRESS, was employed on the Athabasca-Mackenzie waterway. The use of this vessel greatly enhanced our continuing surveys along this important transportation artery which grows in importance with the rapidly expanding activities of the petroleum industry in the Arctic.

Closer to home, a large scale survey was completed of Secret Cove and Smuggler Cove on the Sechelt Peninsula, the results of which will be of value to the many fishermen and recreational boaters now using this area. Also as an aid to the boater a manuscript for the first edition of the B.C. Small Craft Guide, Vol. 1, has now been completed.

Research and development on new hydrographic techniques has continued. The introduction of side scan sonar and the velocity meter into this program is expected to have an important impact on future hydrographic work as will the continued studies into the development of airborne hydrographic techniques.

A notable event in 1972 was the visit of PARIZEAU to Japan in October. PARIZEAU went directly to Japan from the Arctic and in Tokyo became the centrepiece of the Canadian display at the 2nd International Ocean Development Conference and Exhibition. This Canadian display, organized by the Department of Industry, Trade and Commerce, was exceedingly well received -- to the extent that a Japanese newspaper headlined "Canada flexes muscles".

On the return from Japan, PARIZEAU carried out TRANSPAC 72, a chemical oceanographic expedition along 35°N across the whole Pacific. The marine CO_2 cycle, circulation in the North Pacific and oil aggregates in the surface waters were studied.

The Ocean Chemistry Division has now completed its move from Nanaimo to new laboratories at our Marine Depot in Victoria. It is to be expected that the Chemistry Division can now "settle in", and at least for some time in the future avoid the effects of frequent moves which have disrupted its work over the past few years. The radio carbon dating laboratory which is being established under our supervision and auspices on the premises of B.C. Research in Vancouver was at the end of the year on the point of becoming operative. The division has been substantially strengthened in personnel and new programs have been initiated in marine hydrocarbons and trace metals, in particular lead and mercury, in the marine environment.

The efforts of the Ocean Physics Division continued to be hampered by the fact that its personnel are scattered over six different locations in Victoria, Esquimalt, West Vancouver and Vancouver. However, substantial progress has been achieved in a wide variety of programs. A concerted effort has been made in Babine Lake in support of Fisheries Service work aimed at attempting to establish the carrying capacity of this lake for salmon following the construction of extensive artificial spawning channels. This work lies outside our terms of reference, but has been undertaken because of its urgency and the fact that the Inland Waters Directorate was unable to carry it out at the requisite time. Our participation in field work in this lake will not extend beyond 1973.

The interests and activities of this Division in the use of airborne and satellite techniques continues to grow. A cooperative program with the French Centre National de la Recherche Scientifique, in which we deployed a number of French buoys in the central North Pacific where they were tracked by the EOLE satellite, yielded very valuable experience. We are also taking a very active role in making use of imagery from the earth resources technology satellite (ERTS 1) and from remote sensing aircraft for oceanographic purposes.

An increasing amount of effort of the Region is being applied towards the numerical modelling of physical phenomena in water bodies of major concern. We now have working one-dimensional numerical models of Victoria Harbour, the lower Fraser River, and Babine Lake, and a working two-dimensional model of the Juan de Fuca-Georgia Strait area. Progress is being made towards three-dimensional modelling.

Ongoing programs as widely scattered as those at Ocean Weather Station "P" in the North Pacific and in Greely Fjord and Cambridge Bay in the Arctic, and Howe Sound on the City of Vancouver's doorstep, continue to demand our attention. In addition, however, MSD, Pacific played an active part in the Department's response to the two significant oil spills which occurred on this coast during 1972. We have also played a substantial role in such environmental impact studies as those on the Squamish Estuary, the Vancouver "Third Crossing" and the Moran Dam. It is to be anticipated that even more of our efforts will have to be directed to such work in the future. It is our responsibility to ensure that our ongoing programs keep us in a position to respond effectively and quickly in such situations.

HYDROGRAPHIC DIVISION

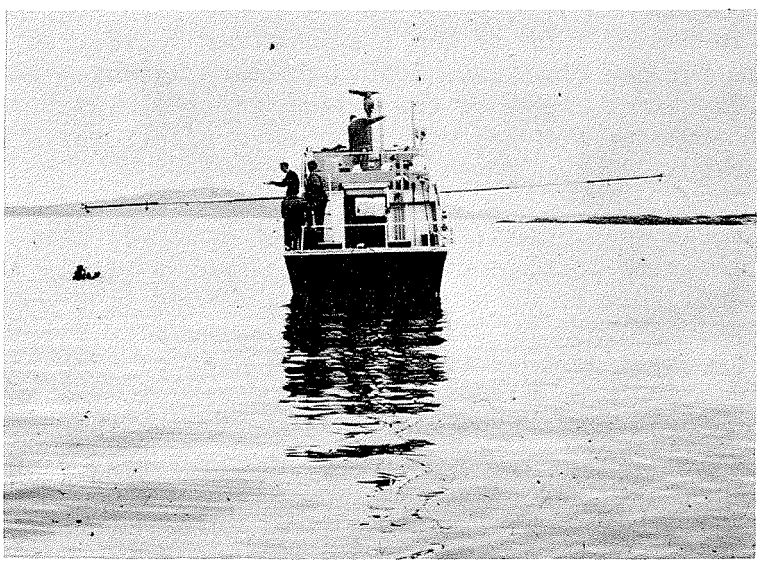
M. Bolton - Regional Hydrographer

The activities of the Hydrographic Division are summarized in the following sections. There are sixty-five full time continuing employees in the Division, over half of whom are considered to be field personnel. Demands on Hydrography continued to grow, far outreaching the resources available.

Detailed planning for a Pacific Coast interdisciplinary resource charting survey was commenced, with Hydrography assuming the role of lead agency. Plans for a major tidal current survey at the northern and western boundaries of the Strait of Georgia are well developed. Both of these major surveys will be undertaken in 1973. Arrangements for the 1973 Canadian Hydrographic Conference, to be hosted by Pacific Region in February, have been completed.

The Region again participated in the Hydrography I (Basic) training program, with the field training being conducted from CSS WILLIAM J. STEWART. One senior field hydrographer audited the Hydrography II training course given at CCIW. Several staff members attended various courses at the University of Victoria, and one hydrographer attended full time in the University Training Plan.

Administration of the Library was transferred to the Division during the year.



M.V. Revisor at anchor near Discovery Island. Ships' staff have just assembled the sweep apparatus and one of our divers is checking the depth of the wire drag.

FIELD HYDROGRAPHY

R. Wills, Regional Field Superintendent
E. B. Clarke
F. A. Coldham
I. J. Campbell
G. H. Eaton
N. S. Fujino
K. Highten
R. C. Hlina
J. B. Larkin
B. M. Lusk
C. G. McIntosh
A. R. Mortimer
R. D. Popejoy
A. R. Raymond
G. E. Richardson
G. W. Rogers
R. W. Sandilands
C. R. Tamasi
M. V. Woods
P. Y. Yee

Hydrographic surveys were carried out in the Pacific Region in 1972 on the same scale as in recent years and the projects undertaken were mainly a continuation of long range programs. A withdrawal of funds about mid season made necessary a reduction in overtime worked and a slightly earlier than normal end of field season, with a consequent failure to fully complete all projects as originally planned.

The Wm. J. STEWART (C.G. McIntosh) sailed from Victoria on May 4. Her survey areas included the northern Strait of Georgia, Masset Harbour and approaches and the approaches to the Skeena River. A Mini-fix chain in the hyperbolic mode was used for positioning in the Strait of Georgia and in other areas RPS, hydrodist and sextant were employed. Modern survey coverage of the whole of the main portion of the Strait of Georgia has now been completed and it is expected that remaining inshore sections including Malaspina Strait, Powell River and Westview will be completed in 1973. Masset Harbour and approaches, last surveyed in 1907, has been completed to modern standards and also the portion of the Skeena River approaches as required to complete coverage for new Chart No. 3985. Primary adjusted control has been established for further surveys of the Skeena River and Arthur and Telegraph Passages. Small revision surveys were carried out in Sechelt Rapids and Prince Rupert Harbour.

The PARIZEAU (R.W. Sandilands) carried out hydrographic surveys, including the collection of magnetic and geological data, in the eastern Beaufort Sea from 27 July to 30 August, having sailed from Esquimalt 4 July and run Gebco sounding lines en route. These surveys at 1:100,000, were a continuation of previous work in the area. An area of 2325 square nautical miles was sounded, 2600 n.m. magnetic profile surveyed, 121 shoals were examined and 133 bottom samples were obtained. At the request of Northern Transportation Company Ltd., Sachs Harbour was resurveyed at a scale of 1:10,000 and a reconnaissance survey of Harrowby Bay was made at a scale of 1:100,000. The Decca Lambda chain established by PCSP was used for positioning in the Beaufort Sea, and the assistance and co-operation given by the Project staff in helicopter transportation services and accommodation for personnel in transit at Tuktoyaktuk is gratefully acknowledged.

Setting a bench mark, and burying capillary tubing for pressure tide gauge at Liverpool Bay, N.W.T.

From 1 to 11 September a party of four from Geological Survey under Mr. J. Shearer were on board PARIZEAU and a total of 1,010 nautical miles of seismic profile were run in the area between Mackenzie and Franklin Bays. In addition 11 cores were obtained, five on or close to pingo-like features and six on a line to give a sampling of the shelf.

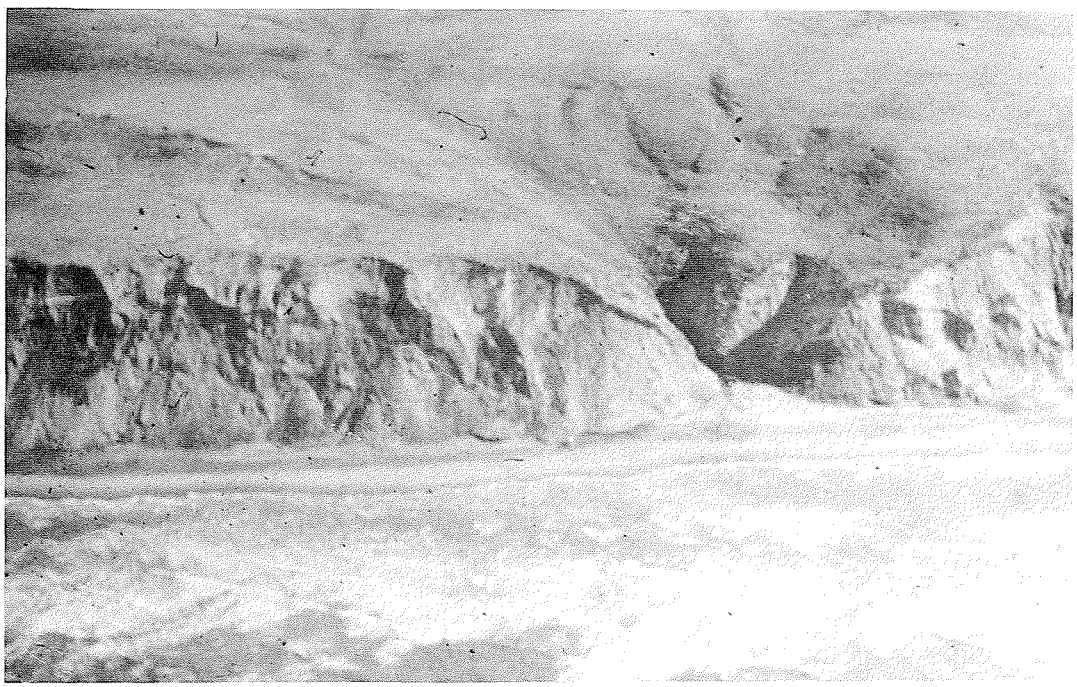
On conclusion of Arctic surveys the PARIZEAU proceeded directly to Japan to participate in the Second International Ocean Development Conference and Exhibition, Tokyo. Gebco sounding lines were continued en route and throughout "Transpac-72". When not engaged on Arctic surveys, hydrographic personnel from the PARIZEAU partly carried out a survey of Esquimalt Harbour which is now 95% complete.

The REVISOR (B.M. Lusk) continued her revisory survey program in southern areas including annual revisions to Vancouver Harbour and the Fraser River. In addition numerous investigations were carried out as the result of reports of new dangers, chart changes, etc. received from the Ministry of Transport, Canadian Power Squadrons, and other sources. The conventional survey of Juan de Fuca and Haro Straits, begun in 1971 was continued and the sourthern field sheet of Juan de Fuca Strait was completed as well as 50% of the northern sheet (Haro Strait).

This year the continuing program on the Athabasca-Mackenzie Waterway was carried out by the charter vessel RADIUM EXPRESS (G.E. Richardson). The vessel and other resources available proved to be a considerable improvement over the facilities of previous years. Sounding was completed from

Camsell Bend to Wrigley, also most of the area from Fort Good Hope to Travaillent River. Reconnaissance surveys were again conducted in the delta, mainly Middle Channel with its many branches leading north from Tununuk to Mackenzie Bay. Napoiak, Taylor and Schooner Channels were also investigated. Many small sounding surveys including Burnt Island, Birch Island, Ft. Norman as well as new ranges, were carried out in conjunction with the normal revisory surveys from Mile 0 to Tununuk. Temporary water level gauges were again operated, gauging stations being established at Miles 738 and 802 and in the Ramparts area. These records are being used in the establishment of a reasonable low water datum for surveyed portions of the river.

An independent launch party (A.D. O'Connor) conducted a large scale survey of Secret Cove and Smuggler Cove on the Sechelt Peninsula, the results of which will be of value to the many thousands of fishermen and recreational boaters now using the area.



Eroding cliffs at Nicholson Peninsula gauging station. Liverpool Bay, N.W.T. Rapid erosion is a common feature of the Western Arctic coast.

HYDROGRAPHIC DEVELOPMENT GROUP

N.M. Anderson, Head
A.D. O'Connor*
J.A. Vosburgh*
P.O. Lee*
R.A. Pierce*
*Rotational Hydrographic Staff

Side Scan Sonar Evaluation. This program has included improvements in towing, depression, and stability; range, resolution and signature repeatability tests; and the development of an expertise in tuning and interpretation. The operational technique can be used to realize the full potential of the side scan concept as a valued aid to hydrography. A detailed report covering all aspects of the concept has been prepared and will be presented at the Annual Hydrographic Conference.

Velocity measurements were taken using a velocimeter (N.U. Sonic Corp. Model 1000-005) and velocity corrections were applied to simultaneous soundings taken by echo sounders in current use. The results have been tabulated and recommendations concerning echo sounder acquisition and operation have been made in a report to be given at the Annual Hydrographic Conference.

Air photography. The University of New Brunswick under contract with the Marine Sciences Directorate Pacific is continuing a program to develop the techniques of stereoscopically measuring water depth from aerial photographs using the analytical plotter.

Fundamental to the development of airborne hydrographic techniques is the determination of position and attitude of each photograph. Traditionally this is done by aerotriangulation of photo identifiable, ground control points which are often not available in marine applications. An opportunity was presented by the Canada Centre for Remote Sensing (CCRS) to develop a system using the Lytton Inertial Navigation System (LTN-51) for the determination of attitude and position. An engineer and a technician from the Marine Sciences Directorate Pacific will be assigned to the project for its duration (approximately 18 months).

Underwater audio communications are needed to increase diver efficiency and provide diver-surface coordination during complex operations. Two systems, HELLEPHONE and SUBCOM, were evaluated and purchase of the SUBCOM system recommended. A report on this system will be included in the Pacific Region's Annual Diving Report which will be presented at the Annual Hydrographic Conference.

Wallace and Tiernan altimeters (Model FA 181) were tested for height determination and repeatability. Tests on two instruments were carried out to determine the feasibility of using them for measuring the heights of structures or geographic features presently measured by other means. A report has been prepared.

SAILING DIRECTIONS SECTION

T. Jones, Head
J.W. Chivas

The projects undertaken by this section in 1972 were:

(a) The completion of the compilation, in a new format, of the 8th Edition of the B.C. Sailing Directions (Pilot), Vol. I.

(b) The completion of the manuscript for the 1st Edition of the B.C. Small Craft Guide, Vol. I.

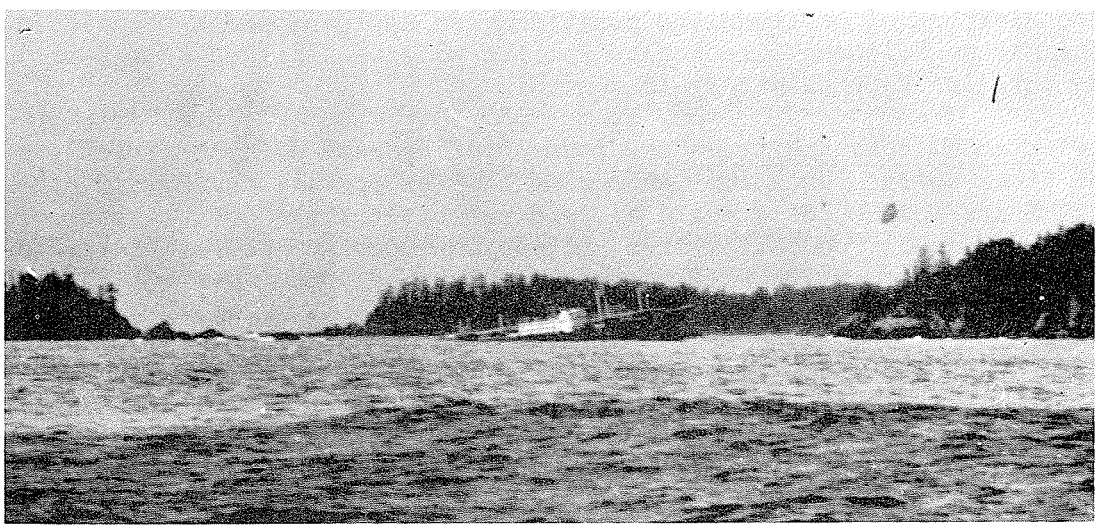
(c) A start to the compilation, in a new format, of the 6th Edition of the B.C. Sailing Directions (Pilot), Vol. II.

During April visits were made to the marinas and other small craft facilities on Vancouver Island, between Sooke and Nanaimo, for the purpose of collecting information and photographs for the Small Craft Guide, Vol. I.

In May, advantage was taken of the last sailings of the Northland Navigation Company's SKEENA PRINCE to circumnavigate Vancouver Island for the purpose of taking photographs and obtaining new information for both volumes I and II of the B.C. Sailing Directions.

In July, the section had the use of CSL FALCON and a coxswain to cruise through the Gulf Islands to collect photographs and small craft information for inclusion in the Small Craft Guide.

The revision of B.C. Sailing Directions, Vol. II, like that done for Vol. I is a major undertaking as it involves a fairly drastic pruning of redundant material in accordance with the policy for the new format, as well as the addition of some new information for the use of small craft. Five of the eleven chapters have been revised.



The oil slick from the freighter VANLENE, ashore in Barkley Sound, Vancouver Island.

TIDAL AND CURRENT SECTION

S.O. Wigen - Regional Tidal Superintendent

The Tidal and Current Section conducts field programs in the Pacific and Western Arctic Regions, and in the Mackenzie-Athabasca Waterway. Its activities for 1972 are reported under the four Units of the Section.

Hydraulic Research

A.B. Ages
A.N. Douglas
K.S. Lee
A.L. Woollard

The one-dimensional numerical model of the Fraser estuary was extended to include the upper tidal reaches of the river and Pitt Lake. The effect of critical freshet discharges upon the delta and its response to a proposed diversion canal were examined by the model. Salinity measurements in the delta were continued. An earlier developed model of Victoria Harbour was further refined and tested.

The Unit participated in the measurement and assessment of two oil spills in the Pacific Region, from the VANLENE grounding in Barkley Sound in March, and from the Atlantic Richfield refinery mishap at Cherry Point, Washington, in June.

The freighter VANLENE, bound for Vancouver from Japan, ran aground on the evening of March 14 at the entrance to Barkley Sound on the west coast of Vancouver Island. Although the weather conditions hindered the oil retrieval operations the heavy precipitation proved to be a blessing in disguise; fresh water runoff tended to keep the oil away from the shores. However, some areas did receive a quantity of oil on the beaches and these are being studied by biologists. A.B. Ages and R. Herlinveaux of the Coastal Zone Oceanography Section were actively engaged in the assessment of the effects of the spill.

Current Surveys

W.S. Huggett
J.F. Bath
T. McNie
K. Morgan
F.V. Hermiston
W.J. Harris
S. Ames

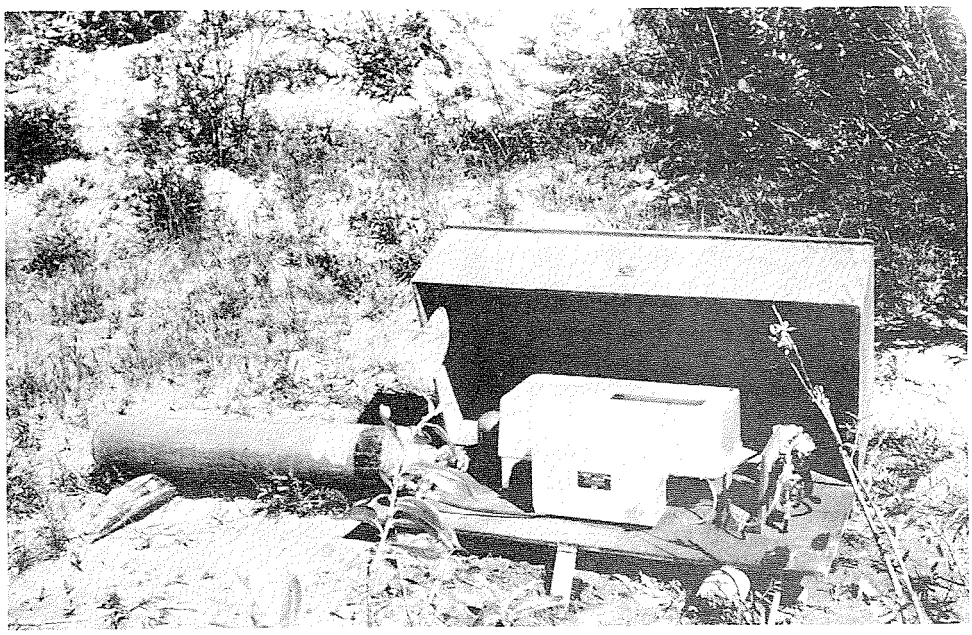
A current survey was carried out in Vancouver Harbour in the period March to May, 1972. The area of survey extended from westward of First Narrows to eastward of Second Narrows.

At the same time, twenty-one current meters were placed in the Strait of Georgia. Ten were moored in positions around the entrance of Howe Sound and Burrard Inlet. One supplied near-bottom velocities for a feasibility study of a pipeline crossing under the Strait of Georgia, and the rest were reoccupations of former stations where longer series of records were required.

A current meter established in Baynes Channel in 1971 and scheduled to run for one year was terminated in March 1972 due to mooring difficulties. The meter moored off Race Rocks is still in position. At both stations sufficient data have been obtained for harmonic analysis and tidal current predictions.

A current meter installed off Robert Banks will be left in place for a period of one year, and in the meantime, is used to give current velocity readings to the Pilots bringing freighters into Westshore Terminals at Robert Banks.

All data from the current meters in the Strait of Georgia survey have been processed and data from lines 2, 4 and 5 have been published. Line 6 is ready for the printers, and line 3 should be ready early in 1973. A draft copy of Vancouver Harbour currents has been completed, and it is hoped to have the final copy out by the middle of next year.



Water level bubbler gauge in its portable gauge shelter at a site on the Mackenzie River.

Tidal Survey

W.J. Rapatz F. Stephenson
R.E. Brown

The Tidal Survey Unit continued its program of water level gauging on the Mackenzie River. Two bubbler gauges were operated in the region between Fort Good Hope and Arctic Red River. The records obtained from these gauges were supplied to hydrographic personnel charting the River. Low water datums were established at the two sites. From Fort Good Hope to the Delta the lack of long-term water level records makes it necessary for future gauge operations to be conducted before charting datums can be established.

In the Western Arctic, tidal studies were conducted along the coast of the Tuktoyaktuk Peninsula and on the perimeter of Liverpool Bay. Nine gauge stations were operated during July and August. Five of these in Liverpool Bay established a preliminary model of tidal patterns in an area where the complex coastline and shallow depths create significant tidal variations in a short distance. This work is an extension of the 1971 tidal study of Eskimo Lakes.

On the British Columbia coast, twelve gauge stations were operated in Juan de Fuca and Georgia Straits as part of the continuing tidal and current studies in these waters.

The teleannouncing tide gauge stations at Steveston and New Westminster have been kept in operation for the benefit of navigators in the Fraser River. The teleannouncing gauge at Tofino has been maintained as a link in the tsunami warning network. Severe storms last winter caused the loss of most of the underwater components of the Langara Island tsunami warning gauge. Since then the installation has been rebuilt using part of the old system but incorporating a much less vulnerable arrangement. The new complex is expected to be in operation by early 1973.

Data Processing

C.E. Stenning
L.E. Ponse
S. Gill
D.E. Hilder

The Data Processing Unit processed all Marine Sciences Directorate tidal records for the Pacific and Western Arctic regions, and forwarded the data to Ottawa for analysis and inclusion in "Water Levels Volume 3".

CHART CONSTRUCTION SECTION

F.R. Smithers, Head
R. Banyard
R.D. Bell
P.C. Browning
D.J. Clark
J.H. Coldwell
E.M. Coulter
D.G. Dobson
K.R. Holman
A.G. Lyon
I.M. Mani
C.J. Nast
M.M. Patton
T.C. Plume
M.S. Taylor
L.G. Thomson
B.M. Watt
V.N. Young

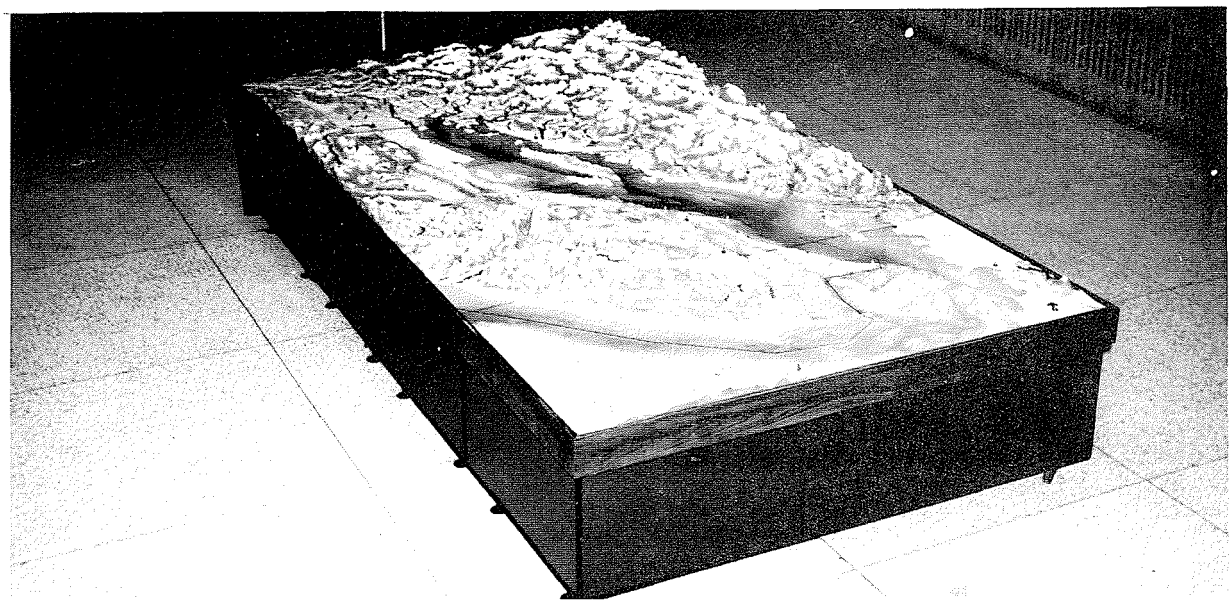
This Section is responsible for the compilation, revision, correction and distribution of the Pacific Region charts and publications. We are also required to provide illustration, drafting, photographic and printing services for the Region.

Compilation

The compilation unit has completed Chart 3687 "Plans in Quatsino Sound" and is processing eight compilations as listed below:

Chart	3512	Ballenas Is. to Cape Lazo
	3532	Baynes Sound and Approaches
	3901-L	Queen Charlotte Sound
	3980	Plans in Smith and Chatham Sounds
	3985	Approaches to Prince Rupert Harbour
	3989	Brown Passage
	3991	Hudson Bay Passage
	3992	Approaches to Portland Inlet

Since July 1972 we have built and set up displays aboard CSS PARIZEAU on her recent visit to the 2nd International Ocean Development Conference in Tokyo, Japan and built four modules for the 1973 Departmental Shopping Mall displays in addition to providing internal illustration and photographic services.

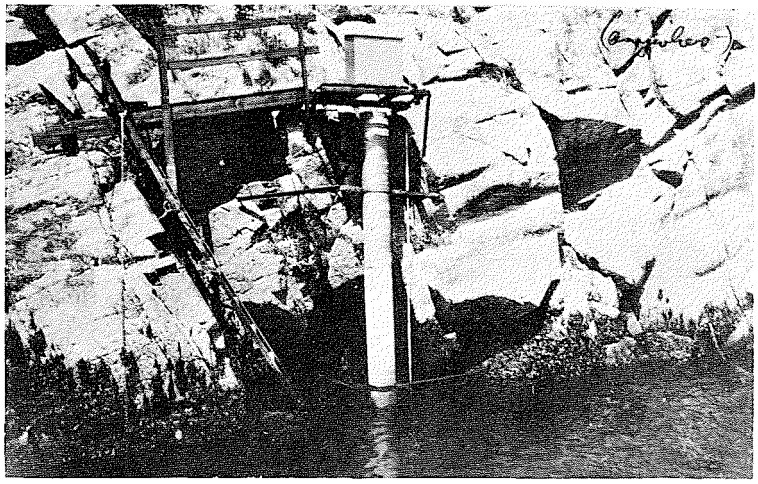


Strait of Georgia Model

Revision, correction and distribution

The revision unit compiled 12 new editions of nautical charts as a result of new survey data and major hydrographic changes. We processed 132 Marep reports from Power Boat Squadron for chart correction or revisory survey action. We promulgated 12 Notices to Shipping and 50 Notices to Mariners for publication by the Ministry of Transport. The chart correction staff have amended 144,227 charts which required 1,669,046 individual hand corrections before they could be distributed to our dealers for sale to the general public. Our chart distribution staff has processed and shipped 130,089 charts, 24,568 tide tables, 2,580 related nautical publications, 158 tidal current atlases and 1,323 miscellaneous prints. The premises of 38 chart dealers were inspected during the year.

Nautical chart displays were manned at the Vancouver International Boat and Sport Show, and, in conjunction with the Departmental exhibit, at two shopping centres in Vancouver and Victoria.



Winchelsea Island, B.C.
Tide gauge stilling well and transmitter.

SURVEY ELECTRONIC SECTION

J.V. Watt, Head	C.F. Ryan
L.W. Dorosh*	W.R. Taylor
R. Mogden*	T.J. Soutar
J.L. Rainko**	J.S. Wallace

*joined during 1972
**left during 1972

The Survey Electronics Section provides electronics engineering and technical support as required by the survey, ships and research operations in the Pacific Region.

The requirements for electronics operational and maintenance support continued to increase with a significant portion of the additional duties being attributable to the 1972 major equipment acquisitions of a velocimeter, a side scan sonar system and another short-range positioning system (Motorola 'Mini-Ranger'). The addition of 'C-Band' test equipment and procedures for calibration and maintenance of the Mini-Ranger System (5.5 GHz) constitutes the major change in the area of operations and maintenance.

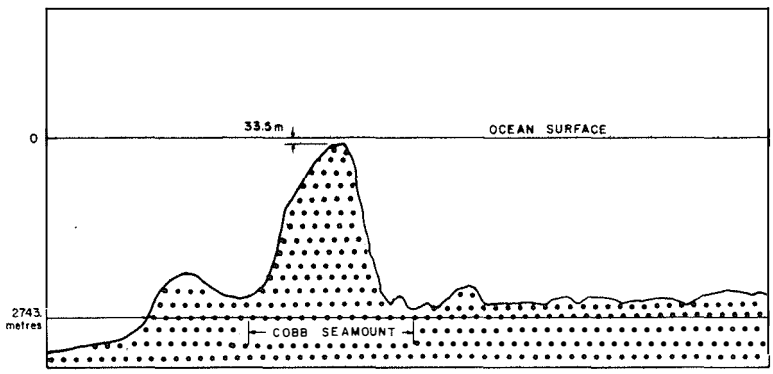
The Section provided full time field support to the WM.J. STEWART party and to the PARIZEAU during the Western Arctic operations and on the Transpac-72 cruise. Further support was provided on an 'as required' basis to the PARIZEAU Juan de Fuca Strait geophysical cruise, to the Mackenzie-Athabasca party, to the local operations of the REVISOR party, the Esquimalt Harbour party and the Secret Cove party, and to the ships VECTOR and RICHARDSON.

The design, development and construction talents of the section were exercised on projects such as trackable drifter buoys, assembly of the velocimeter equipment, examination of an Atlas sounder on loan from Central Region, design and construction of a X-Y recording BT system for applications in Babine Lake, continued work on a thermistor chain/data acquisition system for Babine Lake, and a study of the errors in radar transponder positioning systems related to transponder delay variations.

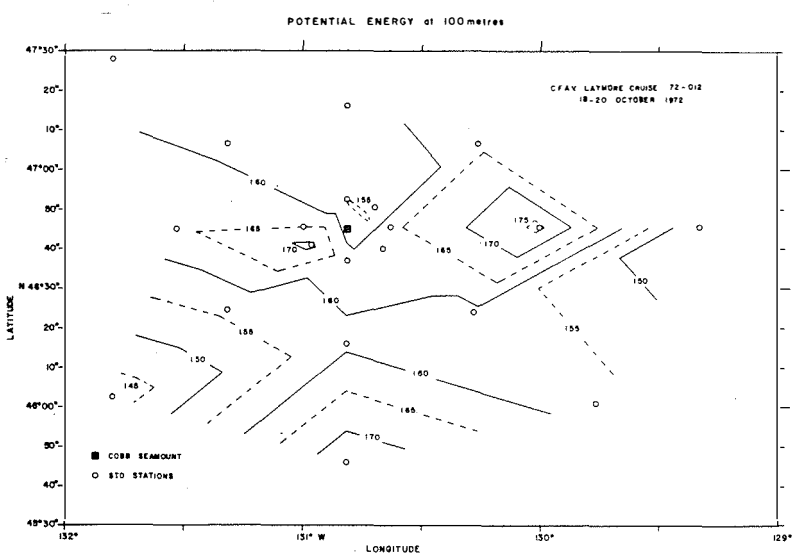
LIBRARY

D. Stastny, Librarian

During 1972 the library was staffed by 1 clerical assistant and 1 professional librarian on a part-time basis. The collection increased to about 2850 volumes (2700 titles) including 132 reference titles, 125 journal subscriptions with 7 complete runs on microfilm, 50 microfiche and a collection of reprints; much of this material was added by gift or exchange.



EAST-WEST PROFILE OF COBB SEAMOUNT



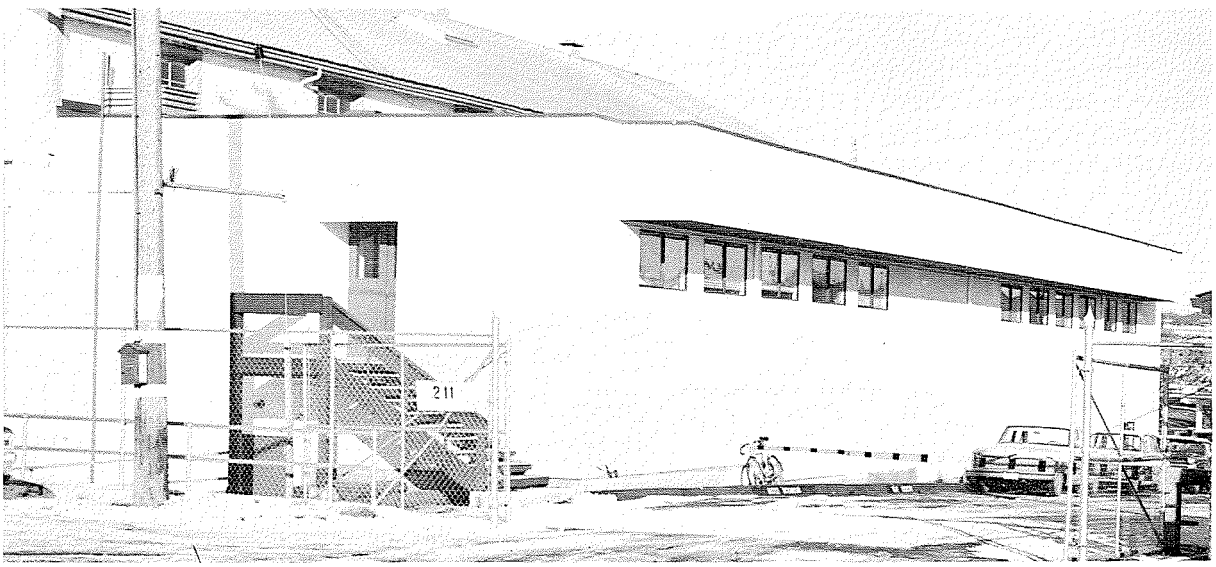
Cobb Seamount, a submarine mountain 200 miles off the coast which rises to within 34 m of the sea surface, has a measurable effect on local oceanographic structure. In particular the potential energy surfaces, which are related to water density, are displaced upwards near the seamount.

OCEAN ENGINEERING DIVISION

FACILITIES AND ENGINEERING PLANNING SECTION

N.A. Todd, Head

The West Coast Institute - The realization of the long talked-of Marine Sciences "West Coast Institute" is without doubt closer in absolute terms than it was at the end of 1971. The elasticity of the time-scale, accepted with historically induced stoicism, is however, accompanied each year by a more acute awareness that the effectiveness of the regional programs is suffering increasingly both from the spatial barriers existing among the various groups and from inadequate facilities. A review of those necessary administrative preliminaries which occurred during the year gives substance to the claim that the date of entry is closer now than it was this time last year.



New Ocean Chemistry Laboratories attached to the Depot Building at 211 Harbour Road, Victoria were completed in November, 1972 for accommodation of the Ocean Chemistry Division formerly located in Nanaimo.

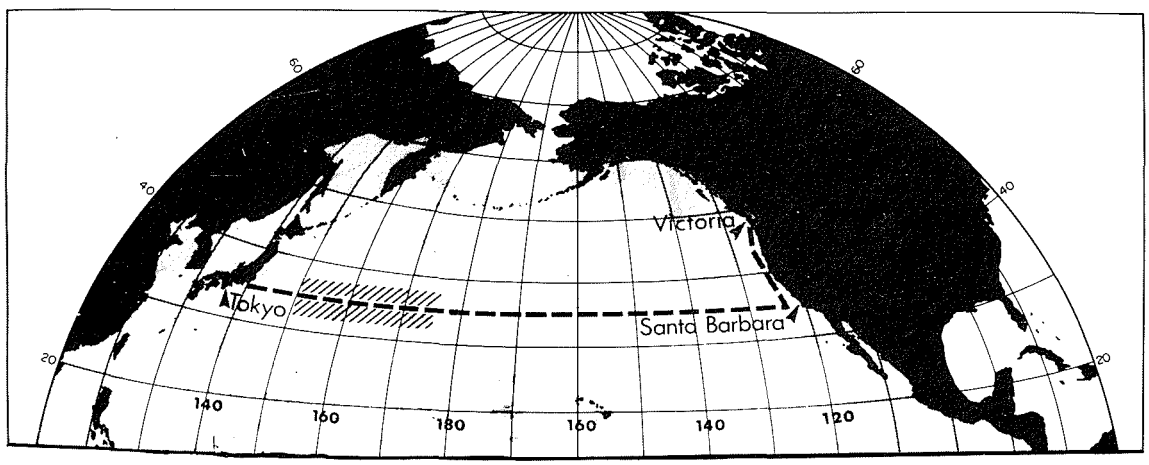
OCEAN CHEMISTRY DIVISION

C.S. Wong, Head
A.B. Cornford
W.J. Cretney
D.J. Francis (NRC Postdoctoral Fellow)
R.D. Bellegay
P. Vandergugten
C.M. Jackson

The main activities of Ocean Chemistry Division in 1972 included the establishment of new chemical laboratories in Victoria and a radiocarbon dating laboratory in B.C. Research (Vancouver), a TRANSPAC-72 expedition from Tokyo to Victoria, a continuing chemical monitoring program at Station "P" and initiation of new programs in marine hydrocarbons and trace metals. The Division was expanded from a strength of 3 in 1971 to 7 in 1972, with two additional graduate students from UBC and UVic working towards their Ph.D. degrees in our laboratories.

Establishment of new laboratories

The new laboratories at 211 Harbour Road, Victoria are designed for chemical oceanographic analyses, nutrients, trace metals, carbonate chemistry, atmospheric and oceanic CO_2 contents, natural and petroleum-based hydrocarbons, and chemical speciation in the marine environment. Instruments available included auto-analyzer, salinometers, pH meters, oxygen titrators, double-beam spectrophotometer, infrared spectrophotometer, gas chromatograph, high pressure liquid chromatograph, infrared gas analyzers and polarograph.



TRANSPAC-72 Expedition on CSS PARIZEAU from Tokyo tp Victoria (October-November, 1972) studied the marine CO_2 cycle, marine hydrocarbons and other chemical oceanographic properties in the Pacific Ocean. Shaded area indicates surface waters with high oil aggregate contents.

TRANSPAC-72 expedition

The Division carried out a 24-day expedition along 35°N in the Pacific Ocean from Tokyo (October 10, 1972) to Victoria (November 2, 1972) aboard CSS PARIZEAU. The scientific objectives were (1) to estimate the seasonal invasion-evasion of CO_2 over large areas of the Pacific ocean and its control by the carbonate chemistry of the surface mixed layer, (2) to study the deep circulation in the North Pacific and (3) to estimate the quantities of oil aggregates and dissolved organics in the surface waters. Parameters observed included pCO_2, total CO_2, alkalinity, T°C, salinity, radiocarbon, silicate, phosphate and nitrate. The chemical data from 19 oceanographic stations to a depth of 4500 m are being processed. Preliminary data of the oil aggregates and plastics, collected by Mr. Green using a neuston net sampler, show high concentrations of oil aggregates in the western Pacific ocean between 150°E to 170°E, while negligible amounts are present in the eastern Pacific and along the coast from Santa Barbara to Victoria. This suggests a similarity in oil aggregate distribution for both the Pacific and the Atlantic oceans, with high concentrations inside the western subtropical gyres. Further experimental work on the chemical composition, age and the biological habitats of these aggregates is being pursued.

CSS PARIZEAU was open to the public October 4-9, 1972 at the Harumi Pier, Tokyo,in support of Canadian participation at the Ocean Development Exhibition. Visitors included the Japanese Minister of the Environment, Japanese industrialists and scientists, the Chinese and other delegations to the 2nd International Ocean Development Conference. During the stay in Tokyo, the scientific party paid official visits to the Sagami Chemical Research Center and Ocean Research Institute at Tokyo University.

Chemical Monitoring Program at Station "P"

Long-term trends of chemical parameters at weathership Station "P" (50°N, 145°W) were monitored. Weekly samples of atmospheric CO_2, surface alkalinity and total CO_2, and surface radiocarbon samples were collected to follow the secular air CO_2 increase over a marine environment and its regulation by the carbonate chemistry of the surface mixed layer. Daily nutrient samples were collected for shore-laboratory analyses with a Technicon autoanalyzer to provide information on long-term nutrient fluctuations in relation to circulation and marine food chain.

Marine Hydrocarbons

The occurrence of petroleum-based hydrocarbons in the marine environment is an area which needs long-term investigation and a capability to detect the very low levels present. Dr. Cretney is setting up a contaminant-free laboratory for the application of gas chromatographic and high-pressure liquid chromatographic techniques to the rapid separation and identification of petroleum residues and natural hydrocarbons. Mr. D. Green, a Ph.D. graduate student from the Resources Department of UBC, has been working on the distribution and fate of oil aggregates (commonly called tar balls) in the marine environment. In addition to the TRANSPAC-72 cruise, Mr. Green

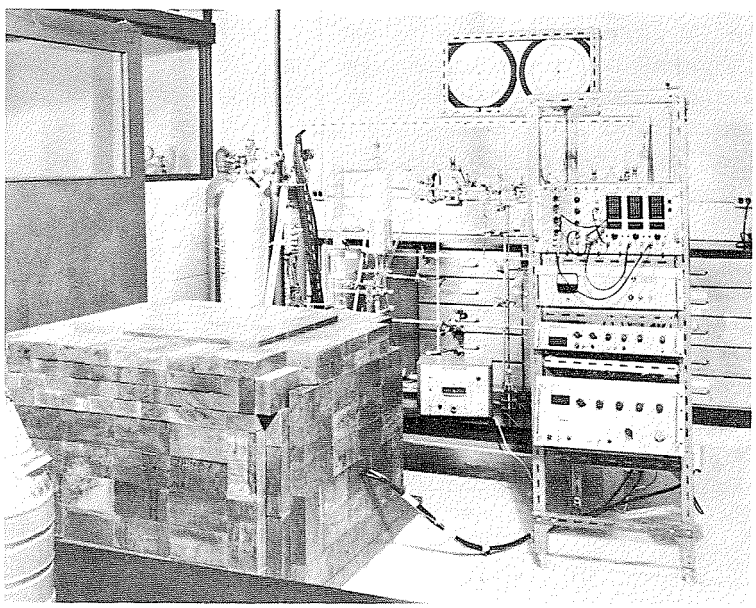
conducted a 3-day search for the presence of oil aggregates in the surface waters of the Strait of Georgia during December 1972. No aggregates were found. This negative result may indicate a clue to the origin of such aggregates: bilges from ships and tankers rather than from coastal communities. This suggestion requires confirmation.

Trace Metals

The objective of the trace metals program is to assess the natural and anthropogenic inputs of physiological significant trace metals into the marine environment, with special reference to coastal and marine waters. Dr. D.J. Francis, a NRC post-doctoral fellow, has been developing an anodic stripping voltametric technique for the analysis of lead, cadmium, copper and zinc in sea water and an ultraviolet spectrophotometric method for mercury. The important problem of the pathways of lead in the marine environment is being investigated by Mr. P. Berrang using mass spectrometric technique, in a cooperative Ph.D. thesis program between the Chemistry Department of the University of Victoria and the Ocean Chemistry Division.

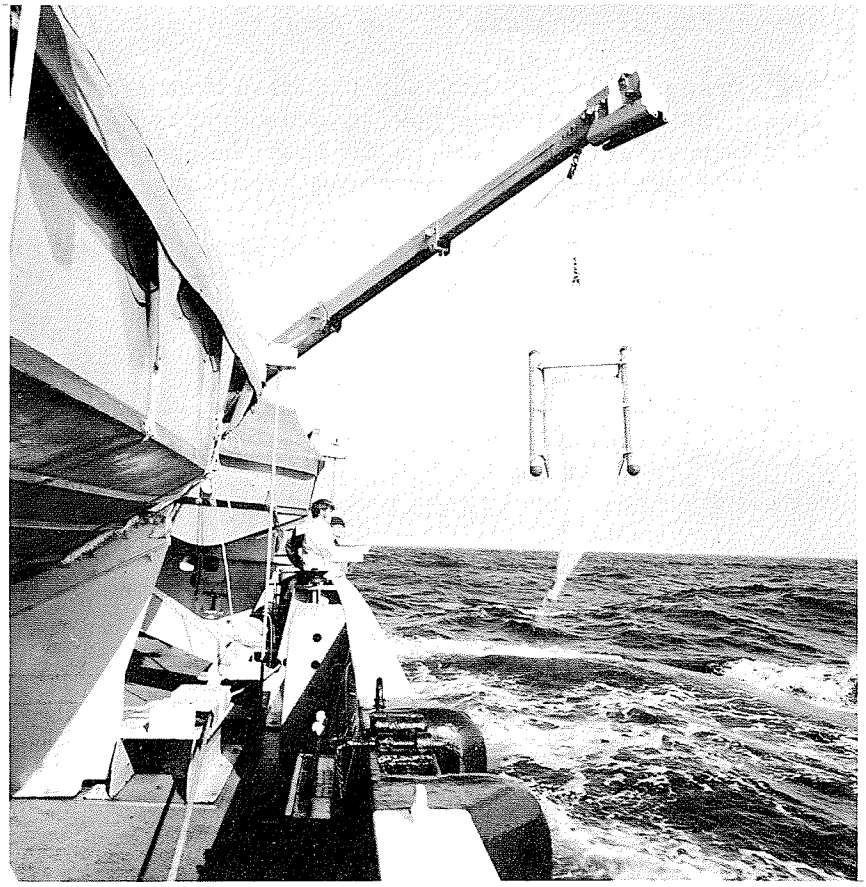
Marine CO_2 Budget

Radiocarbon dating technique is perhaps the most important geochemical tool ever discovered and is of increasing applications to archaeology, geology, geochemistry, metereology, oceanography and pollution. Part of the effort in the Marine CO_2 budget program is devoted to radiocarbon measurements, essential in the understanding of the CO_2 cycle in nature, especially the air-sea CO_2 exchange rate, the speed of deep water movements and the rate of mixing from surface into deep waters. A radiocarbon laboratory at B.C. Research is being set up under the supervision of Dr. A.B. Cornford, and is expected to be in routine operation within a few months.



Ocean Chemistry Radiocarbon Laboratory located at B.C. Research, Vancouver, will be used for studies of air-sea CO_2 exchange rate, speed of deep water movement and rate of mixing between surface and deep waters.

The invasion and evasion of CO_2 in seawater is another aspect of the marine CO_2 budget program under investigation. To measure the partial pressure difference of CO_2 between air and surface ocean, an automatic measuring system for shipboard use during the TRANSPAC-72 expedition was constructed. Preliminary data indicated that along 35°N, the same track as the Scripps LUSIAD Expedition showing oceanic CO_2 undersaturation in May-June 1972, the surface waters now showed supersaturation in winter months. This demonstrates the importance of time-series measurements for oceanic CO_2 and for such purpose, two of these automatic systems will be installed on the weatherships in 1973-74.



The Neuston-Net surface sampler used in collection of oil aggregates and plastics during the TRANSPAC-72 cruise. The sampler was towed for 20 minutes at 4 knot, at 37 stations from Tokyo to Victoria. Oil aggregates ("tar balls") were plentiful in the western Pacific but rare in the eastern Pacific.

OCEAN PHYSICS DIVISION

P.W. Nasmyth, Head

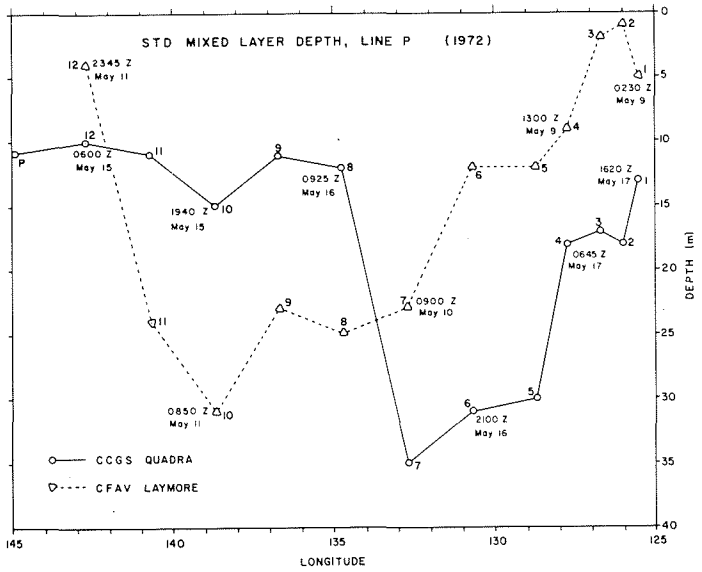
The Ocean Physics Division has increased to 37 permanent scientific and technical personnel of which 15 are professional scientists. Distribution of effort in the division has changed only slightly during the year, but the changes that have taken place may be indicative of future trends. There has been a significant increase in remote sensing, numerical modelling and in the oceanography of the coastal zone, all related in some degree to pollution and ecological problems of the Canadian west coast. An intensive but short term study of the physical limnology of Babine Lake, undertaken as a contribution to a multi-disciplinary study of the lake, has absorbed a substantial amount of effort. This program will continue through 1973, when the resources will be re-assigned to further increase the level of effort in the coastal zone, probably with some shifts of emphasis to the Arctic.

Physical arrangements for housing the division are still less than satisfactory. Locations occupied have now increased to a total of seven, of which five are in or near Victoria, one is in West Vancouver and one in Vancouver. The overall efficiency of operation inevitably suffers.

Activities of the division are reported separately by Section.

OFFSHORE OCEANOGRAPHY SECTION

J.F. Garrett, Head
S. Tabata
R.E. Thomson
D.B. Smith
K. Abbott-Smith
C. De Jong
B.G. Minkley
W. Hansen

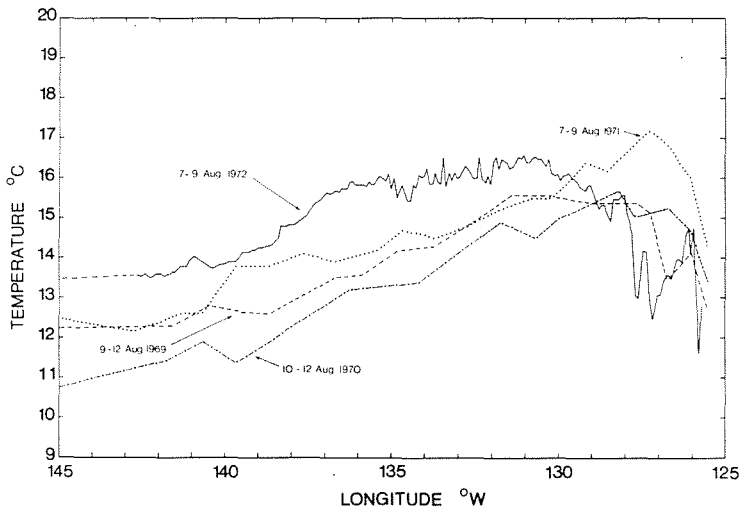


Variations over 4 to 8 days of the depth of the wind-mixed layer along Line P. The values mark the depth at which the first sharp decrease in temperature of the water occurs when measured downwards from the ocean surface.

Our efforts to understand oceanic water motions and physical processes leading to modifications of ocean water properties have diversified during 1972 as may be seen from the following brief descriptions of our activities.

Weathership Oceanography. The oceanographic time series at Ocean Station P (50°N, 145°W) was continued for the sixteenth year, with oceanographers from Offshore Oceanography or Ocean Chemistry aboard all but one of the nine patrols during 1972. The resulting data reports bring the number of volumes in the series to 54. (Garrett).

Sea Surface Temperatures along Line P. As well as bathythermographs and continuous depth profiles of temperature and salinity, sea surface temperatures are routinely observed along Line P between Swiftsure Bank and Station P by the Canadian weatherships. For most cruises temperature data from engine intakes are available as well as "bucket temperatures" and bathythermograph data. These data may be used to describe the ocean climate, to examine the variability of ocean temperatures with respect to time and distance along the Line, to interpret upwelling and water movements off the coast and to provide monitored data for fisheries and defence purposes.



There is a strong correlation between the albacore tuna catch and the distance from the coast over which the water temperature is greater than 15°C. The figure shows sea surface temperatures between the Strait of Juan de Fuca and Ocean Station P (50°N, 145°W) for the past four summers. The continuous temperatures for 1972 are based on engine intake, approx. 3 m below the sea surface, while the others are from bucket samples.

The record catch of albacore off the coast of British Columbia in the summer of 1972 has raised the question of whether or not their abundance was related to unusual oceanographic conditions. The albacore is known to be distributed in oceanic waters with surface temperatures in the range of 14-23°C but are caught generally in waters whose temperature is in a narrower range, 15-21°C. Although it is not uncommun to encounter sea surface temperatures exceeding 15°C off the Pacific coast of Canada during summer months, the occurrence of water whose temperature was greater than 15°C was much more widespread in the summer of 1972 than in the past few years, occupying approximately 400 miles along Line P. During 1971, 1970 and 1969 such warm water was found for 260 miles, 140 miles and 200 miles, respectively, while the albacore catch was 7.6, 3.7, 1.6 and 2.5 million pounds in these respective years. Although this would yield an apparently linear relationship, the picture is complicated by variations in fishing effort and skill. (Tabata).

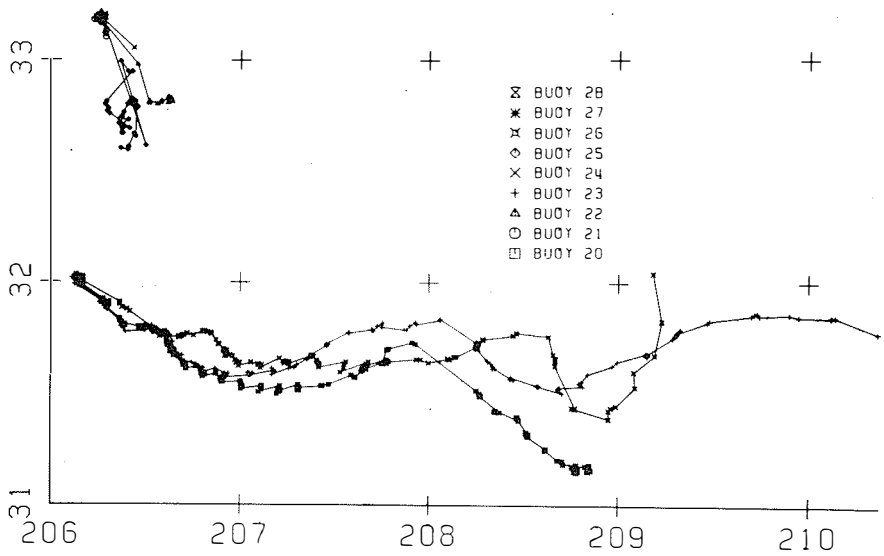
Representativeness of Line P sampling. In May an exploratory cruise to measure salinity-temperature profiles of various stations between Swiftsure Bank and Station P was made on CFAV LAYMORE in conjunction with the exchange of the weatherships CCGS QUADRA and CCGS VANCOUVER. Preliminary results using data from the three ships indicate large temporal changes of properties within the two-week period as well as large spatial differences between regions north and south of Line P. It is hoped that a new understanding of the meaning and representativeness of the historical Line P data will be obtained from further studies of this type. (Thomson).

Oceanic Noisiness. A study of the noisiness or high frequency variability of the temperature-salinity profiles obtained along Line P since 1970 by the weatherships is underway. It is hoped that this will substantiate the conclusion drawn from strictly visual inspection of the data that indicates the ocean along Line P is noisier over rough terrain than over smooth abyssal regions. (Thomson).

Energy and Energy Flux in Planetary Waves. A theoretical study aimed at increasing understanding of the effects of bottom topography on water motions indicates that the energy and flux of energy associated with planetary waves (which may be thought of as slowly varying large scale current patterns) is conserved within a closed ocean basin of any shape and bottom topography. Furthermore, it has been demonstrated that there is in fact a potential energy associated with these waves as a result of the earth's spin and depth changes.

Preliminary results for the bottom topography of the eastern side of the North Pacific indicate a slowing of planetary waves by the rough, nearly random bottom terrain. Also it appears that such waves may gain or lose energy through interactions with the bottom depending on their orientation relative to the depth contours and to the north. Work is continuing on this subject. (Thomson).

Cobb Seamount: The influence of topography on local water properties. After a cruise aboard CFAV LAYMORE to investigate space-time variability in the region of Line P indicated a pattern in the distribution of water properties apparently related to Cobb Seamount, two further cruises were made in an attempt to detect "wake" disturbances about the seamount. Preliminary results indicate a depth persistent distortion of the density field in the vicinity of the seamount which could be attributable to flow past this obstacle. Complementary weathership and U.S. Coast Guard observations at the time of the first LAYMORE cruise have also given a spatial picture of the temperature distribution with depth between the seamount and the B.C.-Washington coast. (Thomson).



Tracks of drifting buoys obtained by means of the French EOLE satellite. The coordinates are north latitude and east longitude. The interval between the clusters of positions along the track of each buoy is one day. Successive positions within the clusters are 100 minutes apart.

EOLE Buoy Project. In a cooperative venture with the Laboratoire de Météorologie Dynamique, of the French Centre National de la Recherche Scientifique, nine drifting buoys were launched from CFAV LAYMORE about 600 miles north of Hawaii at the beginning of February. Attached to large square sails or drogues at a depth of 25 m, these buoys were tracked by the French EOLE satellite. The object of the experiment was to study the rate of horizontal dispersion of disturbances of the oceanic mixed layer. Although all the buoys failed within a month, enough data was obtained from the three which lasted longest to provide estimates of the dispersion rate. The somewhat disappointing failure rate is attributed to the fact that this was the first attempt to use the EOLE remote platform electronics, which was designed for use on balloons in a meteorological experiment, in buoys. (Garrett).

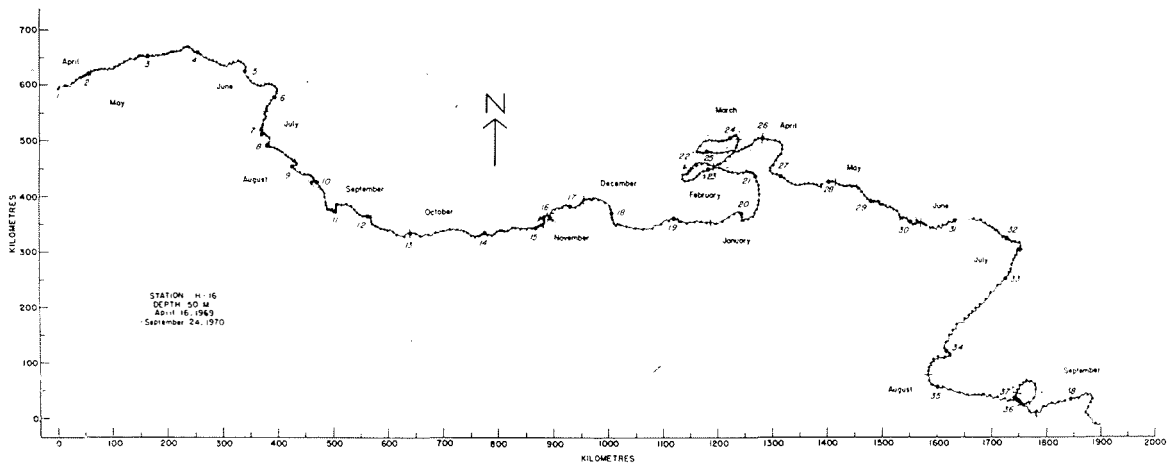
Vorticity Mixing. A theoretical study of vorticity mixing in the ocean has resulted in a general law governing the conservation of vorticity within an ocean and the refutation of an established theory on forces arising from vorticity mixing. (Stewart and Thomson).

Current Velocity and Water Temperature in the Strait of Georgia. All the current velocity and water temperature data obtained from a line of 3 moored buoy stations between Valdes Island and Point Grey during 1968 through 1970 have been processed, summarized and reported in four volumes of data reports. For each of 83 sets of measurements made at 10 or 15 minute intervals over periods ranging from 3 to 8 weeks, the summary contains histograms of current speed, current direction, current direction in polar representation and temperature, as well as a progressive vector diagram of current velocity.

A preliminary examination of the data indicates that significant non-tidal currents are present. Along the eastern side of the Strait a persisten northerly flow of about 5 km/day is superimposed on the tidal current. A net northerly flow of about 2 km/day is present in the deeper levels (200 m) in the centre and at the western side, but is less well defined than on the eastern side. At 500 m on the western side there is a northerly set with an average speed of about 4 km/day, but at the corresponding depth in the centre the set is eastward, at about the same speed. The presence of these net currents has significant bearing on the transport of materials such as pollutants and low mobility marine organisms. (Tabata).

Longshore Currents Generation by Internal Waves. The persistant northward flow just off the Fraser River delta and Point Grey, which has been seen in current meter and drifting drogue observations as well as aerial photographs of the silt distribution, appears to result from something other than wind or tidal effects. New theoretical work indicates that this current might result from the breaking of internal waves in shallow water, since in Georgia Strait these waves have the proper directionality and energy to generate such flows. (Thomson).

Georgia and Juan de Fuca Straits Data Catalogue. A catalogue listing all discoverable physical oceanographic data for Georgia and Juan de Fuca straits, giving indexes by areas and listing possible composite time series is nearing completion, and will be available early in 1973. A companion volume on biological oceanographic data possible relevant to water quality is also being prepared. (Garrett).



The displacements due to current velocities near the centre of Georgia Strait were observed at 15-minute intervals over a period of 17 months. Although the net velocity is to the east, flows in other directions occur for periods long enough to be significant from the point of view of effluent movement and disposal.

COASTAL ZONE OCEANOGRAPHY SECTION

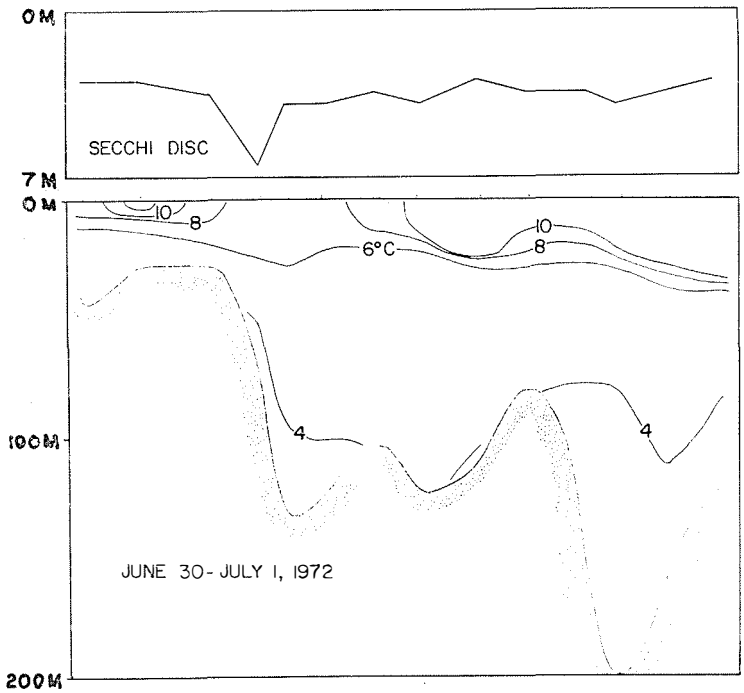
D.M. Farmer, Head
L.F. Giovando
W.H. Bell
R.H. Herlinveaux
R.E. Johns
H. Hollister
J.A. Stickland
R.H. Bigham
L.A. Spearing
K.A. Gantzer
J.A. Meikle
R.E. Forbes
E. Wilson

This year the resources of the oceanographic section, West Vancouver, were used to form a new group called "Coastal Zone Oceanography". The purpose of this section is to study oceanographic problems along the B.C. coast and in the Arctic. In addition, a program to study Babine Lake was undertaken in 1972 in response to a request from the Fisheries Research Board. Together with a number of other DOE projects in the area, the work is being conducted within the framework of the "Babine Lake Steering Committee". The section has also continued to provide physical oceanographic support for the Fisheries Service programs undertaken by the Pacific Environment Institute.

Babine Lake Project. The purpose of this project is to provide a background of physical limnology necessary to the proper interpretation of biological and chemical studies in the area. The scientific investigations in Babine Lake of which our physical study is part, are motivated by concern for the future of the salmon fishery and especially the recently constructed spawning channels, in the face of a changing environment. The observation program began in May 1972 and consists of a succession of bathythermograph stations taken throughout the lake (twice a week along the major axis), and the monitoring of winds, currents and temperature profiles with recording instruments. The BT program has logged some 12,000 miles and produced a detailed commentary on the lake's changing thermal structure. These efforts have revealed the existence of areas of upwelling, an unexpected form of autumnal cooling and the time and space dependence of wind-mixing. It is evident that orographically induced wind divergence is a fundamental significance to the lake's dynamics; the deployment of additional anemometers to measure it is central to the 1973 program.

Processing of current meter and thermistor chain data has been hampered by the failure of tape translation equipment. Initial data processing has shown a number of interesting features such as wind-mixing, thermocline development and the complex patterns of wind drift, barotropic currents and other dynamic events in the lake. The Black Point current measurements will continue through 1973 and should provide considerable insight into the exchange processes occurring between the two major basins of the lake.

The success of this project is in large measure dependent upon an appropriate method for handling and storing data. The system is set up to store and retrieve data from any number of instruments in chronological order, on a 10-minute time base. This time base represents our highest sampling frequency, all recording instrument clocks are synchronized. It is thus a simple matter to retrieve data from any combination of instruments over a specified period for further processing such as contouring or time series analysis.

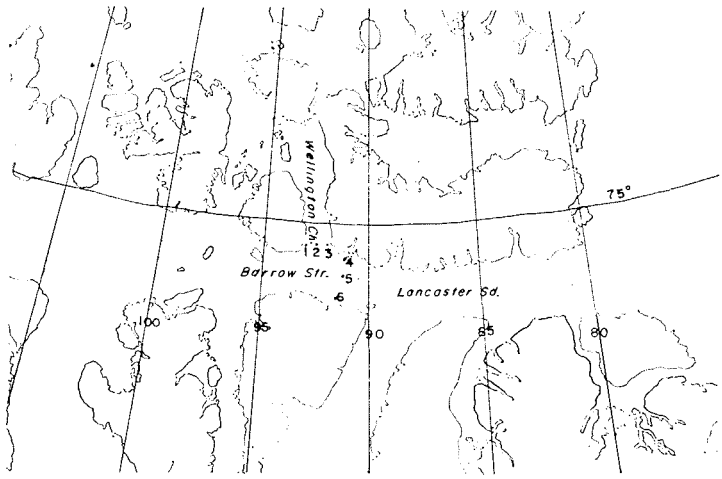


Temperature section of Babine Lake showing the correspondence between transparency (secchi depth) and upwelling.

During the winter of 1972-73 temperature observations will be taken through the ice in addition to measurements from subsurface moored instruments. During 1973 we hope to integrate the physical program with a biological productivity project. The observations will terminate at the end of 1973. (D. Farmer).

Howe Sound Project. A program of oceanographic data collection was established in Howe Sound, a fjord-type estuary adjoining the Strait of Georgia. Two buoys, with instruments for measuring water currents and temperature at four depths, were maintained in the southern half of the main channel for most of the year. In November, they were moved into the northern half of the Sound. Two hydrographic station cruises were undertaken, in February and June. Data reduction routines were established and a start was made on assesing the oceanographic features implied by the data. (W. Bell).

Arctic Oceanography. A much reduced oceanographic program was carried out in the Arctic this year due to the limited amount of icebreaker time made available. However, oceanographic stations were taken across the channel in Wellington Channel and Barrow Straits. Samples from these stations were frozen and taken back for nutrient sample analysis by the Fisheries Service.



Positions of oceanographic stations occupied in September 1972.

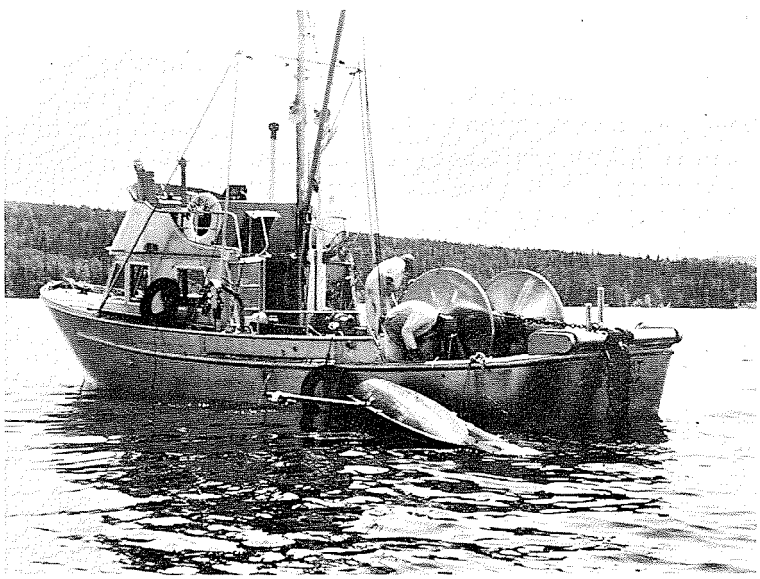
Plankton samples were collected for analysis by the Environmental Protection Service. Bottom samples were collected to provide background information and will be analyzed for their biological make-up and metal content by the Fisheries Research Board. At each oceanographic station a current-speed profile was attempted to determine the shear zones across Wellington Channel, Barrow Straits and Lancaster Sound. The main velocity shears appear to be around the 10 m depth (ice thickness about one foot). Light transmission properties were observed down to 80 m in the blue-green (BG12) and red-green (RG1) ranges at several locations. A report will be prepared when samples analysis is complete. (R. Herlinveaux).

Strait of Georgia. Data obtained in the Five Finger Island area near Nanaimo, B.C., for use by the Greater Nanaimo Sewerage and Drainage District in the placement of a new sewage outfall have provided insight into currents in the area. The use of surface drogues confirms that shallow motion, in the general area shoreward of Five Finger Island and to the southeast, is a complicated function of wind, tide and "shoreline" characteristics. By the same means surface net motion somewhat seaward of the proposed outfall site appears to be essentially east or southeastward.

The current profiling indicates that subsurface ebb currents are generally southeasterly and between 0.2 and 0.4 knots. The corresponding flood currents are of the same order in speed but the current direction fluctuates much more. The net movement, however, is generally southeasterly. Such movement is essentially confirmed by the 6-week series of current readings, which indicate easterly or southeasterly movement for up to three weeks or so at a time. Several day periods of quite restricted motion are also found. Net movements of the order of 10-20 cm/sec can occur over 1-2 months. This suggests the prevailing movement of water (both surface and subsurface) from the proposed site of the outfall is toward Gabriola Island. (L. Giovando).

North Pacific Surface Temperatures. A study has been made of the basic characteristics of Canadian and Japanese monthly mean sea-surface temperature data obtained by merchant shipping in the general vicinity of the present Ocean Weather Station P (50°N, 145°W) during the period 1927 through 1933. About two Canadian (thermograph) readings per month were involved; these data have not previously been reported. Each Japanese (bucket) mean monthly value included several readings within the two "5-degree" squares north of "P" and cornering on it; the values represent a portion of a data series collected from 1911 through 1938.

The agreement between the two sets of data appears generally good - in spite of the fact that the Canadian data were obtained in a different manner and were much less numerous than were the Japanese, and that the two data sets were processed independently. An annual oscillation is clearly evident in both cases. The results suggest that this oscillation is more consistent between the two sets than is the mean -- and appear to be in general agreement with those obtained from similar investigations carried on elsewhere. The consistency between the two sets for the period 1927-33 would appear to enhance the value of both entire sets, especially the Japanese (because of its greater length), as "pre-weathership" contributions to an examination of the oceanic climatology of the North Pacific. (L. Giovando).



Laying a current meter in Babine Lake with the F.R.B. seiner TAHLOK.

Squamish Estuary Study. A review of the physical oceanography of the Squamish Estuary area, at the head of Howe Sound, has been prepared. This was done for the Federal-Provincial Task Force on the Squamish Estuary Harbour Development.

Oceanographic data, especially those upon water movements, are scanty, but some conclusions can nevertheless be indicated. A typical horizontally layered water structure exists in the area, being characterized by the predominant salinity structure generated by the runoff from the Squamish River. Surface currents near the mouth of the river are strong and basically southerly in the summer, the freshet providing speeds of up to 3 knots or more. The surface movement in the eastern portion of the estuary area are much more modest. The appearance at times of a counterclockwise movement in the eastern portion is suggested. Movement decreases in magnitude with depth; below 2-30 ft speeds are very small and comparable throughout the area; no marked preference for direction appears to exist. The surface movements noted above appear in general to be qualitatively confirmed both by examination of aerial photographs of the silt-laden river water and by movements of free-floating drogues.

A further, shorter report on the Manquam Channel, at the eastern side of the Squamish delta has been prepared as a supplement to the above report on the Squamish estuary. (L. Giovando).

Daily Oceanographic Observations in 1972. In 1972, surface oceanographic observations were made daily at 16 shore stations along the B.C. Coast. The observation consists of a sea surface temperature and the measurement of the seawater density by a hydrometer.

During the first 6 months of 1972, the monthly mean sea temperatures were significantly below normal at the stations along the northern mainland and ocean coasts. Temperature conditions were near normal during July and August with the exception of above normal temperatures in August at Langara Island and Amphitrite Point. In September below normal conditions again prevailed and continued into October.

At the stations in the Strait of Georgia, sea temperature trends varied from month to month, but below normal conditions were more frequent. A normal trend in the monthly mean sea temperatures during the first 3 months was interrupted by significantly below normal temperatures in April. A brief normal period in May and June was again halted by below normal conditions in July. Above normal temperatures occurred in August, followed in September by a return to below normal temperatures which also prevailed in October.

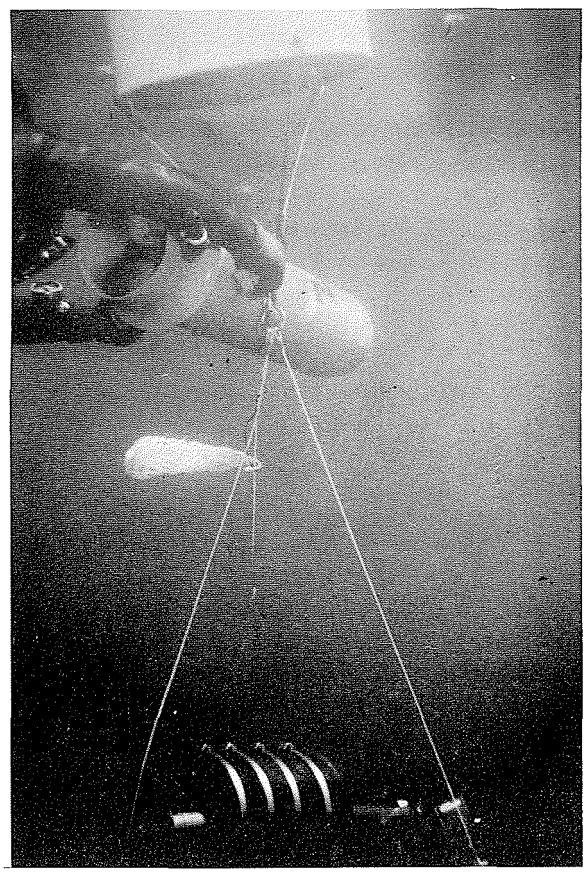
Monthly mean salinities at the stations on the ocean coast and in Hecate Strait were often below normal during the spring and summer months. This can be associated with excessive river discharge and higher than normal coastal precipitation amounts during the same period. Normal conditions prevailed during the winter and fall.

At the Strait of Georgia stations the salinity conditions were generally near normal. The most notable exception was the occurrence of below normal salinity at Entrance Island and Cape Mudge in June, because of the high Fraser River discharge. (H. Hollister).

Computing Services. In addition to the multichannel data storage and retrieval system developed for the Babine Lake project, programs have been written for data presentation of various types including Progressive Vector Diagrams, Histograms, Contours and Time Series Plots. A teletype and fast card reader link up to the UBC computing centre has been established. Programming support has also been provided for FRB personnel at PEI. (R. Johns).

Associate Research. A review has been commenced of oceanographic data from the eastern Beaufort sea with a view to interpreting distribution in the light of modern mixing theory. The earlier work on inlet dynamics has been extended to include a net seaward volume transport, thus providing more realistic landward boundary conditions. The dynamic implications of this refinement have not yet been explored.

On the invitation of the United States National Science Foundation, Dr. Cameron attended an international symposium in Hokkaido, Japan and presented a paper on the budgetary aspects of circulation schemes for the Bering Sea. (W.M. Cameron).



Divers installing Bass tide gauge in Brentwood Bay, B.C.

OCEAN MIXING SECTION

P.W. Nasmyth, Head
A.E. Gargett
G.W. Chase
R.C. Teichrob

The study of turbulent mixing in the ocean has continued through 1972, with a 5-week experimental operation during January-February in the region southwest of Cape Flattery and out as far as Cobb Seamount. Data from that operation are not yet completely analyzed but a significant qualitative result is that both the occurrence of intensity of turbulence were very much lower than has been observed in part of the same area and at the same time of year on previous occasions. Earlier measurements have indicated that, on the average, approximately 20 percent of the total volume between the thermocline (approximately 75 m) and our maximum depth of 300 m was turbulent. In the latest experiment only something like 1 percent of the total volume contained detectable turbulence.

At this time we have no satisfactory explanation for the difference. A possible factor may be that the weather was unusually good this year with less wind and lower sea state than normally expected during the winter months. The observed result then may lend strength, in a negative sort of way, to the idea that, even far below the thermocline, turbulence may be generated by indirect effects of surface wind and the resulting sea state.

A few pieces of record from the platinum velocity and temperature sensors have been analyzed, but results are not always convincing, due to one or both of two factors, the general low intensity of turbulence observed during the cruise and the short space/time extent of those patches which did show higher levels.

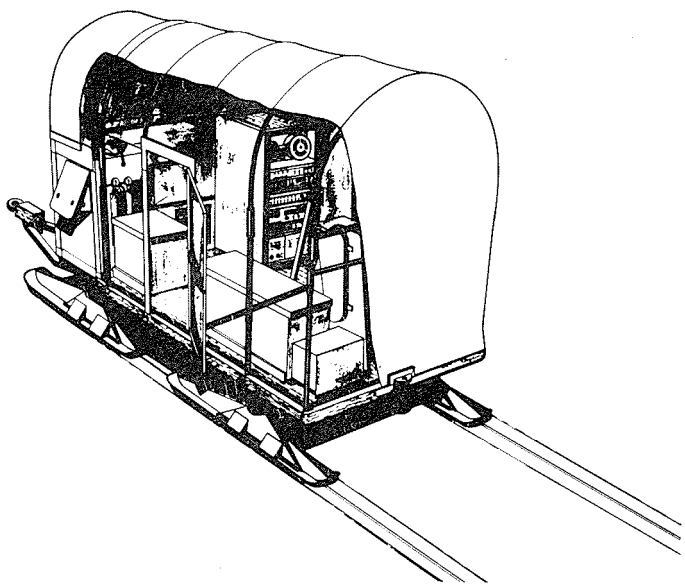
The disappointing nature of the turbulence data lead to closer examination of supporting data which is obtained from the towed body. In particular with the winch set to cycle the towed body through 100 ft in depth, time series of the thermistors and the depth gauge mounted on the body can be used to estimate the horizontal coherence of small scale temperature structure over distances up to 2 km. Analysis of all data available, on a line from Cobb Seamount (200 miles offshore) to the continental shelf, has not yet been completed.

Data from the conductivity head mounted on the body should allow similar statistics on horizontal coherence to be compiled for the vertical structures of both salinity anddensity (or associated parameters like the Väisälä frequency).

FROZEN SEA RESEARCH GROUP

E. L. Lewis, Head
J. D. Bradbury
R. A. Lake
A. E. Moody
K. Fujino (visiting scientist Sapporo, Japan)
S. W. Moorhouse
R. G. Perkin
D. L. Richards
R. B. Sudar
J. A. Sutherland
E. R. Walker

During February and April 1972 field operations were conducted in Cambridge Bay, N.W.T. where measurements were made of the temperature and salinity of the water column beneath the growing sea ice. This completed the set of experiments begun in the summer of 1971. A study of the data from all four field operations has now been completed and a draft paper entitled "Oceanography of an Arctic Bay" is ready for submission to a journal. Of particular interest is the evidence of dense waters produced by under-ice convection running downwards from the shallows of Cambridge Bay into deeper waters. Heat and salt budgets of the bay have also been worked out, the former in terms of meteorological parameters. The rapid changes in water structure during freeze-up have been documented and include the response of the system to the wind and tidal cycles.



Complete oceanographic sled as used on Cambridge Bay 1972. The sled carries a complete recording system. CTD and other sensors are lowered by the winch at the rear through the hole in the deck which is positioned over a hole in the ice.

In August 1972 a tide gauge and three temperature profile recorders capable of one year's unattended operation and recording were installed in the vicinity of our Greely Fjord base (80°36'N, 79°35'W). In addition, a preliminary survey of a site to measure runoff from the land was made. Owing to the permafrost and the extreme fragmentation of overlying soil, it is necessary to pick such sites with great care as, except during peak flood conditions, maybe only one half of the runoff is visible at the surface. Oceanographic profiles were obtained which, because of the almost continuous ice cover, will give the basic density profile with which the present winter's ice growth/convective system must interact.

Experiments to determine the freezing point of sea water in the range 20-35°/oo have been completed and show values about 0.01°C lower than those presently used as standard given by Hansen[1]. Experiments are proceeding on the effect of pressure on the freezing point. A critical review of data collected utilizing our Conductivity-Temperature-Depth (CTD) system led to experiments on sensor time constants using an abrupt change of water properties produced in a vertical 25' length of 2' diameter pipe. These studies have modified our sampling procedures. We have undertaken testing of an untrasonic current meter with a potential threshold of 1 mm/sec and have started some study of sonic direction determination for use with it in Arctic waters where the earth's magnetic field is too nearly vertical to be much use. Some modifications to our existing mechanical equipment used for making oceanographic measurements for over-ice traverse are being made as a result of experiences at Cambridge Bay where on one day in February the wind chill reached the equivalent of -115°F.

The tide gauge designed by the group has now gone out to industrial production and another company is starting a "systems" section to develop and market CTD measurement and recording equipment based on our designs.

An Arctic Fjord Workshop attended by 15 delegates from four countries took place July 5-7, 1972. Dr. H. G. Gade of the Geophysical Institute, University of Bergen, worked with us May-July on the interpretation of the Cambridge Bay data.

[1] Hansen, H.J., Experimental Determination of the Relation Between the Freezing Point of Seawater and its Specific Gravity at 0° C., Meddelelser Fra Kommissionen for Havundersøgelser, København, Serie: Hydrografi, Bind I, Nr. 2, pp. 1-10, 1904.

American ERTS-1 satellite picture of the Vancouver area taken from a height of 600 miles at 1040 July 30, 1972 on an ebb tide at a time of relatively high Fraser River discharge. The silt in the river water makes the delta coastline hard to distinguish. The geometry of the plume can be seen down to very low contrast levels when the photograph is electronically enhanced.

Pictures such as this will be available from the Canada Centre for Remote Sensing for all of Canada to 82° north and out to several hundred miles off shore.

REMOTE SENSING

J.F.R. Gower (under contract)

A report on a literature survey of the uses of remote sensing from aircraft and satellites in oceanography and hydrography was distributed in January 1972, and since then an experimental program has been started to test some of the ideas and techniques.

Some of these tests involved the use only of commercial equipment and charter aircraft (Sippican XBT test, Boeing LRPA exercise), others were carried out using the facilities of the Canadian Centre for Remote Sensing (high level aerial photography, satellite photography) and one involved development of a system to be flown in a commercial charter aircraft (infrared surface temperature measurement).

In general, the most widely used remote sensing technique is aerial photography. The Canadian Centre for Remote Sensing has a wide capability for applying modern photographic techniques for evaluation purposes, and one of the duties of the remote sensing consultant has been to help other workers make use of the CCRS facilities and to advise CCRS on other possible applications. Photography over the Fraser River Plume in the Strait of Georgia and over Babine Lake was ordered during the year.

A new development has been the availability of space photography of all of Canada (to 82°N) from the US ERTS-1 satellite. The CCRS is reponsible for processing and distribution of Canadian pictures and considerable coverage has been ordered from them of B.C. and the Canadian Arctic. The resolution (about 60 m) has been found sufficient for silt motion and ice and snow cover studies. The multiband pictures also give a very stable colour rendition which allows small water colour changes to be detected.

After aerial photography the next most widely used remote sensing technique is now thermal infrared imaging. The CCRS has concentrated on high resolution work emphasizing temperature variation but for oceanography, lower resolution measurement of surface temperatures is often more useful. An improved (narrow band) version of the PRT-5 radiometer was purchased during the summer and built into a system to be flown in a Beaver floatplane. The system allows continuous in-flight calibration and output recording on paper chart and magnetic tape. A test flight over Babine Lake showed that an accuracy of 0.2°C is quite feasible and that the radiometer can be set up to scan 35° either side of the nadir. Further flights over the Juan de Fuca Strait and Babine Lake are planned for next year.

Various other techniques that have applications more specifically to oceanography were also investigated. A joint experiment with the Boeing Aircraft Company's prototype Long Range Patrol Aircraft (a highly instrumented Boeing 707) was carried out to investigate the feasibility of wind velocity and surface current measurement by comparing navigational data from a doppler radar and from an inertial navigation system. It turned out that the doppler radar received insufficient return signal from the very calm sea surface on the day of the flight, although some useful data was collected. Boeing has since made other data available, and a repeat flight is also a possibility. This investigation is also being continued with a doppler radar to be flown from a rented DC-3 aircraft in 1973. The radar has been purchased and necessary modifications will be carried out by Dr. M. Miyake of IOUBC under contract.

A contract with Dr. G.A.H. Walker of the Geophysics Department, UBC, was being negotiated in December 1972 for construction and testing of a prototype water colour spectrometer. This unit would be based on an integrated silicon photodiode array from which digitized spectral intensities could be recorded on magnetic tape. Such a spectrometer should be sensitive, compact and rugged and hence ideal for airborne work in water quality and productivity studies.

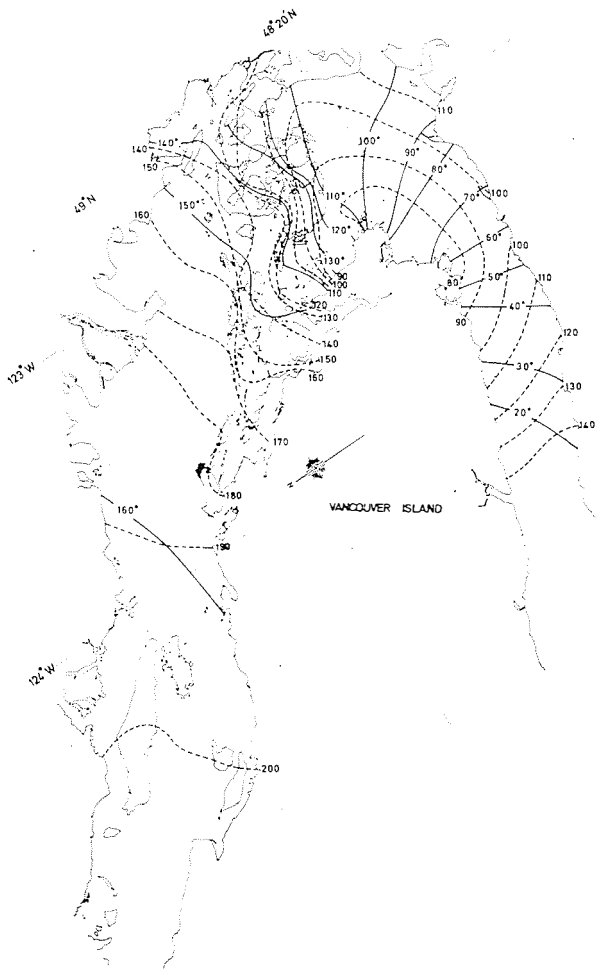
Expendable sensors that can be dropped from aircraft should be extremely useful in applying remote sensing techniques. In conjunction with Offshore Oceanography the Sippican wire connected XBT was tested from a Beaver floatplane and found to give useful results from low altitudes.

NUMERICAL MODELLING SECTION

P. B. Crean L. Smith
R. F. Henry P. Richards

To provide an understanding of the water movements requisite to efficient management, complementary numerical model and field studies of the Strait of Georgia and Juan de Fuca Strait are being undertaken. A successful tidal model has been evolved using a system of joined one and two-dimensional numerical schemes. This model is being modified to incorporate effects of fresh water runoff and winds. (Crean).

A one-dimentional model of Babine Lake was begun in order to study seiche action and to establish wind stress coefficients. (Henry).



The full line shows places at which high tide is at the same time and the dashed line places at which the high-low tide difference is the same, for the twice-a-day (M_2) component of the tide, as derived from a numerical model of Georgia Strait.

SHIP DIVISION

E.N. Geldart, Regional Marine Superintendent
F.S. Green, Assistant Marine Superintendent

Pacific Region ships provided successful support to all prescribed 1972 programs and completed their assignments without mishap or unscheduled interruptions in service.

C.S.S. PARIZEAU

Master, A.G. Chamberlain
Chief Engineer, D. Marr

Following the January 1972 annual refit in Yarrows Ltd., Victoria, PARIZEAU served the requirements of MSD (Tidal and Currents); UBC (Biology); FRB (Biology); PEI (Biology); and GSC (Geophysics) until June 5. The ship was then converted to Western Arctic Hydrographic configuration and departed Victoria on July 4 to the Western Arctic. Hydrography was performed in this area until August 31.

On September 12, following twelve days of geophysics (GSC) PARIZEAU commenced her voyage from the Western Arctic to Tokyo, Japan, where she attended the International Ocean Development Conference. During the voyage from Tokyo to Victoria the functions of MSD Ocean Chemistry were performed. The remainder of the year was taken in converting to oceanographic configuration, ice-damage survey and annual refit. With the exception of badly damaged bilge keels and a leaking stern tube seal ice-damage was negligible.

C.S.S. WM. J. STEWART

Master, T.P. Scanlan
Chief Engineer, J.D. Henderson

Following the annual refit and winter decommission periods WM.J. STEWART engaged in Hydrographer Training from February 14 to April 29 in the general vicinity of Chemainus and Ladysmith, Vancouver Island.

During the period April 30-October 6 she carried out the regular hydrography assignments in the areas of Strait of Georgia, North B.C. Coast and Massett, Queen Charlotte Islands. The remainder of the year was occupied by annual refit and winter decommission.

C.S.S. VECTOR

Master, C.A. Macaulay
Chief Engineer, G.W. Clouston

Following the January 1972 annual refit, VECTOR served the requirements of MSD (Ocean Chemistry, Tidal and Current, Research and Development); UBC (Chemistry, Biology, Physical Oceanography); PEI (Ecology); UVic (Ocean Physiology) in B.C. coastal areas.

C.S.S. RICHARDSON

Master, C.M. McIntyre
Chief Engineer, I.N. Henderson

The overdue quadrennial refit and survey was performed on RICHARDSON in Stirling Shipyards Ltd., Vancouver. In conjunction with the pollution abatement program in DOE vessels a two-unit "Sani-vac" vacuum toilet and holding tank system was installed by Matsumoto Shipyards Ltd., Vancouver. Following MSD's acquisition of PISCES IV, RICHARDSON was assigned the role of tender-vessel to this craft.

C.F.A.V. LAYMORE

Master, M.J. Dyer
Chief Engineer, T.J. Taylor

C.F.A.V. LAYMORE was made available in 1972 to Pacific Region scientific users by way of a 75%-25% cost-sharing arrangement between MSD and DND. During this period LAYMORE served PEI (Chemistry, Ecology and Biology); Canadian Forces (Diving Unit); FRB (Ecology); MSD (Ocean Mixing and Ocean Chemistry); UBC (Equipment trials); DREP (Equipment trails); and UVic (Ocean Survival).

M.V. RADIUM EXPRESS

Master, H. Bennett
Chief Engineer, R. Green

Northern Transportation Co.'s M.V. RADIUM EXPRESS was chartered during the navigational season to support the Mackenzie River Hydrographic party. This recently refurbished vessel proved a vast improvement on last year's charter vessel, PILOT II.

PISCES IV

Chief Pilot, D. Harrison
Pilot, P.S. Legallais

PISCES IV, a deep-dive submersible craft, became the most recent addition to the Pacific fleet. It is intended to operate this craft, attended by seven seconded Canadian Forces personnel, from a chartered barge until the acquisition of a more suitable chartered mothership can be arranged. PISCES IV's operations will necessarily be restricted until this transition becomes effective.

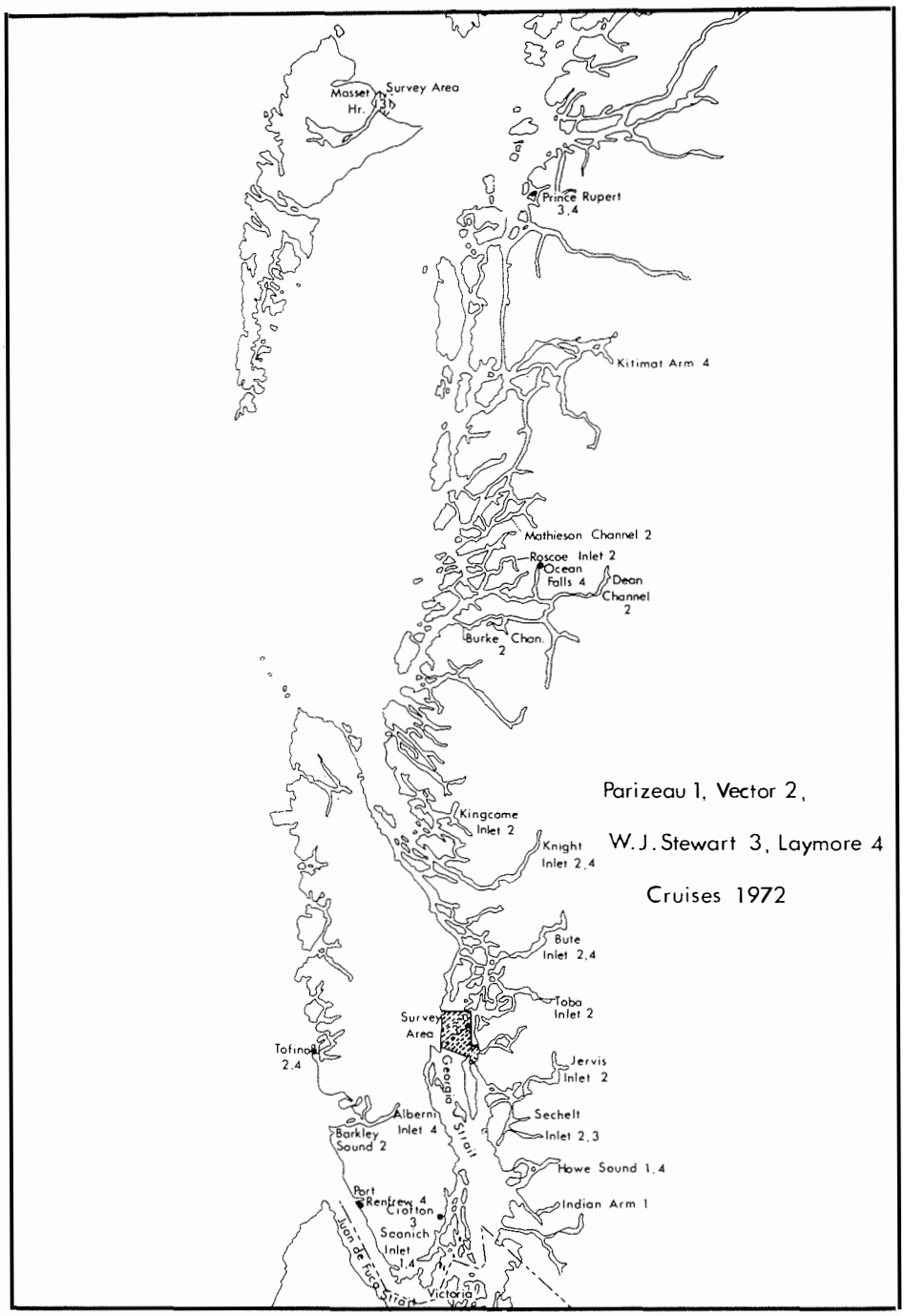
LAUNCHES

Pacific Region's twenty-five survey launches and assorted power craft performed exceedingly well and registered a minimum of down-time due to mechanical and structural failures. The new set of engines in C.S.L. REVISOR totally eliminated the multitude of mechanical difficulties previously experienced by this launch.

The Hamilton-Jet boat used in the Mackenzie River survey experienced good results except for a faulty engine which caused the hydrographers some difficulty. The fitting of a better engine and the supply of a spare engine is expected to eliminate this defect during the next season.

DEPOT

The launch repair facilities in the Victoria depot continued to contribute to the recent success in launch operations. The fortunate acquisition of good tradesmen and improved maintenance methods are considered largely responsible for this result.



TASK FORCE, COMMITTEE AND SIMILAR ACTIVITIES

Stewart, R.W.

Joint Organizing Committee (JOC) of Global Atmospheric Research Program (GARP) - Chairman.

Canadian Committee for GARP.

Advisory Committee on Oceanic Meteorological Research (ACOMR).

Physical Oceanographic Commission of IAPSO - Chairman.

Scientific Committee on Oceanic Research (SCOR) - Canadian representative.

National Research Council - Advisory Committee on Physics.

IAMAP - IAPSO - SCOR Working Group on Air-Sea Interaction.

Pacific Region Board.

The Sea Use Council (USA) - Vice-Chairman.

International Council of Scientific Union - COSPAR Committee on Space Research.

The Royal Society of Canada - Selection Committee (interdisciplinary).

Federal-Provincial Task Force on Strait of Georgia.

Water Management Executive Committee.

Steering Committee, Patricia Bay Ocean Institute - Chairman.

English, W.N.

Working Group on Abatement of Pollution from DOE Ships - Chairman.

Pacific Sub-Committee on Oceanography of CCO - Chairman.

Pacific Region Board - Alternate.

The Sea Use Council - Alternate.

Canadian Committee on Oceanography.

Coastal Waters Committee of Water Management Service. Co-chairman.

Estuary Working Group of Pacific Region Board.

Working Group on Remote Sensing for Oceanography of the CACRS - Chairman.

Steering Committee, Patricia Bay Ocean Institute.

Canadian Advisory Committee on Remote Sensing.

Comité d'Evaluation - Programme de Doctorat en Sciences de l'Eau, Université du Québec.

Hydrographic Division

Anderson, N.M.
Working Group on Remote Sensing for Oceanography of the CACRS.

Bolton, M.
Pacific Sub-Committee on Oceanography of CCO - Alternate.

National Hydrographic Survey Officers' Appraisal Board.

Canadian Institute of Surveying, Victoria Branch - Vice-Chairman.

Canadian Hydrographers Association - National President.

Steering Committee, Patricia Bay Ocean Institute - Secretary.

Sandilands, R.W.
Regional Working Group on Estuaries.

Workshop on Offshore Surveys for Mineral Resource Development.

Smithers, F.R.
Public Information Group, DOE Pacific.

Wills, R.
Survey Technology Advisory Committee, BCIT.

Ocean Engineering Division

Todd, N.A.
Steering Committee, Patricia Bay Ocean Institute.

Ocean Chemistry Division

Cretney, W.J.
Ph.D. Dissertation Committee - Mr. D. Green at UBC (Hydrocarbons).

Wong, C.S.
Advisory Committee - GEOSECS, Carbonate Chemistry Panel.

Advisory Committee - GEOSECS, Panel on Standardization of the Carbon Dioxide System.

Advisory Committee on expanding GEOSECS.

Working Group - International Commission on Water Quality.

Local Program Planning Committee - 13th Pacific Science Congress.

Coastal Water Quality Committee of MSD, Pacific Region.

Ph.D. Dissertation Committee - Mr. D. Green at UBC (Hydrocarbons).

Ph.D. Dissertation Committee - Mr. P. Berrang at UVic (Trace Metals).

Advisory Committee - National Science Foundation IDOE Project CEPEX Heavy Metals Variations in Biological Productive Systems.

Ocean Physics Division

Farmer, D.M.
Babine Lake Steering Committee.

Lewis, E.L.
Arctic Ocean Technology Advisory Committee of the Arctic Institute of North America.

Nasmyth, P.W.
IGOSS Group of Experts on Technical Systems Design and Development and Service Requirements - Chairman.

Tabata, S.
Regional Cross-Mission Task Force on Environmental Impacts of the proposed Moran Dam.

Regional Cross-Mission Task Force on Environmental Impacts of Squamish Harbour Development.

Regional Cross-Mission Task Force on the Environmental Impacts of the proposed Burrard Inlet Third Crossing.

Regional Cross-Mission Task Force on the Environmental Impacts of the Alternate Manquam Channel - Squamish Harbour Development.

Review Committee for Fraser River Delta Front Sediment Budget Study.

Science and Technology Mission to Japan: Sector IV Oceanography and Ocean Technology.

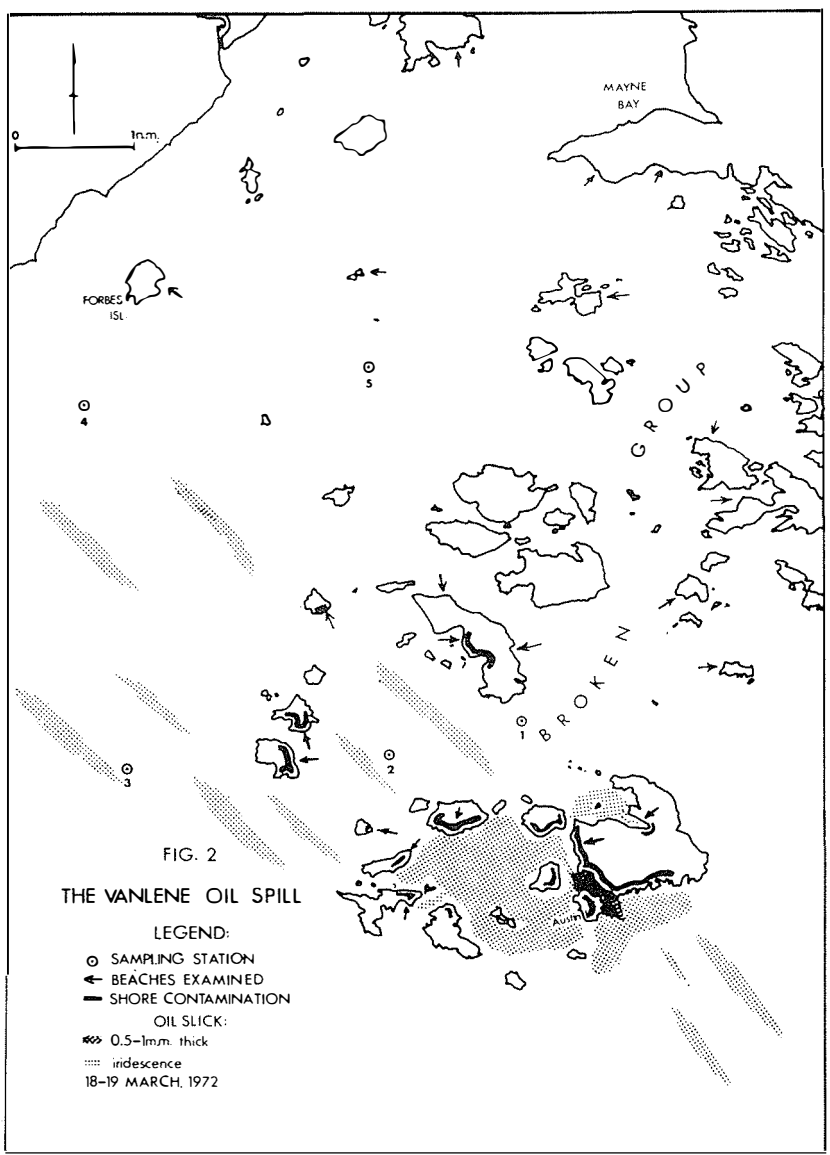
RESEARCH AND DEVELOPMENT CONTRACTS

		TOTAL AMOUNT
1.	Establish Carbon 14 dating laboratory for analysis of Oceanographic and other samples. B.C. Research. (continued from 1971).	$37,700
2.	Carry out the study of remote sensing applications to hydrography and oceanography. Dr. J.F.R. Gower. (continued from 1971).	$16,000
3.	Inform and demonstrate to Canadian scientists the Japanese approach to problems in Arctic oceanography. Dr. K. Fujino, Hokkaido University. (continued from 1971).	$12,000
4.	Study temperature and conductivity microstructure in inlets and seas as an aid to understanding turbulent mixing and transport. Institute of Oceanography, University of British Columbia. (continued from 1971).	$20,000
5.	Production and bench testing of a prototype spectrometer for sea colour monitoring. Prof. R.D. Spratley, University of British Columbia.	$1,560
6.	Conduct the first phase of a study of fjord and inlet dynamics of the British Columbia Coast (a) examine the two-dimensional structure of the currents in the surface layer in two regions; (b) examine the vertical current structure in more detail at a number of points. Institute of Oceanography, University of British Columbia.	$15,185
7.	Provide airphoto flight specifications for tide controlled photography of the Labrador Coast and offshore islands, to be designed to optimize the photographic factors in order to maximize the water depth penetration of the imagery. Airphoto Analysis Associates Ltd.	$375
8.	Provide interpretation of hydrographic data from colour aerial photographs and mapping of 35 nautical miles of shoreline in Haro Strait, Vancouver Island. Airphoto Analysis Associates, Ltd.	$8,000
9.	(a). Develop the mathematical model and related computer program for stereo-compilation of depths in shallow water from colour aerial photography. (b). Compare the accuracy of stereo-compiled depths to each sounding profiles. (c). Evaluate the effect of the operator back-ground on the accuracy of the interpretation of shallow water photography. Dept. of Survey Engineering, University of New Brunswick.	$3,864
10.	Design, test and supply two thermistor chains. B.C. Research.	$4,000

11. Furnish results of observations obtained in submersible experiments on Cobb Seamount including analysis of submersible operating problems and techniques in the open ocean. Arctic Marine Ltd. $4,500

12. Conduct feasibility study for the development of a low-cost reliable combustion engine for underwater use. Dr. E.G. Hauptmann, University of British Columbia. $14,000

13. Assist F.S.R.G. in research projects with particular reference to the application of Norwegian experience to the solution of problems in Arctic Fjord circulation and to interpret the results of Scandinavian studies in Fjord and inlet circulation systems in relation to Canadian problems, particularly winter time circulation in Cambridge Bay, N.W.T. Dr. H.G. Gade, University of Bergen. $1,550



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_____: Strait of Georgia Section 4, Gabriola Island to Gover Point, 1969-1972. (*Manuscript report series*, v. 10).

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PROFESSIONAL AND TECHNICAL STAFF

DIRECTOR

R.W. Stewart; B.Sc., M.Sc. (Queen's), Ph.D. (Cantab.), FRSC, FRS, D.Sc. (McGill)

DEPUTY DIRECTOR

W.N. English; B.A. (Bri.Col.), Ph.D. (Calif.)

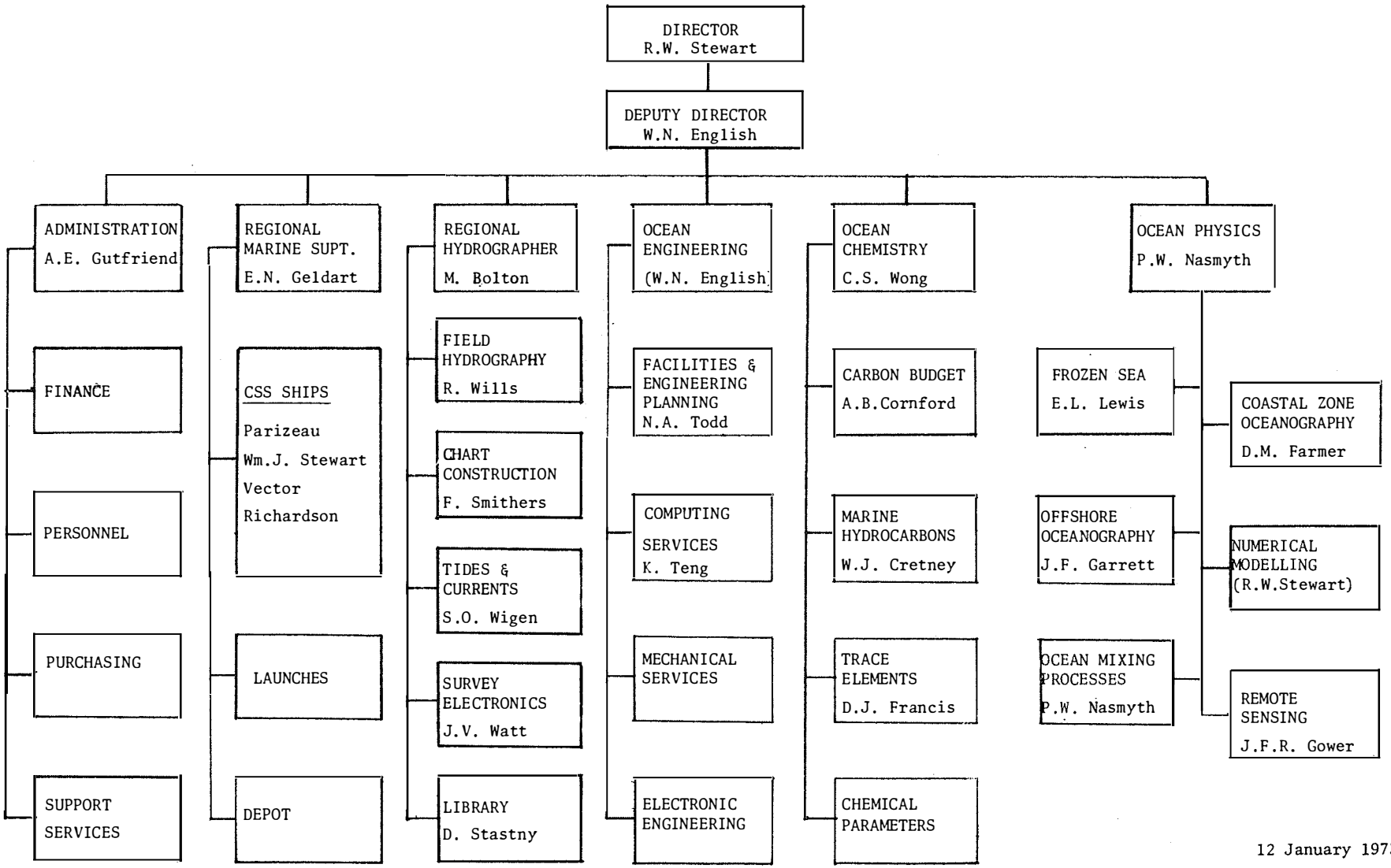
ADMINISTRATION

A.E. Gutfriend, Administrative Officer
E.E.S. Adair
R.M. Cotton
M.I.K. Craton
R.W. Crouch
D.B. Crowell
C. Firth
J.N.J. Gravel
J.Y. Hackney
A.M. Hartley
S.A. Lyon
F.V. Mitchell
S.J. McLellan
A. Mortensen
J.E. Parsons
A.M. Robert
L.E. Thirkell
C.D. Thomas
T.S. Van Dusen
L.M. Vinden

HYDROGRAPHIC DIVISION

M. Bolton, Regional Hydrographer
A.B. Ages; B.A.Sc., M.A.Sc. (Brit. Col.), P. Eng.
N.M. Anderson; Dip. A.I.T.
R. Banyard
J.F. Bath; Master, F.G.
R.D. Bell
K. Bennett
R.E. Brown
P.C. Browning
I.J. Campbell
J.W. Chivas; Master, F.G.
D.J. Clark
E.B. Clarke
F.A. Coldham
J.H. Coldwell
E.M. Coulter
D.G. Dobson
L.W. Dorosh
G.H. Eaton; Dip. B.C.I.T.
N.S. Fujino; Dip. B.C.I.T.
F.V. Hermiston
K.Highton; Dip. B.C.I.T.
R.C. Hlina; Dip. B.C.I.T.
K.R. Holman
W.S. Huggett; Master, F.G.
T. Jones; Master, F.G.
L.B. Larkin
P.O. Lee; Dip. B.C.I.T.
B.M. Lusk
A.G. Lyon
C.G. McIntosh; Master, F.G.
A.R. Mortimer; Master, F.G.
C.J. Nast

ORGANIZATION CHART
Marine Sciences Directorate, Pacific Region



12 January 1973

W.J. Norris
A.D. O'Connor
M.M. Patton
A.R. Philp
R.A. Pierce
T.C. Plume
L.E. Ponse
R.D. Popejoy
W.J. Rapatz; B.Sc. (Victoria)
A.R. Raymond; Dip. Algonquin College
G.E. Richardson
G.W. Rogers
C.F. Ryan; Dip. R.R.E. (England)
R.W. Sandilands ; Lt. R.N. (ret'd)
F.R. Smithers
C.E. Stenning
C.S. Tamasi; Dip. B.C.I.T.
M.S. Taylor
W.R. Taylor; Dip. R.C.C.
L.G. Thomson
J.A. Vosburgh; Dip. B.C.I.T.
J.S. Wallace; Dip. S.A.I.T.
B.M. Watt
J.V. Watt; B.A.Sc. (EE), P. Eng. (Brit. Col.)
S.O. Wigen; B.A.Sc. (Brit. Col.) P.Eng.
R. Wills; Master Mariner, F.G.
M.V. Woods; Dip. B.C.I.T.
P.Y. Yee; Dip. B.C.I.T.
V.N. Young

OCEAN ENGINEERING DIVISION
N.A. Todd; B.Sc. (Glasgow), M.A. (Carleton)

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