LIGHTHOUSE

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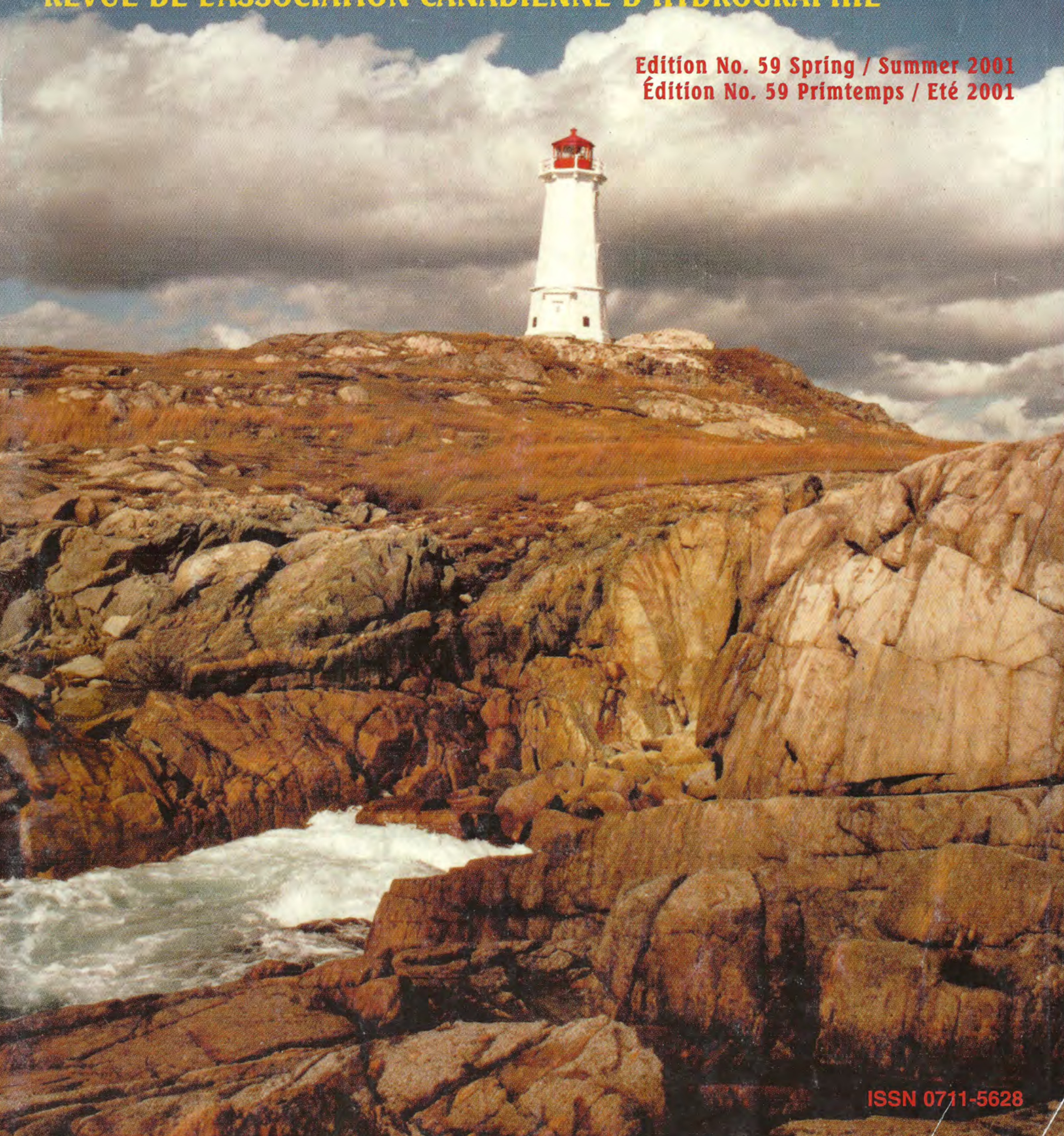

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Journal of the Canadian Hydrographic Association Revue de l'Association Canadienne d'Hydrographie

contents contenu

LIGHTHOUSE

Edition/Édition 59 • Spring/Summer Printemps/Été 2001

regular features/chroniques

Every edition also receives much assistance from the Central Branch Lighthouse Committee and other CHA volunteers.

Chaque édition est réalisée grâce à la collaboration du comité Lighthouse de la section Centrale et d'autres volontaires de l'ACH.

Views expressed in articles appearing in this publication are those of the authors and not necessarily those of the Canadian Hydrographic Association.

Les opinions exprimées dans les articles de cette revue ne sont pas nécessairement celles de l'Association canadienne d'hydrographie.

LIGHTHOUSE is published twice yearly by the Canadian Hydrographic Association and is distributed free to its members. A membership application form can be found on page 6 of this issue. Yearly subscription rates for non-members are $20 for Canadian residents and $25 for non-residents. Please make cheque or money order payable in Canadian funds to the Canadian Hydrographic Association.

La revue LIGHTHOUSE est publiée deux fois par année par l'Association canadienne d'hydrographie et distribuée gratuitement à ses membres. Une formule d'adhésion se trouve en page 6 de cette édition. Les tarifs annuels d'abonnement pour les non-membres sont de 20$ au Canada et de 25$ hors Canada, payable par chèque ou mandat-poste en devis-es canadiennes à l'ordre de l'Association canadienne d'hy-drographie.

Back issues/Éditions antériures

Back issues of Lighthouse, Editions 24 through 58 are available at a price of $10 per copy. Please write to the Editors.

Les éditions 24 à 58 de la revue Lighthouse sont disponibles au coût de 10$ par copie en écrivant aux rédacteurs en chef.

Advertising Rates/Tarifs publicitaires

For a rate card and specifications see page 60 of this issue.

Pour les tarifs et les spécifications publicitaires, se référer à la page 60 de cette édition.

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All Lighthouse correspondence should be sent to/ *Adressez toute correspondance au:*

Editors, Lighthouse, Canadian Hydrographic Association
867 Lakeshore Road P.O. Box 5050 Burlington, ON Canada L7R 4A6
Telephone/Téléphone: (905) 336-4558
Fax/Télécopieur: (905) 336-8916
E-mail: Lighthouse@car.dfo-mpo.gc.ca

notes mots

Message from the National President
Mot du Président national

With this edition, we welcome our new co-editors, Earl Brown and Paola Travaglini. The new cover is to herald the dawn of a new Lighthouse. In the past, Lighthouse has been the communication tool for hydrographers world-wide. The new Lighthouse will still be the major tool for CHA communication, and I join with the Directors of CHA in welcoming the new editorial team. The seas have been rough for Lighthouse in the past, but we are embarking on a new course. The editors still need information, articles and letters to help in the communication of information. The editors are to be commended for their interest and the volunteering of their time and efforts. As readers we must help by providing articles, news and feedback. The marine tradition of launching a vessel with a magnum of champagne can be continued in the launch of the new Lighthouse, by raising your glasses and drinking a toast to the future. Good winds and smooth sailing!

Ken McMillan

Editors' Note
Note de les redacteurs

We are pleased and proud to assume the duties of co-editors and we look forward to ensuring that Lighthouse continues to reflect the diversity of our association and is a journal that members will read and discuss among colleagues and associates with a great deal of pride.

It is our intent that the content of Lighthouse will remain much the same as it has been in the past, with a good balance of technical and non technical material. We encourage articles which will be of interest to our members, subscribers, private industry, academia and those in all levels of government.

It is our plan to feature a different lighthouse on the cover of each edition of the journal. If you have a favorite lighthouse or know of one that has a rich history and is deserving of being displayed on the cover of Lighthouse, please forward the information to us.

This edition of Lighthouse is being widely circulated. Our intention is to substantially increase our readership and it is our belief that Lighthouse will become the journal of choice for those wishing to know what is happening in the hydrographic and related communities in Canada.

The format of subsequent editions of Lighthouse may be slightly modified as we gather our thoughts after the publication of this edition. We have several ideas in mind but it is too early for their discussion. The point we want to leave with you is that Lighthouse will be a dynamic journal and we will constantly look at ways to make it more interesting and thought provoking. We welcome your comments and suggestions.

Finally, we wish to pass on our thanks to the past editor, Terese Herron, who dedicated much of her time and with a great deal of enthusiasm ensured that Lighthouse maintained a high standard. Well done Terese and we look forward to your continued active participation.

Earl Brown and Paola Travaglini

directors directeurs

National President:
Ken McMillan
489 Enfield Rd, Burlington, ON L7T 2X5
Bus: 905-639-0931 Fax: 905-639-0934
E-mail: kmcmillan@mcquestmarine.com

National Secretary/Treasurer:
Brian Power
867 Lakeshore Rd Burlington, ON L7R 4A6
Bus: 905-319-6928 Fax: 905-336-8916
E-mail: powerb@dfo-mpo.gc.ca

Quebec Branch:
Bernard Labrecque, Director CHA
53 St. Germain Ouest
Rimouski, PQ G5L 4B4
Bus: 418-775-0600 Fax: 418-775-0654
E-mail: labrecqueb@dfo-mpo.gc.ca

Pacific Branch:
James Wilcox, Director CHA
PO Box 6000, 9860 W Saanich Rd
Sidney, BC V8L 4B2
Bus: 250-363-6375 Fax: 250-363-6323
E-mail: wilcoxj@dfo-mpo.gc.ca

Ottawa Branch:
Dave Gray, Director, CHA
615 Booth St. Ottawa, ON K1A 0E6
Bus: 613-995-4516 Fax: 613-996-9053
E-mail: grayd@dfo-mpo.gc.ca

Central Branch:
Andrew Leyzack, Director CHA
867 Lakeshore Rd. Burlington, ON L7R 4A6
Bus: 905-336-4841 Fax: 905-336-8916
E-mail: leyzacka@dfo-mpo.gc.ca

Prairie Schooner Branch:
Bruce Calderbank, Director CHA
74 Granlea Place SW,
Calgary, AB T3E 4K2
Bus: 403-246-1265 Fax: 403-246-3333
E-mail: bruce_calderbank@nucleus.com.

Editors, Lighthouse:
Earl Brown, Paola Travaglini
867 Lakeshore Rd, Burlington, ON L7R 4A6
Bus: 905-336-4558 Fax: 905-336-8916
E-mail: lighthouse@car.dfo-mpo.gc.ca

CHA Academic Awards Program:
Barry Lusk, Manager
4719 Amblewood Dr. Victoria, BC V8Y 2S2
Fax: 250-658-2036
E-mail: luskbm@telus.net

Cover

Louisbourg Lighthouse
Photo copyright Chris Mills

Chris Mills is a founding member of the Nova Scotia Lighthouse Preservation Society. He served as a lightkeeper for nine years in Nova Scotia, New Brunswick and British Columbia. Mills now works as a journalist in Halifax.

Canadian east and west coast lighthouse images for sale — including many remote lightstations, and lighthouses before de-staffing.

Contact Chris Mills at : ketch@ns.sympatico.ca
or (902) 868-2313

Louisbourg Lighthouse near Cape Breton, Nova Scotia.

The lighthouse constructed by the French in 1734 at Louisbourg was the first established in Canada, and the second on the North American continent. Louisbourg, built near the northeast corner of Cape Breton Island, was the base from which the French planned to hold New France against the English. The initial plan to build a tower and light was made in late 1727, though the formal decision to build was not made until spring of 1729, after one of the King's ships, *Le Profond* nearly met its end in the harbour which was marked only by a navigational cross, and periodically by a bonfire.

During the second British seige of Louisbourg, the tower was heavily damaged, particularly so on the evening of June 9, 1758, when British batteries and naval vessels opened a heavy bombardment on Louisbourg. The light was deemed beyond repair and left to disintegrate.

During the 19th century, maritime officials took steps to reduce the many navigational risks and ship wrecks along the Atlantic coast. One of the new lighthouses built was the second for Louisbourg, completed in 1842. Fire destroyed this building in 1922.

The Lighthouse that stands today was completed in 1923, a year after the second light burned. It is a white concrete octagonal tower, 55 feet high.

Please see : http://WWW.Ednet.NS.Ca/educ/heritage/nslps/louisbourg.htm for more information about the Louisbourg lighthouse(s).

Index of Advertisers/Index des annonceurs

CHA l'ACH

The Canadian Hydrographic Association (CHA) is a non-profit, scientific and technical group of about 500 members with the objectives of:

- advancing the development of hydrography, marine cartography and associated activities in Canada;
- furthering the knowledge and professional development of its members;
- enhancing and demonstrating the public need for hydrography;
- assisting in the development of hydrographic sciences in developing countries.

It is the only national hydrographic organization in Canada. It embraces the disciplines of:

- hydrographic surveying;
- marine cartography;
- marine geodesy;
- offshore exploration;
- tidal and tidal current studies.

The Canadian Hydrographic Association is formally affiliated with the Canadian Institute of Geomatics. It is informally associated with the Hydrographic Society.

L'Association canadienne d'hydrographie (ACH) *est un organisme sans but lucratif réunissant un groupe scientifique et technique de plus de 500 membres ayant des objectifs communs, comme:*

- *faire progresser le développement de l'hydrographie, de la cartographie marine et de leurs sphères d'activités au Canada*
- *permettre les échanges d'idées et le développement professionel de ses membres*
- *rehausser et démontrer l'importance de l'hydrographie auprès de public*
- *assister au développement des sciences de l'hydrographie dans lespays en voie de développement*

Au Canada, l'Association est la seule organisation hydrographique qui embrasse les disciplines suivantes:

- *levé hydrographique*
- *cartographie marine*
- *géodésie marine*
- *exploration extra-côtière*
- *étude des marées et courants*

L'Association canadienne d'hydrographie est affiliée à l'Association canadienne des sciences géomatiques, et non-officiellement liée à la Hydrographic Society.

What the CHA Can Do For You:

- advance your knowledge of hydrography, cartography and associated disciplines, and keep you abreast of the latest development in these disciplines;
- enable you to develop and maintain contacts with others involved with hydrography, nationally and internationally.

These benefits are provided through the publication of Lighthouse (one of only three journals in the world devoted exclusively to hydrography), through the sponsorship of seminars, colloquiums, training programs, national conferences, and branch and national meetings.

Ce qu'elle peut faire pour vous L'ACH vous offre des avantages tels que:

- *parfaire vos connaissances de l'hydrographie, de la cartographies et des disciplines connexes, tout en vous tenant au courant des nouvelles techniques et des derniers développements réalisés dans ces domaines;*
- *établir et maintenir des contacts avec ceux qui oeuvrent en hydrographie, au niveau national et international. Ces avantages sont transmis par l'entremise de Lighthouse (une des trois revues au monde traitant exclusivement d'hydrographie) et par la tenue de séminaires, de colloques, de programmes de formation et d'assemblées régionales et nationales.*

Lighthouse

The journal of the Canadian Hydrographic Association, Lighthouse, is published twice yearly and distributed free to its members. Timely scientific, technical and non-technical papers and articles appear in the journal, with authors from national and international academia, industry and government. Present circulation of Lighthouse is approximately 900.

La revue de l'Association canadienne d'hydrographie, LIGHTHOUSE, est publiée deux fois l'an et distribuée gratuitement aux membres. Des articles scientifiques, techniques et non techniques, provenant du milieu de l'industrie ou du gouvernement autant national qu'international, apparaissent dans cette revue. Le tirage actuel de la revue est d'environ 900 copies.

Membership

Membership is open to all hydrographers, those working in associated disciplines, and those interested in hydrography and marine cartography.

Comment devenir membre

Le statut de membre est offert aux hydrographes et à tout ceux oeuvrant ou ayant un intérêt dans des disciplines associées à hydrographie ou à la cartographie marine.

Branch & Regional Activities

The Canadian Hydrographic Association has five (5) branches located across Canada. National headquarters is located in Ottawa.

Sections et activités régionales

L'Association canadienne d'hydrographie possède cinq (5) sections à travers le Canada. L'administration central se trouve à Ottawa.

For further information write to:
Pour plus d'information, s'addresser au:

National President/ Président national
Canadian Hydrographic Association
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Suite/Bureau 400
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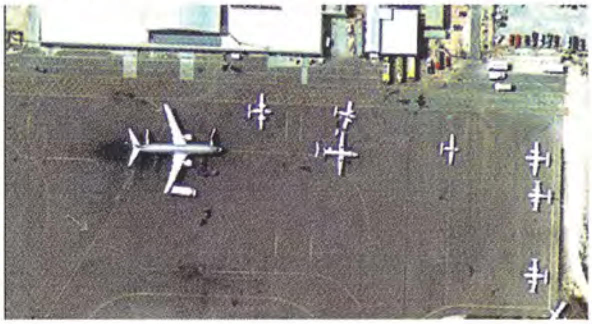

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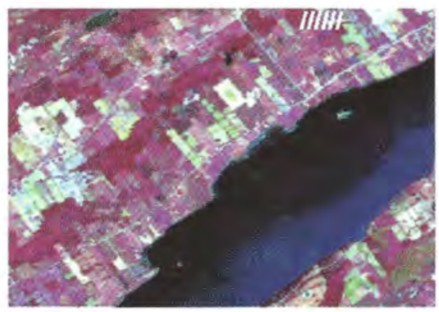

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The Atlantic Canada Lighthouse Inventory Project

By Rick Welsford, Jim Barkhouse and Steve Grant

Louisbourg Light (NS) built by the French 1731-1734 and first lit in 1734. After a short but eventful life of fires and reconstructions, it was destroyed in 1758 by British forces during the second siege of Fortress Louisbourg, which is located across the harbour from the light. The first British lighthouse was built in 1842. It burned and was replaced by the present 55 ft. octagonal cement tower in 1923.

Introduction

Lighthouses, for more than 2000 years, have been the principal method of near-shore navigation for mariners. At the same time, they warn of hidden or imminent dangers and provide a guiding beacon for safer passage. They are a confirmation of a successful return home after a prolonged period at sea. Mariners and landlubbers alike view lighthouses as something almost spiritual, and reassuring whenever viewed from a distance.

The continued navigational use of lighthouses is threatened in the 21st century by new electronic navigation systems such as the Global Positioning System, Radar and Electronic Charts. The growing use of these devices reduces the importance of lighthouses, except perhaps for their historic or aesthetic value. Throughout the world, redundant lighthouses and their related properties are therefore being redeveloped as marine tourism destinations.

In May 2000, the first ever Canadian Lighthouse Alternative Use Conference was held at White Point Beach Lodge, Nova Scotia, bringing together Canadian lighthouse enthusiasts, Canadian Coast Guard members and delegates from around the world, including Australia, the U.K. and the U.S. Some delegates were leaders of national lighthouse organisations who came to share their experience. Others were organisers of lighthouse tours and related activities. Many of the presentations dealt with issues important to those who operate, promote or market their lighthouse projects to others. As the remainder of this paper describes, Canada is a guiding light in this area and the future of our beautiful and historic lighthouses is brighter because of this.

The Atlantic Lighthouse Inventory Project

The Lighthouse Product Club is a partnership, bringing together the Canadian Tourism Commission, Atlantic Canada Opportunities Agency (ACOA), the Nova Scotia Department of Tourism and Culture, the Prince Edward Island Department of Fisheries and Tourism, the New Brunswick Department of Development, Tourism and Culture, and members of the Atlantic Lighthouse Council (ALC). There are over 300 lighthouses in Atlantic Canada and a goal of the Product Club is to profile the importance of lighthouses as a Canadian cultural tourism product.

To be successful, the Product Club has undertaken a program of market and inventory research to identify products and markets with the most potential. To enhance existing lighthouse sites and develop new lighthouse tourism products, a system of networking, communication and training is now being implemented. This will support existing members but also provide assistance in other regions of Canada and for associated industry stakeholders within Atlantic Canada.

The lighthouse inventory component of the Product Club program got underway the fall of 2000 and involved a team of two knowledgeable researchers visiting as many of the lights in the three Maritime provinces as possible within certain time, budget and weather constraints. For this project, a fairly broad definition of what constitutes a 'lighthouse' was used and included everything from 2-3 metre round fibreglass towers to traditional large lighthouses. The team also documented numerous replicas and decommissioned lights. During the 35 day field program the team travelled nearly 13,000 km and shot over 100 rolls of film. In all, 245 lights were visited; photographs of all aspects of each lighthouse and property were taken and a 20-page questionnaire was started. Many questions could not be answered at the sites so the team is now doing research to obtain the additional information as they enter it into a digital database management system. To date the team has identified 318 'lighthouses' in the Maritime provinces. Of the 73 lights not visited, all but a few are on islands and 23 of those were photographed from a distance. Many of the remaining sites will be visited next year. Nearly 100 lighthouses exist in Newfoundland & Labrador.

Clearly this is a work in progress but at this stage we can at least share, in the following two pages, some of the beauty and history that Atlantic Canadian lighthouses have to offer.

Swallowtail Light (NB) (left), *is one of several lights in the Maritimes that have to be secured by guy wires against the strong winds. Shown in the background is the ferry* Grand Manan V *which operates between Blacks Harbour and Grand Manan Island. Swallowtail was built in 1860. Access to the light is via stairs down the side of a cliff and across a wooden bridge over a deep gorge to a small islet. The old lightkeeper's house is operated as a Bed & Breakfast during the summer.*

Brier Island or Western Light (NS) (below), *is an imposing 60 ft. octagonal cement tower with red and white horizontal bands. It stands on the rocky western tip of Brier Island (home of Joshua Slocum) amid the swirling Bay of Fundy tidal currents. The present light was built in 1944; two previous lights were built in 1809 and 1832.*

Cape Jourimaine Light (NB) (above), *stands on a headland between the old Cape Tormentine ferry terminal and the new Confederation Bridge. It was built in 1869-70. The light is located adjacent to the Cape Jourimain National Wildlife Area and a major nature centre will open there in the spring of 2001.*

Prim Point (PEI) (below), *(not to be confused with Prim Point Light, NS at the entrance to Digby Gut) was built 1845-47 and was the first round brick lighthouse in Canada. At 60 ft. it is one of the largest in PEI and is clearly visible from Charlottetown, across Hillsborough Bay. A shingle outer layer was added in the early 1900's to protect the brick.*

Indian Head Light (PEI) (above), *is a one-of-a-kind lighthouse located at the eastern entrance to Summerside Harbour at the end of a one mile long breakwater/sand bar. The octagonal house with its two story octagonal light tower on top was built in 1881 and is clearly visible in the distance from the Summerside waterfront.*

The Wood Islands Lighthouse (PEI) (right), *stands on a headland adjacent to the NS – PEI ferry terminal and is now part of a Provincial Park. The 50 ft. square tapered tower with its attached dwelling was built in 1876 and was extensively renovated in 1950. It is open as a museum during the summer.*

References and Additional Information

1. Courtney Thompson, "Lighthouses of Atlantic Canada – A Pictorial Guide", CatNap Publications, PO Box 848, Mt. Desert, ME, USA, 04660, 2000.

2. Stephens, D. and S. Randles, "Discover Nova Scotia Lighthouses", Nimbus Publishing and NS Dept. of Economic Development and Tourism, 1998.

3. Stephens, D. and S. Randles, "Discover Prince Edward Island – Adventure and Lighthouse Guide", Nimbus Publishing, 1999.

4. Nova Scotia Lighthouse Preservation Society Web Page: http://www.ednet.ns.ca/educ/heritage/nslps/

5. New Brunswick Lighthouse Preservation Society Web Page: http://www.nblps.f2s.com/

6. Prince Edward Island Lighthouse Preservation Society Web Page: http://members.home.net/nancy1/index.html

7. The Lighthouse Preservation Society of Newfoundland & Labrador Web Page: http://www.geocities.com/nf_lighthouse_society/index.html

About the Authors

Rick Welsford *is the Managing Director of the Atlantic Lighthouse Council and provides guidance, advice and supervision of the operations of the organisation and its contracted responsibilities with the various founding partners. He is a graduate of Dalhousie University (B.Sc., Biology) with twenty years of varied consulting experience with marine science and engineering programs.*

Jim Barkhouse *began his career as a technician and writer for Sperry Gyroscope and Hermes Electronics. He served as an MLA for fourteen years and was Nova Scotia's Minister of Fisheries and Aquaculture from 1993-1998. He currently operates a marine tourism business in Chester, Nova Scotia (Capt'n Evans' Wharf). Jim's new book of photographs, "Chester by the Sea," was published in July, 2000.*

Steve Grant *is a P.Eng. (NS) and C.L.S. and retired from the Canadian Hydrographic Service in 1996 after 25 years of service. During that time he was a Navigation Specialist, Regional Tidal Officer and Manager of the Field Surveys, Data Management and Nautical Publications Divisions. Since his retirement he has taught courses and consulted on GPS and Electronic Charts and done a bit of sailing.*

For more information please contact:
Rick Welsford
The Atlantic Lighthouse Council
233 LaHave Street, Bridgewater, NS, Canada B4V 2T6
Phone: 902-543-3925 Fax: 902-624-1537
Email: r.welsford@ns.sympatico.ca

Appel de candidatures

Président National, ACH

Les mises en candidature sont maintenant ouverte pour le poste de Président National de l'Association canadienne d'hydrographie. Le poste de Président National deviendra vacant le 31 décembre 2001 lorsque monsieur Ken McMillan se retirera après deux mandats.

Le Président National est le chef exécutif du conseil de la Corporation. Il préside toutes les assemblées générales de la corporation et les réunions du bureau de direction. Il est responsable de la gestion générale et active des affaires du bureau de direction de la Corporation. Il s'assure que toutes les ordonnances et résolutions du bureau de direction soient mises en application.

Le Président National sera élu pour une période de trois (3) ans et sera rééligible pour un mandat subséquent.

La mise en candidature pour ce poste fermera le vendredi 31 août 2001 à 24 heures.

Le bureau de direction formera un comité d'élection pour recevoir les candidatures, informera les membres et tiendra une élection. Les candidatures peuvent être envoyées aux Vice-Présidents des Sections ou au Secrétaire National.

Les candidats seront annoncés dans l'édition d'automne du Lighthouse.

Call for Nominations

National President, CHA

Nominations are now open for the position of National President of the Canadian Hydrographic Association. The National President's position becomes vacant on December 31st 2001, when Ken McMillan is retiring after having served two terms in office.

The National President is the chief executive officer of the Corporation. He presides over all general meetings of the corporation and of the board of directors. He is responsible to the board of directors for the general and active management of the affairs of the Corporation. He ensures that all orders and resolutions of the board of directors are carried into effect.

The National President will be elected for a period of three (3) years and will be eligible for re-election to one (1) additional term of office.

Nominations for this position will close on Friday, August 31, 2001 at 24:00 hours.

The board of directors shall appoint an elections committee to accept nominations, inform the membership and conduct the election. Nominations should be sent to the branch Vice-Presidents or to the National Secretary.

Candidates will be featured in the fall edition of Lighthouse.

Radio Positioning Accuracies

by Bruce Calderbank, Hydrographic Survey Consultants Intl. Ltd., Calgary, Alberta

Introduction

Offshore radio positioning came of age during World War II and remained a staple of the offshore industry until early 1994 with the full implementation of the Global Positioning System (GPS). The positioning accuracies of various offshore surveys, structures and platforms relied on radio positioning during that time. The author provides information on the accuracies of various systems used in that period to facilitate reconciliation between new and old offshore survey data and for historical purposes.

Fixed Electronic Radio Navigation and Positioning Systems

Tabulated on pages 14 and 15 are the fixed electronic radio navigation and positioning systems available prior to the wide-spread use of GPS. They are grouped by transmission frequency and sorted within each group alphabetically by system and manufacturer.

The principle methods of transmission were pulsed and phase comparison systems with various combinations employed. Over the years a tremendous variety of radio positioning systems were developed.

Pulsed systems consisted of a master and two or more slave stations. Positions were determined by the time relationship between the pulses transmitted by the master station and those re-transmitted by the slave stations.

Phase comparison systems also consisted of a master and two or more slave stations. However, positions were determined by the phase relationship between the constant radio transmission from the master and each of the slaves.

Super high frequency (SHF or microwave at 1 to 10 GHz) systems included such standards as Miniranger and Trisponder. At these high frequencies, the signals travelled in nearly a straight line, with minimal reflection or refraction, and hence were generally known as line-of-sight sytems. Although extremely accurate, these were fairly short range systems. Maximum range was dependent on the elevation of the master and slave antennae. Also, any object in the direct transmission path would block the signals.

Ultra high frequency (UHF at 400 to 450 MHz) systems included such standards as Syledis and Maxiran. At these frequencies, the signals tended to follow the curvature of the earth to a slight degree, resulting in fairly accurate results at over-the-horizon distances. These systems were generally very accurate within the line of sight. A considerable amount of both reflection and refraction by the tropospheric layers of the atmosphere resulted in a greater degree of ambiguity in the position as the distance increased beyond the horizon.

Medium frequency (MF at 1.6 to 3.4 MHz) systems included such standards as Argo and HyperFix (including its predecessors HiFix and HiFix 6). Low frequency (LF at 70 to 130 kHz) systems included such standards as Decca Navigator, Pulse 8 and Loran-C. At these frequencies, the signals relied on reflecting off the ionospheric layers of the atmosphere to obtain the larger than beyond-the-horizon distances. However, these systems were affected by skywave signals that were propagated by way of the ionisphere.

During daylight hours, ultraviolet rays from the sun ionised the denser atmospheric gases closer to the earth, creating the D-layer. Radio waves entering this layer are scattered and absorbed. Consequently, the ground-wave signal was usually stronger than the reflected signal. At night, the electrons in the ionosphere reunite with the ionised gases and become polarised, and the D-layer disappears. The radio waves are then free to travel upward, where they are reflected by higher layers. Consequently, the reflected signals could be stronger than the ground-wave signal at over-the-horizon ranges.

The high frequency systems (SHF and UHF) were affected by atmospheric conditions, which included humidity, temperature and pressure.

The conductivity and permittivity (dielectic constant) of the surfaces over which the ground wave travelled affected the ground waves used by low-frequency systems (MF and LF). To improve the efficiency of these systems, a ground mat was laid at the shore antennae. To further improve the signal reception, some of these systems employed phase-locking at the master base station where the receiver monitored the transmission of the other slave stations. Whenever the phases started to drift, the receiving station adjusted the phase of its own transmissions to match that of the incoming transmissions.

Processing Principles

The commonly used classification processing principles employed by the radio navigation and positioning systems are described on the next page.

Processing Principle	Description
Phase Comparison	Measured the received signal relative to that of another reference carrier wave, which could have been generated by one of the following methods: a carrier wave received from another station; a carrier wave transmitted from the vessel; or an internally generated carrier wave.
Pulse - Match (or PRN Code)	The receiver replicated exactly the pseudo-random noise (PRN) code which was cross-correlated with the received signal to determine the appropriate time shift.
Pulse - Time Difference	The timing differences in the transmitted and received pulses were established.
Pulse – Wavefront	The pulse wavefronts in the transmitted and received pulses were compared and aligned so that they remained perpendicular to the line between the vessel and the fixed station.

Some systems used a combination of pulse-matching and phase-comparison to achieve better positioning. The mode or method of computation depended on the type of lines-of-position (LOP) generated. Some systems provided a compound mode, which allowed a combination of range/range and hyperbolic patterns to be combined within the system receiver to generate a position.

The accuracy quoted is dependent on proper calibrations in accordance with good survey practices before, during and after the survey. The range quoted is the maximum effective range at which acceptable positioning would have been achieved under typical circumstances.

Determining the Optimum System

The main points considered when determining the optimum positioning system for marine geophysical, site surveys, rig positioning and offshore construction surveys were as follows:

- availability
- frequency licences required
- maximum expected range
- required accuracy
- coastline configuration
- availability of adequate geodetic control
- number of users required
- cost
- logistics and related expenses

Transit Accuracy

The Transit system was the predecessor to GPS. However, the system did not provide 24 hour coverage and there were only 5 (in 1989) or 6 (by 1990) satellites available in the constellation deployed. All were in polar orbits, with heights between 1100 and 1200 kilometres, and with a period of between 105 and 110 minutes. Due to large precession of the satellites in their orbits, the orbits' planes moved with respect to each other and regularly crossed.

For instance, an observer off Nova Scotia would have expected on average 14 to 18 useful passes per day. Each pass lasted for up to 18 minutes and at least 15 satellite passes would be needed to achieve acceptable final positioning, which might take 2 days or more to collect. This allowed the point positions collected to be averaged with a good degree of certainty in the final co-ordinates. Offshore positioning for a moving vessel was complicated by the north / south component of the ship's velocity, which affected the relative radial velocity between the Transit receiver and the satellite.

If Transit were used, there would be the issue of the datum transformation values used by the positioning contractor to go from WGS72 (a global datum in use from 1974) to the local datum. There is also the possibility that a variant of WGS72 was used, such as NWL-9D (Naval Surface Weapons Laboratory) or NWL-10F. These were slight improvements over WGS72. For most offshore applications, the datum transformation values for any of these systems would be considered the same as for WGS72.

Doppler Technique	Horizontal Positioning Accuracy (1σ)	Minimum Number of Passes Required
Point Positioning	±10 metres	at least 15 acceptable Transit passes
Translocation	± 1 metre	at least 4 acceptable passes common to each Transit receiver with one mounted on the jack-up drilling rig and the other on a first-order geodetic point (not suitable if vessel was floating)
Translocation	between ± 0.5 and ± 1 metre	at least 17 acceptable passes common to each Transit receiver.

After 'Doppler Positioning Techniques Applicable to Different Position Accuracy Requirements' in Gregory J. Hoar, "Satellite Surveying", Magnavox, September, 1982, pages 4 to 14.

Some Common Radio Positioning Systems

The following information was compiled from a variety of sources and extracted from the manufacturer's specification sheets. Some of the main sources were as follows:

- "Positioning and Mapping at Sea" incorporated into IPMS, the E&P Knowledge, and Learning System produced by IHRDC of Boston, by Pieter G. Sluiter, with E.S. Sodbinow, Editor and N.A. Arstey, Series Editor in 1989, pages 217 to 219.
- "Fixed Electronic Radio Navigation and Positioning Systems" by Offshore Navigation Inc. (ONI) published in 1986.

Manufacture	System	Principle	Mode	Resolution (metres)	Accuracy 1σ (m)	Range (km)	Max LOP	Max Mobile	Comments
Super High Frequency (SHF or Microwave at 1 to 10 GHz)									
Christian Huygens Laboratorium	Artemis, Mk III Mk IV	Pulse - Wavefront	Range/ Bearing	0.5 to 1.5 m direction 0.03 degrees	± 2	25	2	1	Only one shore station required. No observational redundancy unless system duplicated. Built in voice link.
SPC	Audister 8D-100		Range/ Bearing		± 1	100	2	1	Transmitters controlled by crystal oscillators for high accuracy.
Cubic Western	Autotape DM 40A DM 43	Pulse and Phase Comparison	Range/ Range	0.1	± 4	100	2	1	Highly directional antennae required constant adjustment to point at vessel. No observational redundancy.
Sercel	Axyle	Phase Comparison	Range/ Range		± 1	5	4	4	
ODOM Offshore	Aztrac	Pulse - Wavefront	Bearing	0.01 degrees	± 1	5	1	1	20 km optional. Used in conjunction with separate ranging system.
Tellurometer (Plessey)	Hydrodist	Phase Comparison	Range/ Range	0.1	± 4	40	2	1	As for Autotape.
Tellurometer (Plessey)	Hydroflex	Phase Comparison	Range/ Range	0.1	± 4	40		6	As for Autotape.
Tellurometer (Plessey)	MRD1	Phase Comparison	Range/ Range	0.1	± 4	100	2	6	As for Autotape. Built in voice link.
Navigation Management	Miniran	Pulse - Match	Range/ Range		± 5	70	2	6	
Motorala	Miniranger	Pulse - Match	Range/ Range	1	± 4	40	4	16	80 km option available. Automatic switching between channels to eliminate range holes available. Numerous models.
Racal	Microfix	Phase Comparison	Range/ Range	0.1	± 4	70	8	16	Measurement time updated every 0.5 seconds.
Krupp Atlas	Polarfix	Pulse - Match	Range/ Bearing	0.5 m Direction 0.03 degrees	± 1	5	2	1	Good for harbour and port work. Laser limited by fog and rain.
Del Norte Technology	Trisponder	Pulse - Match	Range/ Range	0.1	± 4	74	4	8	Ranges de-skewed automatically and presented as if obtained simultaneously
Ultra High Frequency (UHF at 400 to 450 MHz)									
Texas Instruments	Geotrac	Pulse - Match	Range/ Range	1	± 5	110	2	1	No observational redundancy.
Navigation Management	Maxiran	Pulse - Match	Range/ Range	1	± 8	370	3	1	Affected by sky wave interference.
Sercel (Syledis)	MR3	Pulse - Match	Range/ Range	0.1	± 5	110	3	4	A long coded pulse of 2.5 msec and low power provided the range. Very accurate within line of sight.
	MR3		Hyperbolic		± 8	110	3	4	
	LD		Range/ Range		± 15	300	3	4	
	SR3		Pseudo Hyperbolic		± 10	110	8	No limit	
	STR4		Range/ Range		± 5	110	>4	>4	
	STR4		Hyperbolic		± 8	110	>4	>4	
	SB5		Compound		± 5	110	>8	>8	
Del Norte Technology	Pulsetrac	Pulse - Match	Hyperbolic	0.1	± 5	110	4	No limit	
Del Norte Technology	UHF Trisponder	Pulse - Match	Range/ Range	0.1	± 8	110	8	8	
Surplus US Army	Shoran	Pulse - Match	Range/ Range	0.01 miles	± 25	300	2	1	Very susceptible to operator error. Not allowed to be operated in Continental US, Eastern Canada, and Europe due to interference with television transmissions. No observational redundancy.
Thompson	Trident III and IV	Pulse - Match	Range/ Range	1	± 10	250	>10	50	

Manufacture	System	Principle	Mode	Resolution (metres)	Accuracy 1σ (m)	Range (km)		Max LOP	Max Mobile	Comments
Medium Frequency (MF at 1.6 to 3.4 MHz)										
						Day	Night			
Prakla-Seismos	ANA	Pulse and Phase Comparison	Range/ Range	0.01 lanes	± 10	400		3	No limit	Ship used an atomic frequency standard, which provided reference against which the phase of the received signal was measured.
Cubic Western	Argo DM54	Phase Comparison	Range/ Range Compound Hyperbolic	0.01 lanes	± 8 ± 10 ± 10	450 450 450	200 200 200	4 4 4	7 11 No limit	Similar to HiFix but with better mirco-processor controls to minimize sky wave effects. Internal smoothing ("time constant") could be misused.
Sercel	Geoloc	Pulse and Phase Comparison	Range/ Range	0.01 lanes	± 10	950		4	No limit	Regular DGPS updates required.
Sercel	Toran O Toran P10, P100	Phase Comparison	Range/ Range Hyperbolic	0.01 lanes	± 8 ± 15	550 700	250 180	2 2	1 No limit	Similar to HiFix but phase locking not used. Coverage from fixed chains in Mediterranean and North Africa. No observational redundancy.
Racal	HiFix	Phase Comparison	Range/ Range Hyperbolic	0.01 lanes	± 8 ± 25	370	180	2 2	1 No limit	Lane count and calibration problems. Both accuracy and useful range varied greatly depending on geometry, climatic conditions and time of day. Daylight operation only at long ranges. Used phase locking techniques. No observational redundancy.
Racal	HiFix 6	Phase Comparison	Range/ Range Compound Hyperbolic	0.01 lanes	± 8 ± 8 ± 10	400 400 400	200 300 300	3 3 6	3 3 No limit	Upgrade of HiFix with observational redundancy.
Racal	HyperFix	Phase Comparison	Range/ Range Compound Hyperbolic	0.01 lanes	± 8 ± 8 ± 10	400 400 400	200 300 300	5 4 5	7 7 No limit	Upgrade of HiFix 6. Coverage from fixed chains in North Sea.
Racal	SeaFix	Phase Comparison	Hyperbolic		± 25	>550		3	No limit	Similar to HiFix.
ODOM Offshore	Hydrotrac	Phase Comparison	Range/ Range Hyperbolic	0.01 lanes	± 8 ± 15	400		2 2	1 No limit	Similar to HiFix, but phase locking not used. Sky wave rejection by filtering techniques. No observational redundancy.
Lorac Services	Lorac	Phase Comparison	Range/ Range Hyperbolic	0.01 lanes	± 8 ± 25	450 700	200 200	2 2	1 No limit	Similar to HiFix but phase locking not used. Coverage from fixed chains in Gulf of Mexico. No observational redundancy.
Ocean Management	OMI	Phase Comparison	Range/ Range Hyperbolic	0.01 lanes	± 10 ± 15	400	200	3 2	No limit	No observational redundancy.
Comp. de Compteurs	RANA-H	Phase Comparison	Hyperbolic	0.01 lanes	± 15	250	150	2	No limit	No observational redundancy.
Teledyne Hastings-Raydist	Raydist DRS Raydist T Raydist N	Phase Comparison	Range/ Range Compound Hyperbolic	0.01 lanes	± 8 ± 25 ± 25	370 700 700	180 180 180	2 2 2	4 3 No limit	Similar to HiFix but phase locking not used. Coverage from fixed chains in Gulf of Mexico. No observational redundancy.
Offshore Navigation Inc	SPOT	Pulse and Phase Comparison	Range/ Range	0.002 lanes	± 10	700	700	4	No limit	Regular DGPS updates required.
Offshore Navigation Inc	Microphase	Pulse and Phase Comparison	Range/ Range	0.001 lanes	± 10	400	300	3	No limit	
Low Frequency (LF at 70 to 130 kHz)										
Racal	AccuFix	Pulse and Phase Comparison	Range/ Range Hyperbolic	10 nano seconds	± 25 ± 35	> 600 > 600		4 3	No limit No limit	Combined with seabed acoustic system to achieve required repeatability.
Racal	Decca Navigator (or Main Chain)	Phase Comparison	Hyperbolic	0.1 lanes	± 50	> 750		3	No limit	Similar to HiFix. Coverage from fixed chains over major shipping routes world wide.
Racal	Pulse 8	Pulse and Phase Comparison	Hyperbolic Range/ Range	10 nano seconds	± 25 ± 35	> 600 > 600		5 4	No limit No limit	Commercial version of Loran-C. Coverage from fixed chains in North Sea.
US Government	Loran C	Pulse and Phase Comparison	Range/ Range Hyperbolic	0.01 µ seconds	± 50 ± 75	> 1500 > 2500		3 4	No limit No limit	Coverage from fixed chains in US, Canada, North Sea, Mediterranean, and Japan. In range/range mode accuracy and stability improved with addition of an atomic clock.
US Government	OMEGA	Phase Comparison	Hyperbolic		± 1500	World-wide		4	No limit	Not accurate enough for minimal seismic requirements.
Satellite Systems										
US Government	GPS	PRN Code & Phase Comparison	Standard Precision DGPS		± 100 ± 12 ± 5	World-wide local		> 4	No limit	Fully operation from 1st January 1994. Accuracy to midnight 1st May 2000
US Government	GPS	PRN Code & Phase Comparison	Standard Precision DGPS		± 5 ± 1 ± 3	world-wide local		> 4	No limit	Fully operation from 1st January 1994. Accuracy from midnight 1st May 2000
US Government	Transit	Doppler				world-wide			No limit	See Transit Accuracy section for details.
CIS Government	GLONASS	PRN Code & Phase Comparison				world-wide		> 4	No limit	

About the Author

Bruce Calderbank *has been involved in the offshore since 1978 after receiving his undergraduate degree in surveying from University of New South Wales. After obtaining a postgraduate Diploma in Hydrographic Surveying from Plymouth Polytechnic in 1980, Bruce worked for a couple of companies before returning to Canada and setting up Hydrographic Survey Consultants Intl. in 1983. He has worked in over 25 countries worldwide and can be reached at* bruce_calderbank@nucleus.com.

Lighthouse puzzler

	CSS Acadia	CSS Baffin	CSS Bayfield	CSS Cartier	Lodestone	Moon shots	Octant	Sextant	North Pole	Prime Minister	Seamount	Superior Shoal
Eaton												
McCulloch												
Kerr												
Ritchie												
North Pole												
Prime Minister												
Seamount												
Superior Shoal												
Lodestone												
Moon shots												
Octant												
Sextant												

Lighthouse Puzzler # 19

One memorable evening a few years ago, four CHA worthies were at Rosie's Bar reliving old times. After a few beers, the tales got taller... Hearing about it later from Rosie herself, can you figure out who managed to sail his ship over the North Pole?

The clues:

1. The one using the sextant was not on *CSS Cartier*, nor was he the one that found the seamount.
2. *CSS Bayfield* was not navigated by a sextant, and, no, it did not find the seamount.
3. Ritchie used the octant.
4. Eaton; the one on *CSS Baffin*; and the one using moon shots did not host the Prime Minister.
5. *CSS Acadia* navigated with a lodestone.
6. Kerr found Superior Shoal but did not use a sextant.

Solution to Puzzler #18

James did the rocks [clue 1] and Andrew the stadia [clue 2] and it was not Dave who did the marina [clue 3] so it must have been Bernard, and Dave who did the ranges. Which means that Bernard had the truck and James the helicopter, and Andrew must have been with Tim.

Sheila, Ken and James fueled up on the way home so it was Tim who was on foot and Dave with Sheila on the Launch. So James was with Barry and Ken was with Bernard.

VARIABLE ERRORS AND FIXED BOUNDARIES:

The Role of Deep Echo-sounding in the United Nations Convention on Law of the Sea (UNCLOS)

By David Monahan

Most hydrographic energy is expended in the water depths that can effect surface shipping, generally less than 40 m, and many hydrographers work their entire careers in depths that average perhaps 25m. Article 76 of the United Nations Convention on Law of the Sea (UNCLOS) requires that hydrographers focus their attention on depths 100 times that, since a line 100 nautical miles seaward from the 2500m depth contour will form the outer limit of some Coastal States in some areas. Measuring 2500m depths differs from measuring 25m depths in several ways. This paper examines differences in the types of errors that contribute to uncertainties at the two depths to help guide hydrographic field surveys that are designed to contribute to fixing the outer boundary.

Introduction

Article 76 of the United Nations Convention on Law of the Sea (UNCLOS) provides a set of rules under which Coastal States may define their continental shelves beyond the 200 nautical mile wide Exclusive Economic Zone (EEZ). To prevent Continental Shelves from becoming overly wide, two outer "constraints" are provided in paragraph 5

" 5. The fixed points comprising the line of the outer limits of the continental shelf on the seabed, ... either ... or shall not exceed 100 nautical miles from the 2,500 metre isobath, which is a line connecting the depth of 2,500 metres."

This gives hydrographers a once-in-a-lifetime chance to have their efforts establish the boundary of their country. In Canada, this will likely be the case offshore Labrador and in the Arctic Ocean. From work done to date, it can be predicted that the 2500m contour will be used to establish the outer constraint in the Atlantic area east of Flemish Cap, as shown in Figure 1. As always, the situation in the Arctic is more complicated, but it appears that Russia, at least, plans on using the 2500m contour all the way to the centre of the Arctic Ocean, where their Continental Shelf will abut ours. As part of determining the 2500m contour, the uncertainty in location of the 2500m contour should be determined. As an illustration of its significance, the 2500m contour off Eastern Canada likely to be used is about 1200 nautical miles long. An error in its location of one nautical mile thereby generates a portion of the earth 1200 sq. nautical miles or 4115 sq. km in size that may be incorrectly assigned either to Canada or to the UN (PEI is 5660 sq. km).

Errors and Uncertainty

All measurements have some error associated with them, and depth measurements are no exception. The errors in depth are grouped into two general types, fixed and variable. Fixed

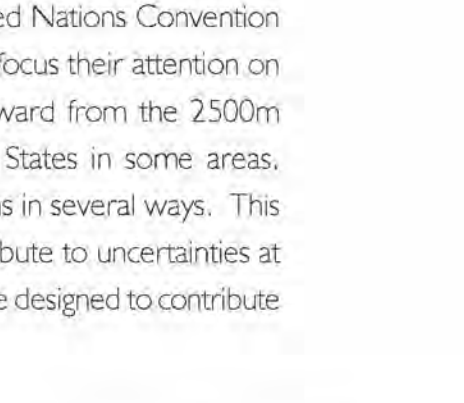

***Figure 1** Sketch map showing the zone within which a claim for extended jurisdiction may fall. The inner heavy line is 200nautical miles from the baselines along the shore. The thin dashed line is the 2500m contour with a constraint line drawn 100nautical miles seaward of it. Note that in the area of Orphan Knoll (OK), this line is shown in two locations, depending on whether the isolated 2500m contour surrounding Orphan Knoll is used or whether the 2500m contour conterminous with the shelf is used as a basis for projecting 100nautical miles seaward. The outer thin grey line is the 350nautical miles from the Baselines constraint line. The outer limit is constrained by the outermost of these two.*

errors are those that are the same no matter how deep the water may be. For example, if the tidal datum is determined incorrectly, the error introduced will be fixed at a constant value independent of water depth. Every sounding taken will include that same error. Variable errors, on the other hand, are different for every sounding, growing larger with increasing water depths. The uncertainty of every sounding then, comes from a combination of its fixed and variable errors. How do they combine?

The Standards for Hydrographic Surveys, Special Publication 44 (S-44) of the International Hydrographic Organization (IHO, 1998), provides a valuable framework for examining the uncertainty of a single depth. It provides the general case in which total error estimates are calculated as the RSS of the constant errors plus the errors that vary with depth, at the depth in question. In symbols this looks like

$$S = \pm\sqrt{(a^2 + (bd)^2)}$$

Where
a = the sum of all fixed errors
bd = the sum of all variable errors
b = factor of variable error
d = depth
with a 95 per cent confidence interval (IHO, 1998).

It is worth spending a little time on this equation. Why aren't the two numbers simply added? Well, an error or uncertainty is not an absolute number in the sense of being a finite distance along the number line. When an error to any measurement, e.g. a sounding, is given, it represents the maximum value that the error is likely to take, 19 times out of 20 (i.e. 95% confidence level). Once out of 20 times, the error can exceed that value, but most of the time it will be less. Errors, at least for "cleaned" data, are more likely to be small than large, and usually follow the bell-shaped or Gaussian distribution curve. When adding two errors from different sources, it is extremely unlikely that both will be at the maximum value, since it's unlikely that either one will be at the maximum, and so would be unreasonable to add the two maxima as if they were simple numbers. It has been determined that squaring each number, adding the results (i.e. the squares) and taking the square root of the sum, produces a number that conforms to the way the world works. This is called the "root sum of squares" in jargon. The result will always be less than a straight addition of the two errors, which makes sense, since the combined error must be more than the individual errors, but less than the two combined. Another aspect of the equation: as one number becomes larger than another, the combined error comes closer and closer to being that of the larger number. If one number is 10 times the other, the smaller adds less than 0.5% to the total error, and can usually be ignored: if one number is 100 times the other, the smaller adds less than 0.01%, and is normally considered noise.

S-44 is a standard to be attained, of course, not a means of measuring, after a survey, what uncertainty the survey actually achieved. It recognises that different parts of the seafloor are of different importance, and breaks surveys into four classes, or Orders, depending on the likely use of the area by surface navigation. For each Order, it specifies the maximum value that "a", the sum of all fixed errors in the equation above can take, and "b", the factor that is multiplied by depth to determine the variable error. As can be seen from Table 1, Row 1, the most rigorous of these, Special Order, calls for a maximum fixed error of 0.25m, and a variable factor of 0.0075, while the loosest, Order 3 has values of 1m and 0.023 respectively. From these, values for the uncertainty at 25m and 2500m are easily calculated, Row 2. It is valuable to determine at which depths the two types of error are equal, Row 3: surveys at less than these depths will be dominated by fixed errors, at greater depths the variable errors take over and continue their rapid growth.

#	ELEMENTS		S-44 ORDER Special	1	2	3	S-44 ORDER Special	1	2	3
			Depth Accuracy				Bathymetric Model			
1.a	Fixed Error		0.25m	0.5m	1m	1m		1m	2m	5m
1.b	Variable factor	x depth	0.0075	0.013	0.023	0.023		0.026	0.05	0.05
2.a	Vert, Uncertainty at	25m	0.31	0.6	1.15	1.15		1.19	2.36	5.15
2.b	Vert. Uncertainty at	2500m				57.5				125.1
3	Depth at which fixed = variable	error	33	38	43	43		38	40	100
4.a	Horizontal Uncertainty	25m								
	Bottom Slope	1 deg	18	34	66	66		68	135	295
		2.5 deg	7	14	26	26		27	54	118
		7.6 deg	2	5	9	9		9	18	39
4.b	Horizontal Uncertainty	2500m								
	Bottom Slope	1 deg				3295				7167
		2.5 deg				1317				2865
		7.6 deg				431				938

Table 1. *S-44 elements. Fixed error and variable factor come from S-44. Uncertainties at 25m and 2500m are calculated from these values, as is the depth at which the fixed and variable errors are equal. Text refers to row #.*

Why Do We Care - Horizontal Displacement Caused by Errors in Depth Measurement

All measurements have errors. This is a well-known fact. Why belabour it? We are concerned because errors in depth measurement translate into horizontal uncertainty in the location of contours (and the 2500 m contour will contribute to the outer limit of Canada, a horizontal line). The simplest way to visualise these uncertainties comes from examining the geometry of a single horizontal depth measurement over a sloping sea floor. Geometrically, this type of depth measurement is a straight line perpendicular to a horizontal line, the sea surface, and a sloping line, the sea floor, with variables being the slope of the seafloor and the uncertainty in depth measurement. In Figure 2, the distance AB between the sea surface and sea floor is exactly 2500m, locating the 2500m contour at B. The uncertainty in AB, (delta d) means that the contour will be displaced landward or seaward by a distance that is a function of the bottom gradient and the difference between 2500m and the true depth. (Horizontal displacement = uncertainty in depth measurement / cosine of bottom gradient.)

What bottom gradients can be expected? The 2500m contours that will be used as part of a Continental Shelf submission will lie on seafloors that generally have gentle gradients, the Continental Slope and Continental Rise. As students, we were all shown simplified cross-sectional diagrams of the Continental Margin, which (despite their enormous Vertical Exaggeration) showed that the average gradient over the Continental Slope was in the order of 2 to 4 degrees. Pratson and Haxby, 1996, probably began the modern era of measuring Continental Slope gradients when they compared both regional and local slopes as measured by multibeam echosounders (MBES) over five portions of the US Continental Slope. Not only were they able to measure gradient locally and regionally, they were able to relate them to lithology and tectonic history. The steepest area they examined was off New Jersey, where they measured a regional slope of 2.5 degrees and a local slope of 7.6 degrees. Monahan and Mayer, 1999, processed the same data and produced colour-intensity slope maps demonstrating that the locally steepest areas were on the canyon walls and that the lower gradients occurred down-slope from the canyons. These observations seem to confirm the 2 to 4 degrees average gradient expected.

We now have two components of contours, measurements and a sea floor. Since Article 76 defines the 2500m contour as "a line connecting the depth of 2,500 metres", we must discuss the uncertainty associated with contour lines. The preparation of deep-sea contours from single-beam sounders has been described by Monahan, 2000, while Hughes Clarke,

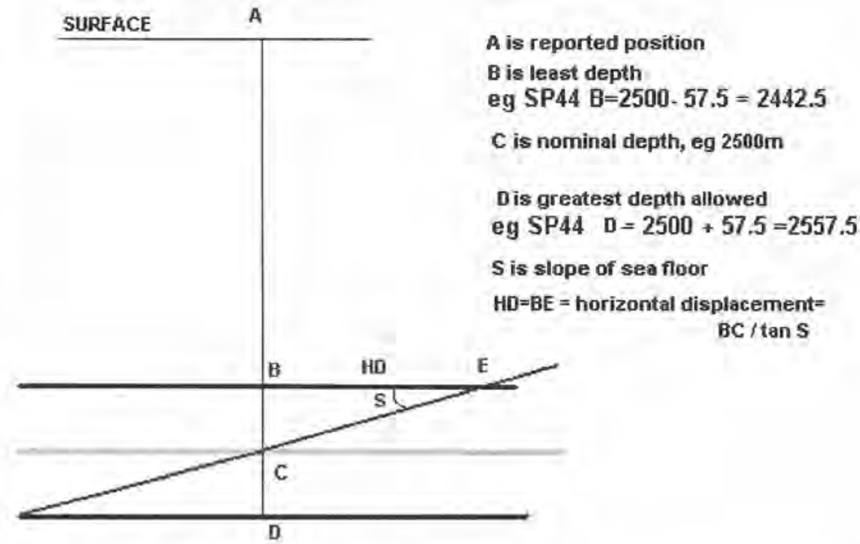

Figure 2 *(after Monahan and Wells, 1999) Geometry of horizontal displacement caused by uncertainties in measuring 2500m.*

2000, has elaborated the application of MBES in the deep ocean, and the means of extracting contour-like lines from it. As a general rule, the uncertainties created in the measurements by fixed and variable errors are not improved during the subsequent expansion from measurements to contours.

Submissions claiming a Continental Shelf must be tendered to the UN Commission on the Limits of the Continental Shelf (CLCS). That body has issued Guidelines (United Nations, 1999) that state that IHO S-44 will be used as the standard for bathymetric uncertainty. S-44 appears to offer error magnitudes for contours, as well as for surveys, if Johnson's, 1997, interpretation of the phrase "bathymetric model" as values interpolated from actual soundings is correct. If contours are streams or strings of interpolated values, then S-44 includes values for the fixed and variable errors, that are naturally and correctly relaxed from those demanded of individual soundings (Monahan and Casey, 1983). Table 1, Row 4, shows the horizontal uncertainties allowed for each of S-44's Orders at 25m and 2500m water depths, for sea floors with gradients of 1, the maximum regional gradient of 2.5 degrees; and the maximum observed 7.6 degrees, for both measurements and contours. It is possible that part of the boundary of a country could be determined with these horizontal uncertainties, although once approved, the line becomes fixed in law and loses all its uncertainty.

As hydrographers, we have to ask first if we can achieve these uncertainties, and secondly if we can exceed them. To do so, we examine the errors that occur in the real world.

Components of Fixed and Variable Errors

Fixed Errors

Since this paper is concerned with 2500m depths, and, as has been shown above, fixed errors are negligible at these depths, it suffices here to refer to Hare's definitive work on errors (Hare, 1997) which contains detailed analyses of fixed errors at navigation depths.

Variable Errors

The principal components of variable error are sound speed and beam width.

The effect of sound speed

Echo sounders measure time. And you thought all along that they measured depth? Ha! They measure the time between transmitting and receiving an echo, and they calculate depth by dividing the time in half and multiplying it by the speed of sound. Clearly, how accurately we know the speed of sound will affect the accuracy of the depth measurement. In shallow water, standard practice is to either perform a bar check periodically, which avoids having to determine the actual speed, or determine sound speed in the water with an instrument called a velocimeter, from which soundings are corrected to true depths using the values it measured. In deep water beyond the depths where a velocimeter can be readily deployed, normal practice is to set the echo sounder to a fixed sound speed (1483 or 1500m/sec) and correct the depths it measures using tables (Carter, 1980). Under stable water conditions, these tables produce data that are consistent and uniform, although there are minor "steps" at the boundaries of each correction area.

What uncertainties in depth can errors in any of these methods of determining sound speed introduce?

Speed of sound varies with the density of the medium through which it is travelling. Since the density of seawater is difficult to measure directly, especially under real-world conditions, we measure two parameters that are easier to measure and that density depends on, namely salinity and temperature. Generally, these can vary widely in shallow water, which includes rivers, estuaries, near-shore zones and the upper layer of offshore water that is effected by surface winds, waves and currents. Deep water, on the other hand, has salinities and temperatures that are much more stable, with little vertical or horizontal variation.

Some examples: suppose that an inshore survey in true depths of 25 m has calibrated its echosounder to show 25m in water which has a salinity of 35ppm, at a temperature of 13 degrees C. Suppose the survey crosses an area where a river enters the sea and the salinity drops to 10ppm: the echosounder will now show a depth of less than 24.5 meters (enough to degrade the survey from S-44 Special Order to S-44 Order 1). Old-time hydrographers might think that at least the depth is shallower and therefore safer, but if the salinity had stayed the same and the water temperature increased by one degree, then the depth recorded would have been deeper than 25m. Of course, under such circumstances salinity and temperature usually both change, and can do so over quite short distances. Hughes Clarke et al., 2000, measured both parameters continuously over Georges Bank and concluded "the water column was varying significantly over length scales of as small as a few 100 metres" and should ideally be continuously monitored.

Now consider deep water, 2500m in particular, and apply similar reasoning as above. Assume that the echosounder has been set to a fixed speed of 1500m/s, the true depth is 2500m, the water has a salinity of 35ppm, and a temperature of 2 degrees C (a typical temperature in Atlantic Canada). If the salinity drops to 34ppm, or if we mistakenly measure it as such, depth shown becomes 2499m, while if salinity rises to 36ppm, depth shown is 2503m, not much to worry about. If the temperature rises by one degree, the depth shown becomes 2508, not a large uncertainty in depth measurement, but one which would create a horizontal uncertainty of ± 478 above a 1 degree sea floor gradient! These examples show that even small changes in salinity and temperature, or small errors in detecting them, can lead to fairly extensive horizontal uncertainty. How realistic are these magnitudes? Well, for most deep ocean areas, they are quite reasonable. However, the Continental Slope east of Newfoundland is an area where ocean currents converge to form what oceanographers call an Intense Frontal Zone, an area in which the water column is far more mixed than normal at these depths. Carter (1980), in the standard tables for sound speed correction, warns that errors of plus or minus 10 metres per second are to be expected in tabulated speed corrections for these zones. The Slope southeast of the Grand Banks lies in three different areas, for which Carter's provides the following corrected depths: an echosounder set at 1500m/s over a true depth of 2500m would report depths of 2489 (Area 9), 2476 (Area 12) and 2498 (Area 15), showing the range of uncertainty likely due to physical conditions. While these are all within the S-44 requirement of ± 57.5m, how well we determine sound speed will effect the uncertainty in the boundary of Canada.

Sound Speed Var'n	Sound Speed error	Vertical Error	Percent of Depth	Horizontal uncertainty on seafloors sloping		
				1 deg	2.5 deg	7.6 deg
m/s	m/s	m	%	m	m	m
1.5	2.5	2.5	0.1	143	57	19
10	16.67	16.67	0.67	955	379	125
15	25	25	1	1433	568	188

Table 2. *Vertical errors and horizontal uncertainty introduced by sound speed errors of 0.1%, 10m/s (after Carter), and 1%.*

The effect of beam width

The discussion of sound speed deliberately oversimplifies the sound in the water as if it were a single ray, to make the geometry easier. Although this is useful, it is not what happens to real sound in real water. In the sea, sound emitted propagates away from the face of the transducer in a pattern that expands and resembles a lighthouse (couldn't resist it!) beam on a dark night. To describe the beam in something that can be handled with fairly simple arithmetic, and to reflect the fact that usually it is the strongest central part of the beam that does most of the work, sonar design engineers use the concept of "beam width" to rate sounders. Beam width is twice the angle between a line perpendicular to the centre of the transducer face and the point where the energy contained in the beam is reduced to half that at the perpendicular. Of course, there is energy outside the beam, and everyone reading this has seen returns from it on occasion, but most of the energy put out, and consequently most of the returned energy (and more important, the first returned energy) comes from inside the beam width.

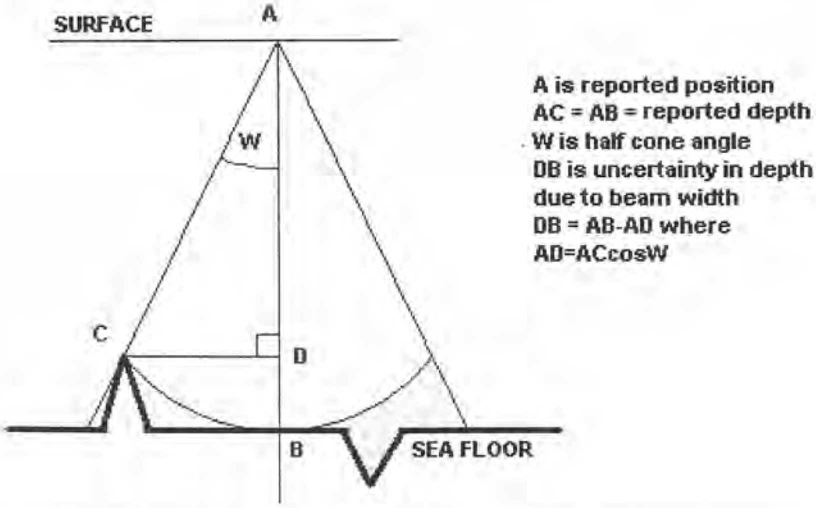

Figure 3. *(after Monahan and Wells, 1999) The effects of echo sounder beam width on horizontal uncertainty.*

Figure 3 is a diagram of the propagating sound wave as it radiates away from the transducer face and occupies an area that becomes increasingly larger with depth. Variable error coming up! As the advancing wave front sequentially encounters the bottom everywhere within the ensonified area, some of its energy is reflected back. Over smooth bottoms, most of the energy makes it back to the transducer, but on rougher bottoms some returning energy will run into interference and either not make it back to the surface, or will arrive there late. Older echosounders record the energy that travels the shortest two-way distance as the 'first arrival' or 'first return' and this will be the depth reported, while more modern echosounders examine the entire returned signal and calculate some point within it as depth.

Beam width produces three different uncertainties. It can smooth the shape of large features and it can obscure features whose wavelengths are less than twice the ensonified area and it can introduce horizontal displacement when the seafloor is sloping. The reasoning behind the latter is the same as that explained in Section 3 (Why Do We Care- Horizontal...) and Figure 2. Some typical values are shown in Table 3. Thirty degrees represents the typical beam width of echosounders in common use for 2500 m depths until quite recently, and much of the legacy data over continental slopes will have been collected by equipment with approximately this beam width. At the other end of the spectrum, 2 degrees (or less) is typical for modern MBES systems. Note that a beam width of 24.6 degrees produces an uncertainty equal to the total uncertainty allowed by S-44.

Nominal beam angle	Beam angle effect	Sound Speed Var'n	Sound Speed error	Vertical Error	Percent of Depth	Horizontal displacement on seafloors sloping		
						1 deg	2.5 deg	7.6 deg
degrees	m	m/s	m/s	m	%	m	m	m
2	0.38	0	0	0.38	0.02	22	9	3
24.6	57.39	0	0	57.39	2.3	3289	1304	431
30	85.19	0	0	85.19	3.41	4882	1936	640

Table 3. *Magnitudes of horizontal displacement over seafloors sloping 1, 2.5 and 7.6 degrees caused by beam width.*

Summary of uncertainties in a single measurement

Sound speed and beam width uncertainties combine as RSS to form the total variable error. Variable errors also come from other elements, for example the fact that in 2500m of water the transducer has moved for more than three seconds before receiving an echo from a sound wave it emitted, but these errors are normally small (or else we don't know how to deal with them). Table 4 shows some values achievable with MBES (2 degrees), an arbitrary number that just meets S-44, and a 30 degree beam width typical of most of the SBES data that currently exists over the Continental Slope. Since the latter do not meet S-44, it seems that the CLCS is demanding that new data be collected as part of a submission.

Combining fixed and variable errors

S-44's formula ("Errors and Uncertainty" section) instructs us to combine the two types of error as RSS. However, since it also gives a maximum value for the fixed error of ±1m, and since the variable error at 2500m is ±57.5, at the maximum, the fixed error is negligible. In fact, at the maximum, the fixed error would have to grow all the way to 12m before the total error grew to 57.6! What is not clear in S-44 is what should be done, in practical terms, in cases where the fixed error exceeds 1m. Since the total error is so completely dominated by the variable error, would a survey whose fixed error was

Nominal beam angle	Beam angle effect	Sound Speed Var'n	Sound Speed error	Vertical Error	Percent of Depth	Horizontal displacement on seafloors sloping		
						1 deg	2.5 deg	7.6 deg
degrees	m	m/s	m/s	m	%	m	m	m
2	0.38	1.5	2.5	2.53	0.1	145	57	19
24	54.63	10	16.67	57.12	2.28	3273	1298	429
30	85.19	15	25	88.78	3.55	5088	2018	668

Table 4. *Typical combined magnitudes of horizontal displacement over seafloors sloping 1, 2.5 and 7.6 degrees caused by beam width and sound speed variations.*

1.5m., say, be deemed to fail to meet the demands of S-44 even though its total error was within bounds?

The situation changes somewhat as the variable error becomes smaller, even approaching the fixed error as it might on the first line of Table 4. Since these numbers are within reach of MBES, Table 4 is repeated as Table 5 with the maximum allowed fixed error. It is clear that fixed errors make no difference at large beam angles, and when sound speed is poorly known, but can become important at MBES-like values.

of 0.6% would cause a sounding to exceed the limits of Spec Order 5 at 25m, as would an error of 1.13% for Order One. Order 2 an 3 would be exceeded at a hair over 2% at 25 m, while at 2500m Order 3 would be exceeded at 2.3%, a number familiar from S-44, since the fixed error of ±1 m would contribute virtually nothing at this depth. In reality, both sound speed and beam width contribute, so that sound speed would have to be known to much better levels than this.

Fixed errors	Nominal beam angle	Beam angle effect	Sound Speed Var'n	Sound Speed error	Vertical Error	Percent of Depth	Horizontal displacement on seafloors sloping		
							1 deg	2.5 deg	7.6 deg
m	degrees	m	m/s	m/s	m	%	m	m	m
1	2	0.38	1.5	2.5	2.72	0.11	156	62	20
1	24	54.63	10	16.67	57.13	2.29	3274	1298	430
1	30	85.19	15	25	88.78	3.55	5088	2018	668

Table 5. *Values of horizontal displacement shown in Table 4 with the addition of the maximum allowed fixed error of ± 1m.*

How Can the Values Specified in S-44 Be Attained?

It is one thing to produce a standard, it is sometimes a different thing entirely to achieve that standard. Armed with the analysis of variable errors above, we can examine some of the constraints on sounders and how they relate to the standard.

Consider first the errors introduced by beam width. To achieve the total error allowed under S-44, there are maximum beam widths beyond which the geometry of the beam dictates that the standard cannot be met. If the sound speed is perfectly known, then in 25 m depth Spec Order requires a beam width of 13.6 degrees or less, Order One requires a beam width of 18.8 degrees or less, while Orders 2 and 3 require 24.6 degrees or less (as Order 3 will in 2500m of water). Now, imagine that beam width is not a factor, and that only a variation in sound speed will produce the variable error, an impossible situation of course, but an illustrative one. An error in sound speed

The planning task for any survey will have to expanded to deal with this. If the planner is reasonably sure that sound speed can be measured to a certain uncertainty, then the maximum beam width can be calculated. Conversely, if the sounder is not alterable, the uncertainty to which sound speed must be measured can be calculated.

Possible Improvements Through the Use of Multibeam Data

Most of the continental Slopes of the world are covered by legacy data, primarily individual tracks, collected over many years. Very little of it is MBES. Coastal States may wish to conduct MBES surveys for UNCLOS purposes, and this paper has shown that in terms of uncertainty, this offers certain advantages.

The use of MBES in continental shelf delineation has been described extensively by Hughes Clarke, 2000, who concludes that MBES can "markedly improve the exact location of the 2500m contour" and that "local absolute maximum protrusions of this discrete contour line can be identified".

These conclusions were tested for an area off New Jersey, USA, by Monahan and Mayer, 1999, who combined contours derived from ETOPO5, the Predicted (Satellite) Bathymetry from NOAA, the GEBCO contours and the 2500m contour from a multibeam survey undertaken for the USGS. They measured the horizontal distances between the contours and found that they occupied a corridor approximately 10 km wide, a value that corresponds well with the horizontal uncertainties shown in Table 1. The MBES-derived contour wove itself through this zone of uncertainty, occasionally, perhaps 5% of the time, "protruding" landward or seaward from the zone. These could contribute to the outer limits by producing a 2500m contour (from which 100 nautical miles will be measured) that could be hundreds of metres to several kilometres seawards from the contours that conform to S-44.

Summary

The 2500m contour plus 100 nautical miles will be used as the boundary of a number of Coastal States. Although the UN Guidelines require only that the contour meet IHO S-44, with uncertainty measured in kilometres, careful hydrographic work with MBES can reduce this uncertainty to hundreds of metres. To do so, hydrographers will have to realign and refine some of their existing knowledge and skills, and will thereby return to their historic roots in the times when hydrography was discovering and refining the boundaries of what was known of the world.

Acknowledgements

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About the Author

Dave Monahan is Director, Ocean Mapping, Canadian Hydrographic Service, Ottawa. A graduate of Dalhousie and Carleton Universities, he has been involved in mapping the oceans for more than thirty years. He worked in large and small companies, universities and a provincial government before becoming a "fed". This year he is on a special assignment to develop Canada's claim over the continental shelf under the United Nations Convention on Law of the Sea (UNCLOS). To prepare the best claim possible, he has relocated to the Ocean Mapping Group at the University of New Brunswick, where the claim has already benefited from the expertise of various faculty members. Outside the University, Fredericton offers a great deal of relevant expertise: for example, Dave is working with CARIS to develop software useful to other nations working on their Law of the Sea claims.

David Monahan
Canadian Hydrographic Service
615 Booth St, Ottawa, Ontario, Canada, KIA 0E6
Email: monahand@dfo-mpo.gc.ca

A multi-disciplinary, multi-agency, multi-beam survey of Georgia Basin

by Rob Hare, Ernie Sargent, Kalman Czotter, Neil Sutherland (Canadian Hydrographic Service)
David Mosher and Vaughn Barrie (Geological Survey of Canada)

Bachground

Georgia Basin, consisting of the Strait of Georgia (Figure 1) and eastern Juan de Fuca Strait (Figure 2), is surrounded by the largest coastal population and development growth in Canada and lies within the most seismically active zone in Canada. It sustains a vital fishery, contains a number of ocean disposal sites and sewage outfalls, and is an area of hydrocarbon exploration interest. The rate of development in the basin continues to increase.

Of particular concern is the Fraser River Delta adjacent to the Southern Strait of Georgia, encompassing greater Vancouver and the associated ferry terminals, port facilities and crucial electrical transmission and communication cable corridors to Vancouver Island. In addition, recent geophysical surveys have delineated active faults within the basin, yet the response of the basin to a major earthquake remains largely unknown. The submarine and coastal portions of this Basin are thus subject to both large development pressures and natural geologic hazards.

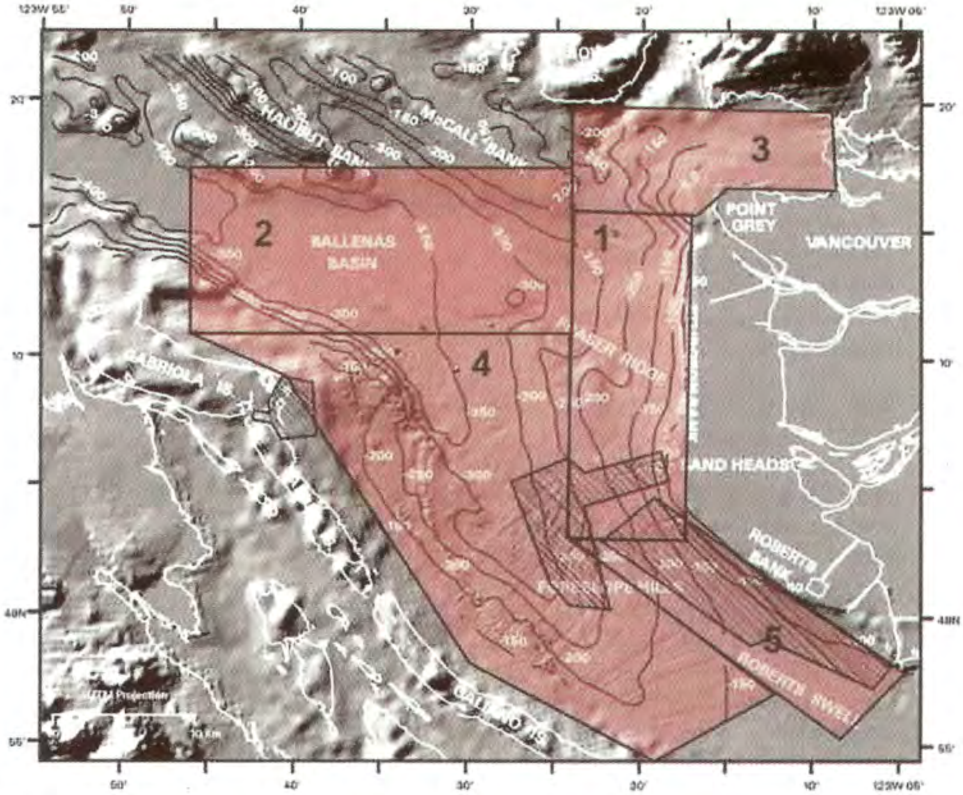
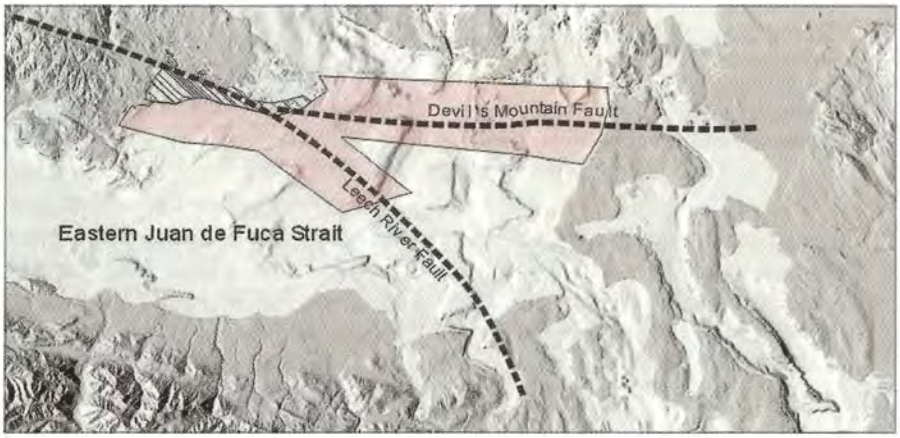


Figure 1 - *Southern Strait of Georgia showing 5 priority survey areas for 2000.*

Submarine slope failure and coastal erosion are the two critical hazards for Georgia Basin. The fundamental foundation to undertake hazard research is to have high-resolution digital bathymetric data as can be provided by modern multibeam echosounders (MBES). This data will greatly aid in the identification of areas of slope instability and surface faulting and provide the framework for further studies using geophysical and sediment characterisation techniques, e.g. using acoustic seabed classification (ASC) technology.

Figure 2 – *Eastern Juan de Fuca Strait, Southeast of Victoria, showing fault zones.*



To help safeguard the population, protect existing and future development, and effectively manage the resources and future utilization of the Basin, the Geological Survey of Canada (GSC) of Natural Resources Canada (NRCAN) has initiated a multi-year program – the Georgia Basin Geohazards Initiative.

For year 2000 surveys, six priority areas were identified: the Eastern part of Juan de Fuca Strait (Figure 2) and five priority areas in the Southern Strait of Georgia (Figure 1). It was estimated that sixteen days would be needed to survey the five areas in the Strait of Georgia based on a 24-hour operational profile, a sounding speed of 10 knots, four-times water depth swath width and 100% swath overlap. The planned survey program will extend over three years in order to complete the survey of Central and Northern Strait of Georgia. Other areas of interest are the regions surrounding the major population centres (Victoria, Nanaimo, Vancouver) and the Southern Gulf Islands.

Figure 3 *- R.B. YOUNG (EM1002) alongside at IOS*

Vessel Name	CCGS R.B. YOUNG (Figure 3)
Built	1990 - Allied Shipyard, Vancouver, B.C.
Crewing	Staffed on the lay-day system with single crew. Crew change every 28 days, therefore 28 days on: 28 days out of service (OOS) with at least two days lost per cruise for start-up and OOS preparation
Operational profile	Capable of 24-hour operations with crew of 7 although reduced to daylight hours only in Georgia Basin due to volume of vessel traffic and floating debris
Length	32.3 m
Breadth	8 m
Draft	2.3 m (3.2 m with EM1002 transducer deployed on ram)
Crew	7
Scientific staff	3
Max. Speed	11.6 knots
Cruising Speed	10 knots (typical sounding speed in Georgia Basin was 8 knots)
Lifting/Cargo Gear	1 aft deck crane

Table 1 *- R.B. YOUNG vessel characteristics*

The Canadian Hydrographic Service (CHS) had several requirements for this project in its initial year. Historic surveys in the Southern Strait of Georgia are based on Minifix positioning, with depths obtained by single-beam echosounders and field sheets drafted manually in the 1960s at a scale of 1:30,000. Artifacts of data collection are clearly evident in Figure 1. While there is no immediate need for multibeam (MB) data in Georgia Basin for nautical charting purposes, the data is far superior to any of the existing surveys. The positional accuracy, target resolution and seabed coverage of MB data has many more applications than just nautical charting.

The newly installed Kongsberg-Simrad EM1002 on the Canadian Coast Guard (CCG) ship R.B. YOUNG needed some projects in order to shakedown the system and to find and solve any start-up problems. Georgia Basin being close to the CHS base of operations at the Institute of Ocean Sciences (IOS) in Patricia Bay allowed the vessel to stay close to home and much-needed technical support in this initial work. In addition, the R.B. YOUNG had been out of service since 1996 so start-up problems with the ship were to be expected. As the vessel was not funded by CHS A-base, project partners were required in order to mobilize a survey.

Project Partners

- GSC, Pacific (GSC-P), NRCAN
- CHS, Fisheries and Oceans Canada (DFO)
- Oceans Directorate, DFO
- Parks Canada Heritage (PCH)
- Public Works and Government Services Canada (PWGSC)
- Department of National Defense (DND), Acoustic Data Analysis Centre (ADAC) Pacific
- CCG, DFO
- Environment Canada (EC)
- National Ocean Service (NOS) of National Oceanic and Atmospheric Administration (NOAA), USA.
- US Geological Survey (USGS)

Other Sectors of DFO are now beginning to show interest in some of the data collected to date, including Stock Assessment Division (STAD) and Marine Environment and Habitat Science (MEHS).

Platforms

Two survey platforms were deployed to carry out MB surveys in 2000: the R.B. YOUNG (Table 1 and Figure 3) and the REVISOR (Table 2 and Figure 4).

Figure 4 - *REVISOR (EM3000) survey in progress (shapes displayed) in Patricia Bay*

Vessel Name	CCGS REVISOR (Figure 4)
Built	1967 - Canoe Cove modified, Victoria, B.C.
Operational profile	Daylight hours operation only
Length	12.2 m
Draft	0.7 m (EM3000S transducer installed in keel)
Crew	1
Scientific staff	2
Max. Speed	12 knots
Cruising Speed	8 knots
Seaworthiness	Limited endurance and seaworthiness
Winch capabilities	Limited towing and winch capabilities

Table 2 - *REVISOR vessel characteristics*

EQUIPMENT

a) KONGSBERG-SIMRAD EM1002 mid-water (95kHz) MBES (R.B. YOUNG)
b) Ram and mechanical pitch stabilization for EM1002 transducer (R.B. YOUNG)
c) KONGSBERG-SIMRAD EM3000 shallow-water (300 kHz) MBES (REVISOR)
d) APPLANIX POS/MV 320 v3 position and attitude sensor (R.B. YOUNG)
e) APPLANIX POS/MV 320 v2 position and attitude sensor (REVISOR)
f) QTCView 38 kHz bottom classification system (R.B. YOUNG)
g) QTCView 200 kHz bottom classification system (REVISOR)
h) Gem System Overhauser towed Magnetometer
i) AML Smart Sensor
j) AML SVP-16 sound speed profiler

OBJECTIVES

Natural Resources Canada

The GSC-P cruise objective was to collect complete MB bathymetric coverage, QTCView single-beam ASC data, and magnetics to provide the baseline data in Georgia Basin necessary to help address the following issues:

a) Sediment distribution and dynamics of the Fraser River delta system.
b) Stability of the near-shore marine sediments.
c) Behaviour of sediments under seismic shaking.
d) Tsunami potential of the area from earthquakes and submarine landslides.
e) Sea level history and coastal response, and how this pertains to climate change and anticipated sea level rise.
f) Neotectonic history of the basin including evidence of active faulting to address seismogenic potential.

Fisheries and Oceans Canada

CHS is interested in up-to-date, accurate and complete MB bathymetry in Georgia Basin for modern nautical charting and safety of navigation requirements. Oceans Directorate is interested in development of a SEAMAP[1] strategy for the West Coast of Canada and the creation of Marine Protected Areas (MPA). CCG are the owners and operators of the two platforms with the EM systems that are owned by CHS.

Parks Canada Heritage

PCH has a proposed National Marine Conservation Area (NCMA) in the Gulf Islands, adjacent to Georgia Basin.

Public Works and Government Services Canada

PWGSC needs MB and ASC data along the Steveston Jetty, where the main arm of the Fraser River empties into the Strait of Georgia, in order to determine the condition of the Jetty and estimate the cost of maintenance and possible upgrade.

Department of National Defence

ADAC Pacific Route Survey has classified Q-Routes requiring precise MB bathymetry throughout Georgia Basin and will release the bathymetry for unclassified purposes once a sufficient data set has been collected such that the Q-Routes cannot be identified by the location of the data.

1 In order for the federal government to have access to the data needed for the effective integrated management of marine resources, it is proposed that a long-term, systematic and interdisciplinary program of seabed mapping, called SEAMAP, be designed and undertaken with federal leadership. (GSC-A et al., 1999)

Environment Canada

EC monitors a number of ocean dumpsites in Georgia Basin and is interested in the impact of these sites on the environment. QTCView ASC data and MB Bathymetry are required at dumpsites located off Point Grey, Porlier Pass, Victoria, Sand Heads, Nanaimo and in Haro Strait.

American Agencies

Both NOS and USGS are interested in Georgia Basin data in US waters. CHS, NOS and Oceans Directorate collaborated on a survey of Admiralty Inlet, USA (Figure 5) using the R.B. YOUNG/ EM1002 in the fall of 2000. Further US waters surveys are planned for subsequent years.

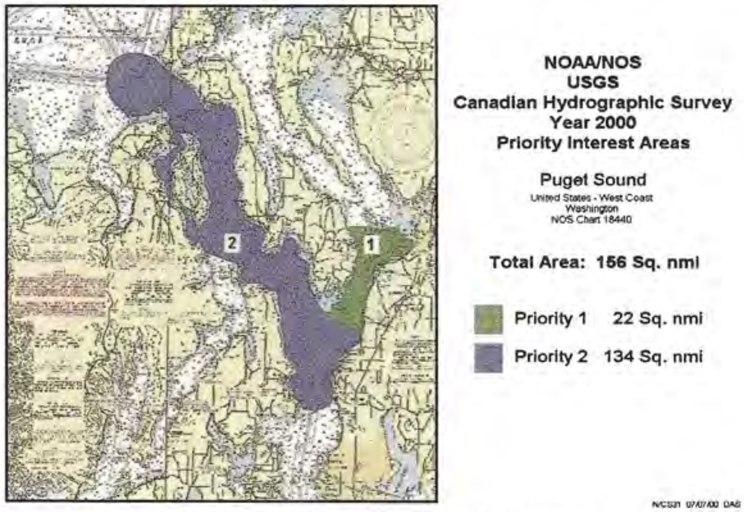


Figure 5 - NOAA Priority Areas in Admiralty Inlet, USA

Stn	Site ID	Range(m)	Reference Port	HW corr'n (min)	LW corr'n (min)	Record length (days)
7795	Point Atkinson	5.1				
7635	Point Grey	5.1	Pt. Atkinson	+7	+4	369
7594	Sand Heads	4.9	Pt. Atkinson	-7	-7	147
7590	Tsawwassen	4.7	Pt. Atkinson	+1	-13	369
7532	Whaler Bay	4.7	Pt. Atkinson	+13	+1	369
7550	Silva Bay	4.9	Pt. Atkinson	+5	+4	369
7917	Nanaimo	5.2	Pt. Atkinson	+3	+4	369
7510	Tumbo Island	4.3	Pt. Atkinson	+13	-5	362

Table 3 - Summary of Tidal station details in the Strait of Georgia

LOGISTICS

Positioning

Most of British Columbia is well served by broadcast Differential GPS (DGPS) corrections. In marine areas, these corrections are available free of charge from four CCG Marine Radio Beacon sites, the closest station being in Richmond, on the Fraser River delta. Because these corrections are broadcast on medium frequency (about 300 kHz) the data rate of corrections is low (200 bps max.) DGPS corrections are also available over an MSAT communication data link using the BC Provincial government Global Surveyor service at 4800 baud. There is a nominal charge to rent the MSAT correction receivers, but the coverage is province-wide[2] and the positioning accuracy is marginally better. There are two reference stations, one at Terrace for the northern part of the province, and one at Williams Lake, which serves the southern part of the province, including Georgia Basin. For this project, the latter service was chosen due to the improved positioning accuracy.

Future surveys in this area may be served by high-data-rate real-time kinematic (RTK) correction services. Two such reference stations are now in place on southern Vancouver Island, which serve Victoria and the southern Gulf Islands. Each station broadcasts on UHF and covers a radius of about 15 km.

Tides in the Strait of Georgia

From Point Atkinson in the North to Tumbo Island in the South the tide range changes from 5.1 to 4.3 metres (Table 3). This range difference North to South combined with East to West cross-strait differences makes Georgia Basin a relatively complex tidal regime. To facilitate sounding in set geographic areas, a set of zones was created using both observed and predicted tides. The boundaries for these zones (Figure 6) were determined through comparison of tidal height and time differences between the available stations. Historical stations were selected based on proximity, record length and accuracy of tidal constituents.

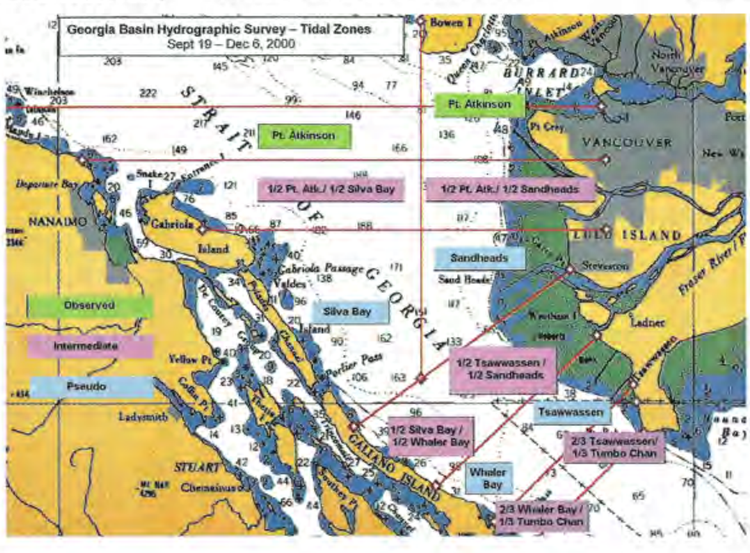


Figure 6 - Tide Zones in the Strait of Georgia

2 Due to the low elevation angle of the geostationary MSAT satellites, corrections cannot be received on the South shore of steep-sided inlets.

Of the 8 stations listed in Table 3, only Point Atkinson and Nanaimo provide observed tides. Tides at all other stations are predicted. Tides from the Nanaimo gauge were not used due to the gauge being located in a somewhat restricted tidal zone. Where applicable, observed tides were applied directly to the measured soundings. In other zones, tides based on both observed and predicted tides were used. Where a zone contains a tidal station but no observed tides, pseudo-tides have been created. Where a zone contains no tidal station, an intermediate tidal station has been created that contains a blend of observed and predicted tides.

Pseudo-tides are calculated by applying observed-predicted differences (residuals) from one station (observed) to predictions at a second station (pseudo). The process is somewhat analogous to DGPS in that a residual at a reference station is applied to correct data at a remote station. Accuracy of these calculated tides depends on a number of factors such as the number of available constituent sets used in the predictions, geographical proximity to the observed station and the severity of meteorological conditions in the area. As well, the tidal signal at both the observed and predicted station must be of the same signal type, e.g. mixed semi-diurnal. Pseudo-tides were mathematically created using CHS Pacific Region Tide-Master software. Pseudo-tides are superior to regular predictions because they account for atmospheric effects such as barometric pressure and wind forcing as seen at the observed tidal station. These values should not be used, however, when validated observed tides are available. Pseudo tides were calculated for Sandheads, Silva Bay, Whaler Bay and Tsawwassen.

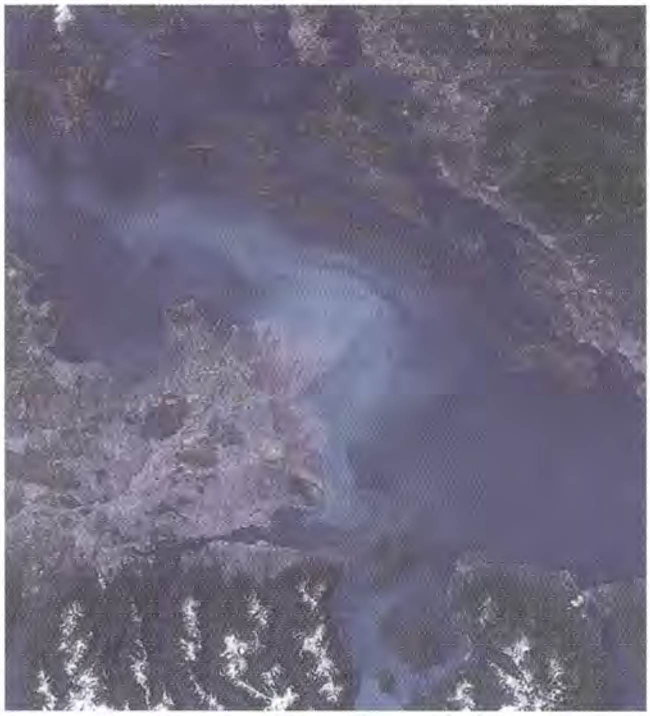


***Figure* 7** *- False-colour satellite image[3] of Fraser River plume in Southern Strait of Georgia.*

[3] NASA image courtesy of Jim Gower, Ocean Science and Productivity Division, Institute of Ocean Sciences

Zones that fall geographically between tidal stations cannot be represented by either station, but instead are accurately represented by a weighted combination of the two. Intermediate station tides were calculated by applying a *weighting* factor to the tides at adjacent tidal stations. The tide range and distance between the controlling stations was used to determine the number of intermediate tide zones necessary and the percentage of tide to apply from each station.

Sound speed profiling

Sound speed profiling is a critical component to successful MB sounding. The Fraser River delta front is one of the worst areas in the world for rapid spatial and temporal sound speed variation (Figure 7). The water column is very strongly stratified and changes significantly due to the discharge of fresh water from the Fraser River, prevailing wind speed and direction, tidal currents and the distance from the river mouth. While the preferred solution would have been to sample sound speed while underway by using Moving Vessel Profiler (MVP) technology, the high cost prevented its purchase this year. Instead, much time was lost with the vessel stopped to take sound speed casts. On the second Georgia Basin patrol, another approach was taken, which involved using an additional vessel (REVISOR) to take sound speed profiles ahead of the sounding vessel (R.B. YOUNG). This method has added costs and complexity – additional vessel, coxswain, two hydrographers and digital cellular communications to the sounding vessel.

OPERATIONS

1999-2000 REVISOR

Prior to the formal definition of the multi-year Georgia Basin project that commenced in 2000, the REVISOR undertook a number of smaller related projects. In 1999, two proposed Marine Protected Areas (MPA) were surveyed for Oceans Directorate: Race Rocks and Gabriola Passage. In addition, an area off Trial Island was surveyed for GSC which is thought to have the largest underwater sandwaves in the world, some 20 metres high (Figure 8).

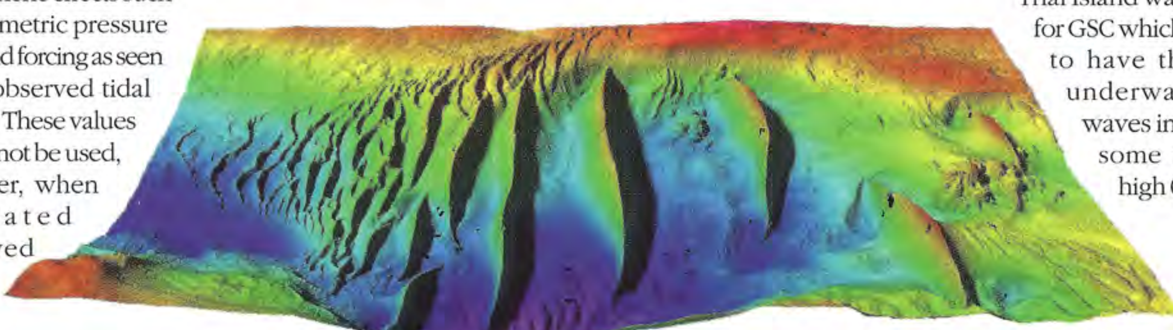


Figure 8 *- Sun-illuminated image of Trial Island sandwaves.*

Some of the other areas of MB surveys in Georgia Basin in the past few years include: Esquimalt and Victoria Harbours, Nanoose and Pedder Bays, approaches to Sidney and Comox. In 2000, the REVISOR also surveyed in the Strait of Georgia in the areas of Steveston Jetty and off Point Grey during the second R.B. YOUNG Georgia Basin patrol.

2000 R.B. YOUNG

The R.B. YOUNG spent the greater part of three 28-day patrols in Georgia Basin in 2000. The first patrol was the maiden voyage of the R.B. YOUNG with its new EM1002 MBES. Unseasonably poor weather conditions provided an opportunity to determine the system's maximum sea-state parameters for the collection of useable data. This shake-down cruise also provided the opportunity to correct some major ship defects in the shaft cooling system and steering system while in local waters. Allied Shipbuilders Ltd., located in North Vancouver, built the ship and recently installed the EM1002 MBES and mechanical ram. This facility is one of the few shipyards on the BC coast that can accommodate the R.B. YOUNG's unique bottom characteristics. Good use was made of this facility on two occasions in 2000.

MB bathymetric data, with intermittent magnetic data and some ASC data were obtained in eastern Juan de Fuca Strait. Complete MB bathymetric and ASC data in GSC Priority Area 1 in the Strait of Georgia was also completed. The magnetometer failed during this portion of the cruise. Due to significant sound speed artifacts encountered during the patrol, June being a time of maximum Fraser River freshet, GSC Priority Area 1 was resounded during the second Georgia Basin patrol.

A patrol is supposed to consist of 28 operational days but this was definitely not the case on the first patrol. The first patrol was reduced by 7 days due to crewing problems. The R.B. YOUNG was suitable for sounding operations for a total of only 8 ˚ days of the remaining 21 days. Twelve and a half days were lost to safety inspections, fuelling, compass adjustment, repairs to steering and shaft cooling systems and transit to and from Allied Shipyards. In addition, each patrol loses at least a day at either end to bring systems back on line and to prepare for the OOS period.

On the second Georgia Basin patrol, an average 11-hour day included time spent taking sound speed profiles. About two hours per day were lost to sound speed profiling. Ship speed was reduced from an initial 8 knots to 3 knots to maintain 1-metre ping spacing. Swath coverage was subsequently reduced to less than 3 times water depth in order to increase ping rate. Two and a half hours were spent daily in transit to and from the work area. 472 person hours were spent processing data, compared to about 167 hours total data collection time (about a 3 to 1 ratio). The REVISOR was also used to collect sound speed profiles ahead of the ship due to the lack of an MVP, an instrument that allows sound speed profiling of the water column while underway. GSC Priority Area 2 was surveyed and GSC Priority Area 1 was resurveyed for the reasons mentioned above.

On the third Georgia Basin patrol, half the survey time (about 10 days) was spent on a MB Survey of Admiralty Inlet (Puget Sound). No QTCView ASC data was collected during this survey. All of NOAA Priority Area 1 and the Southern 20% of NOAA Priority Area 2 (Figure 5) were completed during this phase of the work.

The remainder (11 days) of the third Georgia Basin patrol was spent on the MB and ASC survey in the Southern Strait of Georgia. A survey speed of 8 knots was once again used to collect data despite the loss of resolution. Three days of the patrol were lost for CSI inspection and in preparation for the long-term lay-up of the ship. One day was lost when the ship struck a deadhead off Howe Sound, forcing a stopover in Ganges to realign the MB transducer and recalibrate the MB system. GSC Priority Area 3 and about half of Priority Area 4 were surveyed during this final patrol of 2000.

RESULTS

From the initial MB data collection for the Southern Strait of Georgia new insights have already been gained into issues that may be of concern. An example is the Foreslope Hills (Figure 9) in the central basin. These features are far more extensive than previously known and are considered to be the result of one or a combination of three mechanisms:

1) a mass failure,
2) *in-situ* rotational displacement and/or
3) migrating sediment waves generated by turbidity currents (Mosher and Hamilton, 1998).

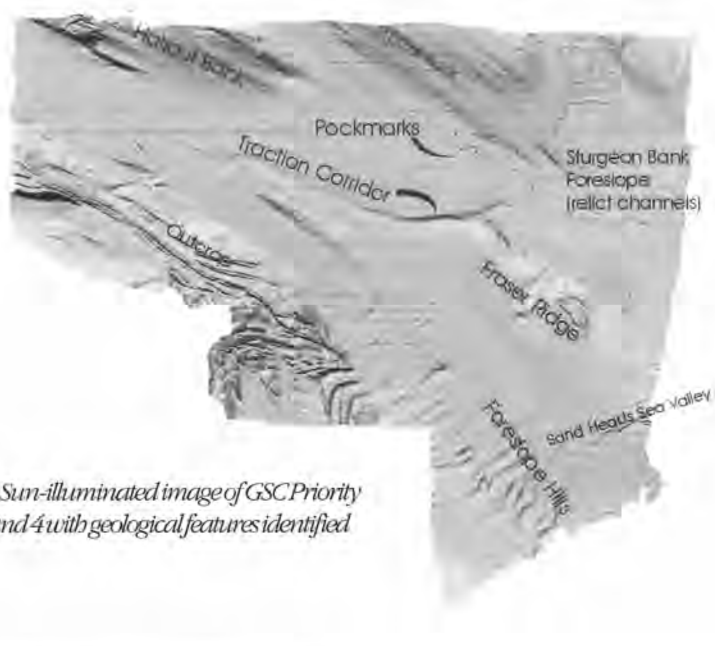


Figure 9 *– Sun-illuminated image of GSC Priority Areas 1, 2 and 4 with geological features identified*

North of the Foreslope Hills is a lineation of pockmarks, gas escape features, that extend for several kilometres in a northwesterly-southeasterly direction with depths into the seabed of up to 15m. These features may relate to the underlying geology, but could also identify gas release related to structural tends in this area of recent earthquakes (Cassidy et al., 2000). Magnetometer data collected simultaneously with the MB data will help to further define potential active faulting.

The traction corridor seen in Figure 9 is a sedimentary channel (i.e. a channel that sediment is transported down). In seismics you can actually see the levees. It may be relict, but it is still well pronounced on the seafloor. The source of sediment is not well understood and it seems to start on the Fraser Ridge. The Fraser Ridge is Pleistocene till, as are Halibut and McCall Banks. It is interesting that the glacial striae (i.e. the gouges made by the glaciers as they swept over and formed the banks) seem to be still present, giving those NW-SE lineations.

Throughout the Holocene, the river-dominated Fraser Delta has prograded by continuous channel switching and avulsion into the Southern Strait of Georgia, as can be seen from the MB images on Sturgeon Bank. However, at the beginning of the 20th century the delta was modified to provide a navigable channel and port facilities for the city of Vancouver. Two causeways to the south of the main channel and one to the north that cross the intertidal zone to the delta foreslope act as barriers to the dominant northward sediment transport causing estuarine and localized seabed erosion. An eroded distributary channel failure complex has been exposed on the delta foreslope, off the southern causeways, by flood tidal flows that scour the seabed and form northward migrating subaqueous dunes, further increasing the delta slope (Barrie, 2000). This, combined with slow sea level rise and seismicity, intensifies the risk of further erosion and instability of the delta, particularly along the subaqueous delta front and the intertidal estuaries. Future MB surveys will complete the coverage for the Southern Strait of Georgia and the upper delta slope. These surveys will provide the needed base data to address the critical issues of erosion and slope stability.

***Figure 10** - EM1002 transducer after first impact: missing piece of cowling (ship in drydock)*

From a CHS perspective, modern bathymetry has been collected in Georgia Basin, which can be used to replace the existing analogue sources from the 1960s. In addition, the R.B. YOUNG, a vessel for which there was no A-base funding in the DFO Science budget, was used for four patrols.

Add to this that ADAC Pacific Route Survey were able to successfully survey their Q-Routes through the basin (the data is presently classified), several dumpsites were surveyed for EC and Steveston Jetty was surveyed for PWGSC using MB and ASC technology.

DISCUSSION

Ship Issues

The R.B. YOUNG has, as experienced during the Kongsberg-Simrad EM1002 Sea Acceptance Trials, a serious acoustic noise problem in moderate to high seastates (4 and above). Bubbles created at the bow by excessive vessel pitching are washed down over the transducer array. Short steep waves, as were encountered in Juan de Fuca Strait in June, exacerbate this problem.

Noisier data means more time spent in data processing. The data can be totally unusable if the noise is severe. The EM1002 acoustic backscatter data collected during these conditions is unusable. The data must be reacquired in better conditions. To obtain reasonable data, the operational seastate for this platform seems to be when wave heights are less than two metres. A more stable vessel that can operate in more adverse seastates would be very desirable as an EM1002 platform.

On several occasions (at least three and possibly four or more times) in the Southern Strait of Georgia, floating debris, probably deadheads, impacted the transducer while the ram was deployed. These events caused the transducer-ram assembly to twist (as much as 12.5°) and broke off pieces of the protective cowling on the forward edge of the transducer (Figure 10 and Figure 11). Damage to the transducer cowling might introduce transducer reception problems from increased turbulence or long-term damage if water starts seeping in under the transducer staves.

However, the ram does appear to be robust and will sustain a gentle knock now and then. Fiducial marks have been placed on the ram in the forward compartment in order to view how seriously the ram has twisted after these events. This allows the operators to twist the ram and transducer fairly close to its proper position. However, this results in a lost day for recalibration after each event. It has also meant more work for divers after each patrol to inspect the transducer for damage and misalignment.

Figure 11 - EM1002 transducer after second impact shows missing cowling, wood fibres and calibration marks on the hull (underwater photo taken by divers)

Fiducial marks have also been placed on the sides of the transducer well on the bottom of the hull (Figure 11) so the divers can line up the transducer externally. Floating debris will continue to be a problem because of the shallow draft and flat bottom of the R.B. YOUNG. The ship needs to have a debris deflector installed in front of the transducer well to minimize this risk. Expert advice is sought for the design of this deflector, such that it does not adversely affect transducer and ship performance. In particular, should protection be installed to merely deflect debris (e.g. a skeg), or to stop it (e.g. a grate)? Should debris become jammed in between the transducer and the deflector, is the servo motor protected (e.g. by a breaker)?

The ship's reverse osmosis (water making) system is not currently working, resulting in the need to make port for water every 2 days. In Puget Sound, the ship was not allowed to pump the black and gray water overboard. The onboard treatment system used so much water to process the waste that water stops were required every day.

Crewing and Logistical Issues

Prior to the first patrol, CHS had the expectation that the ship would be able to sound on a 24-hour basis. Negotiation with Coast Guard in the project planning stages indicated that the only requirement to change from a 12 to a 24-hour operational profile was the addition of a second engineer. This addition to the ship's complement reduced the available berth space for scientific staff by two (loss of a 2-berth cabin), without any accompanying increase in operational hours.

In addition, time (2 to 2 ˚ hours) is lost in transit to and from the work area on a daily basis when operating the daylight-hours-only profile. The ship cannot work a 24-hour day in Georgia Basin, partly because of the problem of floating debris (mostly deadheads) coming from the Fraser River and Howe Sound and partly because of the accommodation limitations of the ship. A 16-hour day may be workable during the summer months due to the increased number of daylight hours. Winter working hours are greatly reduced, thus making the vessel less of a bargain. In the Southern Strait of Georgia it is possible to run lines such that, at the end of the day, there is a nearby place to tie up. In subsequent years of this project, surveying in the Northern Strait of Georgia will be required. More time will be lost in transit in this area because of the increased distance to suitable facilities.

The R.B. YOUNG/EM1002 has for the most part been used in year 2000 as a very large sounding launch. Because of this she requires a captain and mate with line-running skills. Such was the case this year with Captain Stuart Aldridge and his crew. His wide-ranging experience from deep-sea work through to buoy tending greatly assisted the planning and day-to-day activities of the ship. Wherever possible, the Captain tied the ship up at a float instead of a wharf to minimize the need for a gangway.

Figure 12 – Kal Czotter readying the SVP on the aft deck of the R.B. YOUNG

A typical shallow-water cast (100 metres) took 1 hour and required three personnel on the aft deck. If more than two casts per day are needed, the available time for sounding is seriously affected. Performing the initial cast before daylight increased the time available for sounding. The number of personnel and amount of time required to deploy and recover scientific instruments over the side, such as the sound speed profiler, is an area of concern. One crew member operated the winch, another kept the bridge informed on the location of the SVP and wire angle with a VHF radio, and a member of the scientific staff deployed and recovered the instrument (Figure 12). With the proper training, the scientific staff member should be able to deploy and recover the instrument as well as inform the bridge with the radio. This would reduce the required number of aft-deck personnel to two. A voice-activated, hands-free headset would make this easier.

An MVP (see capabilities of MVP technology in Figure 13) could significantly reduce the one-hour time period needed per SVP cast. As it was, the REVISOR was used to take static sound speed casts ahead of the R.B. YOUNG in GSC Priority Area 1, off the mouth of the Fraser River.

Multibeam Issues

The Kongsberg-Simrad EM1002 data collection and USL CARIS data processing systems worked well, after a few initial problems. There are still, however, a few system improvements that could optimize data collection performance.

The nadir beam depth automatically determines the ping-rate of the swath. The only way to increase the ping rate is to reduce the swath width. This problem seems to be caused by the larger processing overhead required by the outer beams.

Manual intervention is required at about 120 metres water depth or the system stays in medium depth mode and starts to lose some of the outer beams. The system has to be forced to deep mode and then returned to automatic mode once the depth returns to less than 120 metres.

The ram's automatic mechanical pitch stabilizer does not report the pitch angle or inform the operator when it reaches the limit angle of maximum pitch. This nearly caused the loss of a day's data when the pitch stabilizer became locked in the limit position without informing the operator.

Sound speed profiling proved to be a problem as expected. The Fraser River plume is subject to rapid spatial and temporal sound speed variation. The Kongsberg-Simrad acquisition system needs the correct sound speed profiles prior to collecting the data in order to compute true depth and position. Correcting the depths for sound speed errors in post mission using CARIS processing software is now possible with the version 5.1 release.

Other Issues

The QTCView ASC system was unable to track the bottom during the Juan de Fuca Strait portion of the survey. The manufacturer was contacted and a software upgrade was installed during the first patrol. This upgrade seemed to cure the problem and the system worked very well for the rest of the patrol and on subsequent patrols.

The Gem System Overhauser Magnetometer instrument worked well until the weather became rough during the Juan de Fuca Strait portion of the first patrol. The system then failed intermittently. The connectivity between the fish and the electronic acquisition system on the ship seemed to fail during the irregular tugging when in rougher sea states (2-metre chop). The faults became more regular during the Georgia Basin portion of the first patrol and, after numerous attempts to fix it were unsuccessful, its use was discontinued. During the second Georgia Basin patrol, the magnetometer worked flawlessly. Unfortunately, the unit was damaged aboard a CCGS JOHN P. TULLY scientific cruise and it was not used during the last R.B. YOUNG patrol.

During the Juan de Fuca Strait portion of the survey, a few intermittent artifacts were discovered. Careful analysis revealed that these errors were caused by faults in the sensor that measures the sound speed at the EM1002 transducer face. The AML Smart Sensor was occasionally displaying multiple sound speed values 100 m/sec faster than the correct value. The manu-

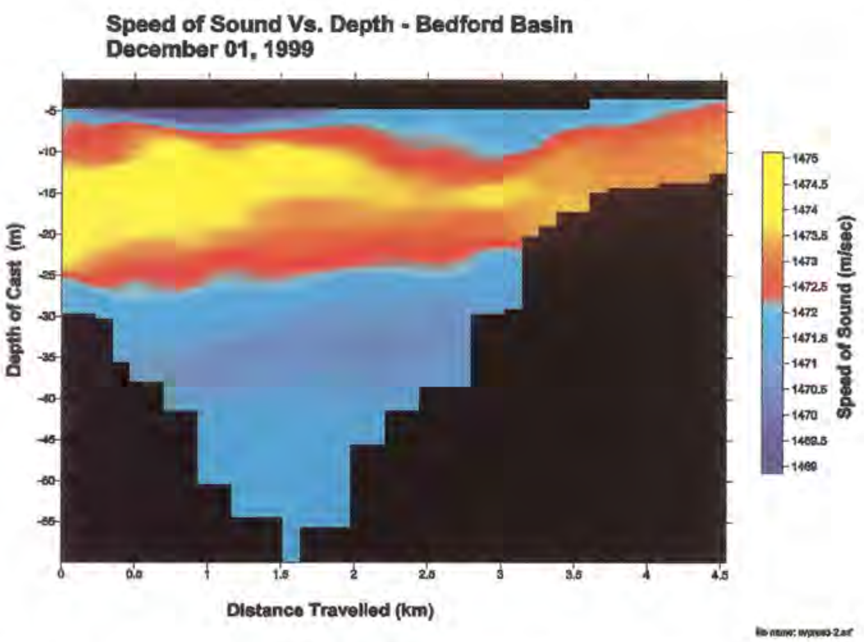


Figure 13 – 2-D sound speed profile from MVP-30 in Bedford Basin, Halifax, NS

There were no days lost due to weather. However, adverse weather conditions severely hampered operations and greatly reduced the quality of the MB data collected, particularly during the first patrol in June. The last patrol, which extended into the first week in December, was blessed with unseasonably good weather. This is not normally the case, so sounding operations with the R.B. YOUNG should be scheduled from May to September, if at all possible, for the reasons mentioned above.

RECOMMENDATIONS

Multibeam Echosounder System

1. Increase the ping rate without sacrificing swath width. We were forced to reduce angular coverage to 55º (less than 3 times water depth) in order to increase ping rate. Initial coverage estimates were based on 4 times water depth. Operational methodology was changed as a result – ship speed was maintained at 8 knots despite the fact that 1 metre sounding spacing on the seabed was not being achieved. Areas of interest must now be revisited at slower ship speed in order to get the required sounding spacing.
2. Improve sound speed profile uploading functionality. We need to be able to upload new sound speed profiles on-the-fly and switch profiles without losing data collection time. We also need an EM SVP format that includes position for areas of rapid spatial and temporal sound speed change.
3. Provide the operator with a visual display on the status of the ram, the pitch angle of transducer and other logged parameters for real-time QC of incoming data.
4. Move to NT operating system in order to minimize the number of computer platforms required and increase the workspace on board.
5. Merlin navigation software needs to be upgraded to accept BSB and S-57 formats for chart backdrops. This would provide the needed context for real-time data collection QC and more effective line planning.
6. Provide password protection (s/w lockout) to EM systems. We need a way to prevent the CCG crew and other (non-CHS) users from turning on, and potentially damaging, the MBES.
7. Backscatter calibration. The Georgia Basin project will require integration of ASC information from a number of sources, including MBES with different frequencies, single-beam ASC technology and possibly sidescan sonar mosaics.
8. Implement MVP technology (MVP-200 preferred). Currently we are spending about 2 hours daily (more in spatially or temporally dynamic sound speed areas such as the Fraser River delta front) taking sound speed casts (i.e. not sounding). In addition, REVISOR and two additional people were required just to take profiles in advance of the R.B. YOUNG in this area. More time could have been spent sounding in the shallower parts of Georgia Basin with the EM3000.

Platform

9. Install a deflector to protect the transducer ram assembly from damage due to surface debris (logs and deadheads).
10. If feasible, move to a 24-hour operational profile. Surveys of shorter duration (fewer operational days) with this profile will be far more efficient than the current scenario due to the amount of time lost in transit with the daylight-hours-only operational profile.
11. Restrict R.B. YOUNG operations to good-weather months only (May–September) in order to minimize bubble wash-down and other data collection problems and increase number of daylight hours should item 10 not be possible.

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Discovering Rocks off Labrador: A Photo Essay

by David H. Gray, Canadian Hydrographic Service, Ottawa, Canada

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Canada's Territorial Sea baselines were promulgated into Canadian law in the 1960's, 1970's and 1980's. The vastness and remoteness of much of the country have meant that there has been significant improvement in the knowledge of Canada's coastal area since their promulgation.

Islands have been found; islands have been proven not to exist.

Examples of the use of satellite imagery and airphotos used to verify charted information are given. The paper provides the geographic coordinates in a world-based geodetic coordinate system.

Introduction

Canada was one of the more active members of the Third United Nations Conference on the Law of the Sea, held at Geneva, New York and Caracas during the 1970's and early 1980's. Slowly, States ratified the Convention, and in November 1994, the United Nations Convention on the Law of the Sea came into force. Canada has some 10,000 km of coastal perimeter and has much at stake, since many of its resources, living and non-living, are located in or under the sea. However, much of this coast is rarely seen and its precise location and details of its features are poorly understood.

History

In 1964, Canada passed the *Territorial Sea and Fishing Zones Act* that provided for the use of straight baselines. In 1967, Order in Council, P.C. 1967-2025 defined the specific points for the straight baselines of Labrador and Newfoundland, also listed some low tide elevations and discrete islands. The Territorial Sea baselines for southern Canada are now defined in *Consolidated Regulations of Canada, 1978, chapter 1550*, commonly abbreviated: *CRC, 1978, c. 1550*. The baselines, low water line segments and individual rocks and islets in Arctic Canada were explicitly defined in domestic law by an Order in Council issued in 1986. Except for the changes caused by the *Canada/France arbitration* in 1992, there has been no further change to Canada's Territorial Sea.

Need to Redefine

In the Orders in Council, the turning points of the straight baselines of the territorial sea are listed with: a geographic name, a geographic position, and a referenced chart. The Canadian Hydrographic Service (CHS) interprets the turning point to be that physical feature, which can be found on that specific chart, at that specific location. On other charts and maps, that same feature may be at a different location; yet it is the physical feature that is being described. One does not need a 'rocket science' degree to look at some of Canada's nautical charts and to realise that the coast has been poorly surveyed. Indeed, there are several areas where there is a suspicion that the nautical chart omits rocks and islets that could influence the location of the territorial sea baseline (either the normal or straight line versions). The results in just one locality follow.

Islands Found & Not Found

Canada, quite literally, is still discovering its coastal extent. The Labrador coast is a case in point. Any shipping along the coast either stays well offshore or stays in the protected waters behind the fringe of islands and reefs. That fringe is laced with rock pinnacles that give little warning of their existence on the sounder, and navigation systems, until the advent of GPS, did not provide adequate positioning. The area outside the fringe is ice-covered or thickly strewn with icebergs, bergy bits, growlers, etc. It is a true application of the Norwegian word for *"fringe of reefs"* or "*rock rampart*" - *skjærgård*. Other meanings include "*collection of reefs and small islands*", or "*archipelago*". Mariners prefer not to enter that fringe area. Without the traffic, there is no need to chart; and without charts, no mariner is going to venture.

Unfortunately, the need to define Canada's Territorial Sea baselines demands that these areas be examined. Until recently, old charts have provided the only source. They have included individual, weakly-positioned lines of track soundings and reports of breakers, rocks and islands, so that the charts are speckled with: "*Reported*", "*Existence Doubtful*" (E.D.), "*Position Doubtful*" (P.D.), "*Position Approximate*" (P.A.).

A joint project, undertaken by the CHS and the Topographic Survey of Canada in 1976, discovered possible islands along the Labrador coast and provided some speculation that charted rocks might not be there. Later, field surveys proved the existence of several islands and some low tide elevations as were suspected. They also confirmed the non-existence of several charted features, including one island that was being used as a turning point in the straight baselines. [LeLievre & Fleming, 1977] One of the found islands has been officially named "*Landsat Island*" to honour the discovery method.

This sort of work was reinstated, under contract to Garry Hunter and Associates, to investigate three possible areas along the Labrador and Baffin Island coasts. Satellite imagery of various types as well as conventional airphotos were examined. The next stage was to carry out a hydrographic survey to positively identify these features and determine their heights. Such an opportunity presented itself in the summer of 1997, when the author searched for, examined, photographed and positioned over 40 rocks and islets along the northern Labrador coast, using the helicopter from the Canadian Coast Guard Ship (CCGS) PIERE RADISSON. It is the author's opinion that the straight baselines should be changed and many low tide elevations added to the definition of the territorial sea baselines. The other areas of Hunter's contract still require field verification.

Satellite Imagery

Because satellite imagery is recorded digitally as the response in various segments of the radio spectrum, ice and rock have different response signatures. These signatures can be used to identify features as rock or ice. However, this is not fool-proof since rocks can be ice covered and ice can be covered with gravel, picked up by an iceberg which has grounded and subsequently rolled over.

Another test can be the use of images taken on different days or years, since the rocks and islands will remain in the same place while the ice will likely have moved. Again, this is not fool-proof since it has been reported that a certain harbour entrance in the Baffin Island area has been totally blocked by a grounded iceberg for several years, thus denying the once per year delivery of provisions by ship.

Given the frequency that satellites overfly parts of the world, one would think that there would be plenty of opportunity to obtain hundreds of good images. This is not the case since clouds cover much of Labrador in summer and during the winters the sea is all ice-covered. The blue part of the visible spectrum is very susceptible to haze, and having breaking waves is better than a calm sea. There are few occasions when there are waves breaking, no clouds and no ice. Also, the cost of satellite imagery is horrendously expensive.

The capability to detect anything is obviously in proportion to its physical size. An

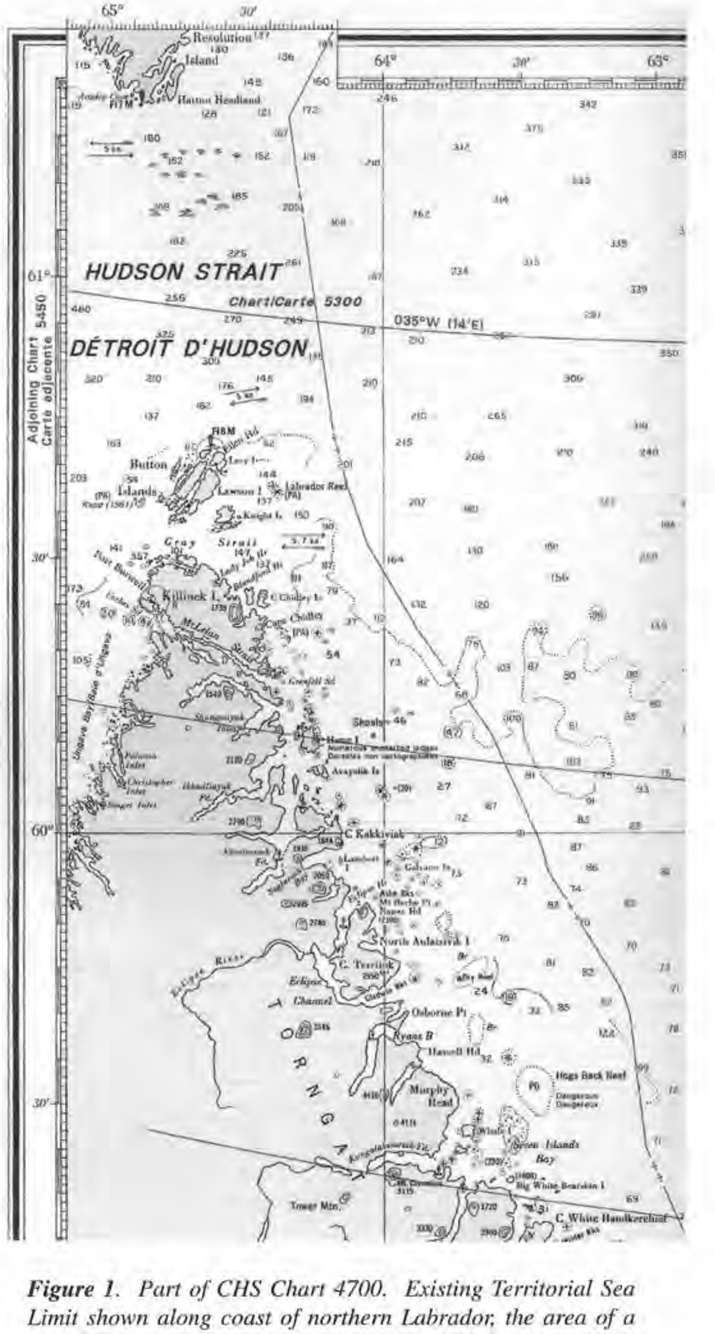

Figure 1. Part of CHS Chart 4700. Existing Territorial Sea Limit shown along coast of northern Labrador, the area of a recent re-examination. Landsat Island (60° 10'N, 64° 02'W) is east of Home Island.
Note that Labrador Reef (dries 2.7 m) was forgotten; the island that causes bulge at 59° 40'N has been proven not to exist.

object of less than one pixel in size will likely go undetected; something the size of one or two pixels may well be missed; and it may take an object the size of several pixels before identification is guaranteed. In 1976, Landsat Island was discovered by satellite imagery and hydrographic surveys in 1976 determined that it measured 45 by 25 metres. This gives some idea what is capable through satellite imagery.

Conclusion

This paper has endeavoured to provide the history behind Canada's existing territorial sea baselines and some insight into the work in re-examining them. Particular effort in that re-examination has been expended in: 1) the identification of the physical feature in hydrographic surveys, airphotos, satellite and other sources of imagery, 2) the correct position with respect to the most common horizontal datum in use in Canada; namely, the North American Datum 1983, or NAD 83 (which is equivalent to WGS 84).

Acknowledgments

The author wishes to acknowledge the assistance of the Captain, officers, crew and particularly the helicopter pilot of the CCGS PIERRE RADISSON in the fruitful field verification program carried out in 1997 along the Labrador Coast. Similar field verification programs are needed elsewhere in Canada to define the most seaward points of land.

Figure 2. *Unnamed rock east of Big White Bearskin Island (59° 21' 54"N, 63° 25' 22"W) as photographed and positioned by GPS in 1997. In 1973, this rock was also positioned by angles and distances of an electronic distance measurement traverse. It is 1.1 metres above high water.*

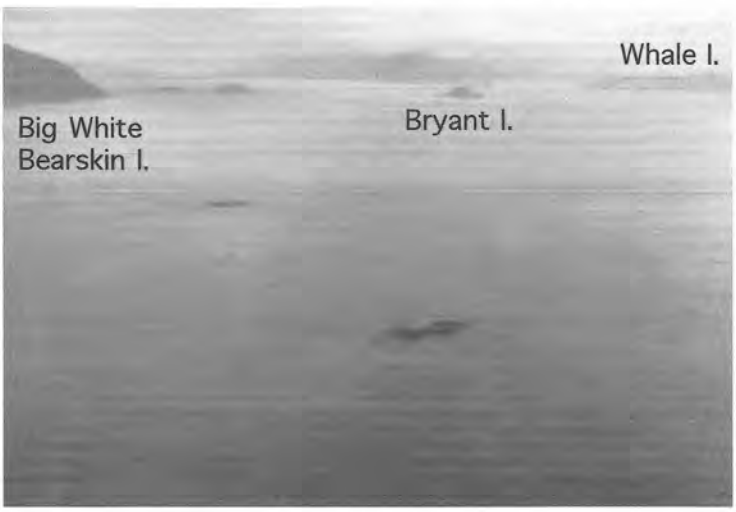

Figure 4. *Same rock as Figure 3. Because helicopter flight happened to occur near the time of low tide, the high water line is clearly visible in this photo. Note the white piece of flotsam on the rock that is also visible in Figure 3.*

Figure 3. *Unnamed rock east of Whale Island (59° 26' 52"N, 63° 28' 55"W) as photographed and positioned by GPS in 1997. It was charted 300 metres from where it was found, but was not identified in the aerial photography. It is estimated to be 2 metres above high water.*

Figure 5. *Three unnamed rocks east of Murphy Head. The westerly rock was seen in the airphotos and satellite imagery and had been surveyed as 1.9 m above low water. The northerly one was seen only in the airphotos. It is located at 59° 30' 30"N, 63° 31' 27"W and is 0.9 m above low water. The easterly rock was not seen in the airphotos or satellite images, but found during this survey to be at 59° 30' 17"N, 63° 31' 24"W and 1.2 m above low water.*

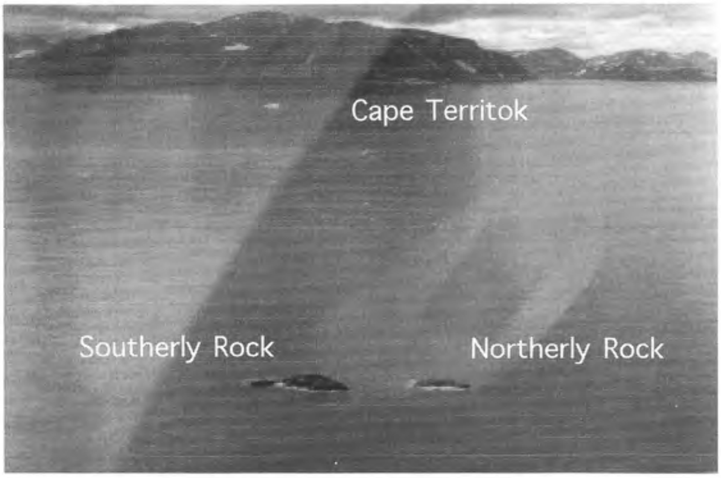

Figure 6. *Two, unnamed rocks east of Cape Territok. The southerly rock was part of an EDM traverse in 1973 and is 2.0 m above high water. The northerly one is located at 59° 43′ 45″N, 63° 43′ 28″W and is 0.5 m above high water.*

Figure 7. *Unnamed rock east of Cape Territok. The rock was shown on a 1973 field sheet but with no recorded depth or height. It was not spotted in airphotos or satellite imagery. The GPS position of the rock is 59° 45′ 18″N, 63° 40′ 07″W, which is about 575 m west of the field sheet position. The rock is 0.5 m above low water.*

Figure 8. *Unnamed rock on the east side of the Galvano Group. The rock was shown on a 1973 field sheet but with no recorded depth or height. It was not spotted in airphotos or satellite imagery. The GPS position of the rock is 59° 55′ 19″N, 63° 50′ 58″W, which is about 125 m east of the field sheet position. The rock is 2.0 m above low water.*

Figure 9. *Unnamed rock on the east side of the Galvano Group. The rock was spotted in airphotos. The GPS position of the rock is 59° 55′ 30″N, 63° 52′ 55″W, which is about 430 m north of the uncontrolled airphoto mosaic position. The rock is 0.5 m above high water. Note the common islands in the middle distance 'moving' relative to the hills in the background of Figures 8 and 9. [Roll 6, #22]*

Figure 10. *Unnamed rock on the east side of the Galvano Group. The rock was spotted in airphotos. The GPS position of the rock is 59° 57′ 08″N, 63° 53′ 01″W, which is about 30 m northeast of the 1973 field sheet position. The rock is 0.5 m above high water.*

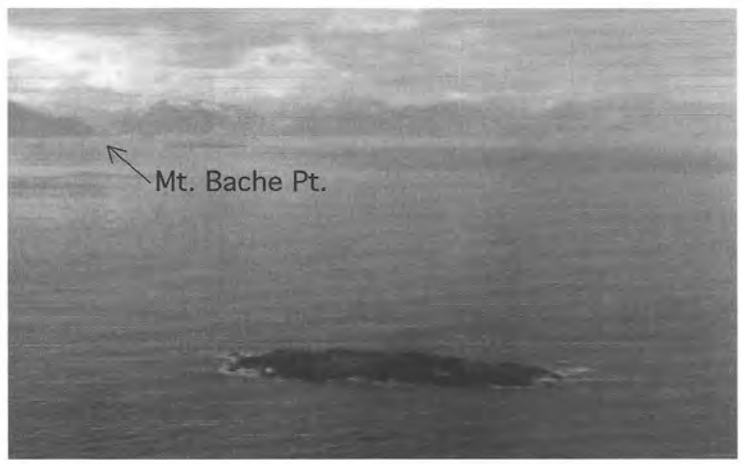

Figure 11. *Unnamed rock east of Cape Kakkiviak. The rock was spotted in airphotos. The GPS position of the rock is 59° 57′ 59″N, 63° 55′ 13″W, which is about 560 m north of the uncontrolled airphoto mosaic position. The rock is 3.5 m above high water. Vegetation was growing on the rock.*

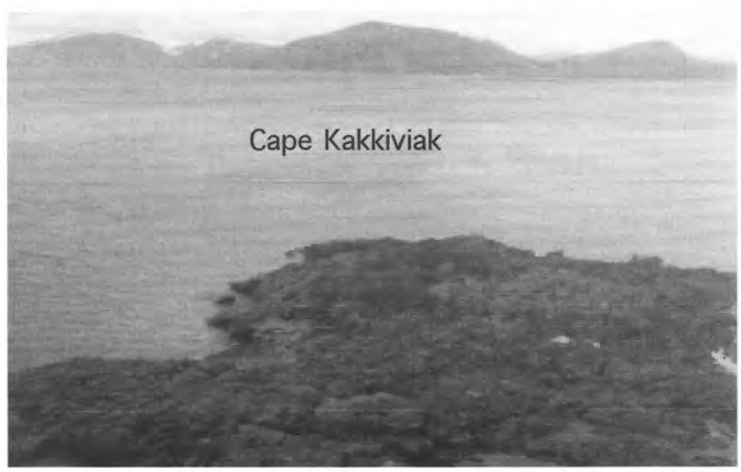

Figure 12. *Two, unnamed rocks east of Cape Kakkiviak. Neither rock was spotted in airphotos; but rocks to the southwest of the westerly rock were. The GPS position of the easterly rock is 59° 58' 03"N, 63° 54' 30"W, and is 0.8 m above low water. The GPS position of the westerly rock is 59° 58' 08"N, 63° 54' 52"W, and is 1.4 m above low water.*

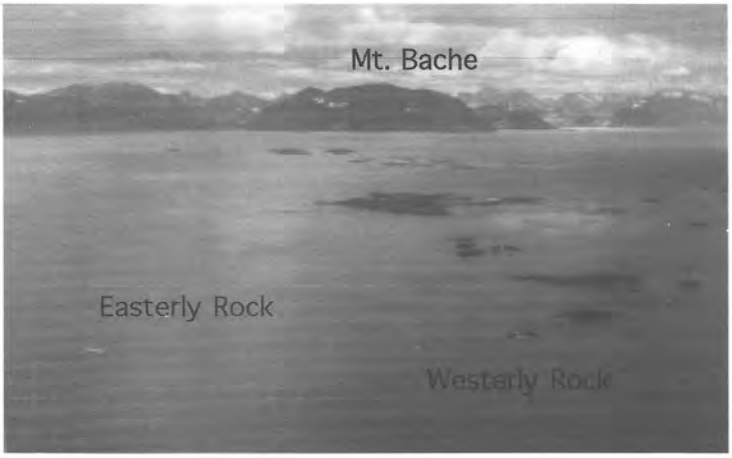

Figure 13. *Unnamed rock east of Cape Kakkiviak. The rock was not spotted in airphotos. The GPS position of the rock is 59° 58' 30"N, 63° 52' 59"W, and is 1.1 m above low water. The GPS position is about 610 m north of the uncontrolled airphoto mosaic position.*

Figure 14. *Unnamed rock northeast of Cape Kakkiviak. The rock was spotted in airphotos. The GPS position of the rock is 60° 04' 32"N, 63° 59' 13"W, and is 3.5 m above high water. The GPS position is about 200m northwest of the uncontrolled airphoto mosaic position.*

Figure 15. *Unnamed rock east of Home Island. The rock was spotted in airphotos. The GPS position of the rock is 60° 06' 53"N, 64° 00' 55"W, and is 2.0 m above high water.*

Figure 16. *Landsat Island. The rock was spotted in satellite imagery in 1973, positioned in 1976 by sextant resection angles between distant hill tops. The GPS position of the island is 60° 10' 37"N, 64° 02' 30"W, and is 6.6 m above high water. The GPS position is 70 m east of the resection position. The rock, to the north was not seen in the 1973 imagery, the 1976 field-work, nor the 1996 airphoto analysis but only during the 1997 survey. Even then, it was only because the survey was done at low tide. Its GPS position is 60° 10' 47"N, 64° 02' 36"W, and its height is 0.8 m above low water.*

Figure 17. *Rock north of Landsat Island. The photograph was taken after hovering over the rock for a minute while GPS readings were taken. The effect of the 'wash' from the helicopter's rotors is plainly visible.*

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A Manual on the Technical Aspects of the United Nations Convention of the Law of the Sea - 1982. Special Publication No. 51, 3rd Edition, International Hydrographic Bureau, Monaco, 1993.

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About the Author

David H. Gray, M.A.Sc. in geodesy, worked for the Geodetic Survey of Canada before joining the Canadian Hydrographic Service in 1971 where he is the geodesy and maritime boundary specialist. As two of his duties, he provides technical advice on maritime boundaries and limits to the Department of Foreign Affairs and International Trade and is responsible for the technical data needed to convert CHS charts to NAD 83.

David Gray:
Canadian Hydrographic Service
615 Booth Street, Ottawa, Ontario, Canada K1A 0E6
Telephone: 613-995-4596 Fax: 613-996-9053
grayd@dfo-mpo.gc.ca

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Canada G1K 4B8 Téléc: (418) 648-4236
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53 St-Germain Ouest
Rimouski, Québec
Canada G5L 4B4 Téléc: (418) 724-0606
contact: Claude Jean(affiliation - ACH Section du Québec)

Kongsberg Simrad Mesotech Ltd.
261 Brownlow Avenue
Dartmouth, Nova Scotia
Canada B3B 2B6 Fax: (902) 468-2217
contact: John Gillis (affiliation - CHA Central Branch)

Terra Remote Sensing Inc.
1962 Mills Road,
Sidney, British Columbia
Canada V8L 3S1 Fax: (250) 656-4604
contact: Rick Quinn (affiliation - CHA Pacific Branch)

Terra Remote Sensing Inc.

Terra Remote Sensing Inc. is a spatial data organization offeringworld class expertise and technology for digital aerial mapping, hydrographic charting and marine geophysical surveying. TRSI's headquarters is located in Sidney, British Columbia, Canada with an American representative office located in the state of Washington. Formerly a division of Terra Surveys Ltd., TRSI is now an independent employee-owned corporation offering decades of successful experience to its global clients.

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TRSI's solutions are in demand wherever organizations need timely and cost-effective access to comprehensive, high quality geospatial information. The captured data, providing geo-referenced aerial imagery to any scale, is then ported directly to computer-aided mapping systems and geographical information systems (GIS) for photo mosaics, planimetric maps, and/or digital terrain models used in routing evaluations and engineering designs. TRSI also performs GIS and geodetic/vertical control analysis, map preparation, merging and processing of independent data sets, and project management and training. The company has successful experience around the globe, including projects in the Caribbean, South America, Africa, the Middle East, Southeast Asia and United States.

Terra Remote Sensing Inc. is an employee-owned company, whose shareholders are the professional and technical staff who are directly involved in the firm's day-to-day operations. Senior management is comprised of a group of specialists with over a century of combined experience in photogrammetrics, hydrographics and consulting engineering. This diverse team of professional engineers, hydrographers, surveyors and geophysicists is supported by a technical staff of GIS specialists, cartographers, and programmers who are all permanent employees of the company.

CANADA STEAMSHIP UPGRADES ECPINS CHARTS

February 2001, North Vancouver, BC - Offshore Systems International Ltd. announced this week that Canada Steamship Lines purchased a fleet-wide upgrade to all of its ECPINS® installations. This upgrade will provide that company's vessels with Offshore's latest commercial electronic chart navigation technology. As part of the agreement, Canada Steamship Lines and Offshore also agreed to cooperate on research and development initiatives regarding the integration of highly detailed bathymetric data into ECPINS and into Canada Steamship Lines' navigation process. These high-resolution depth soundings will enable more secure navigation and more effective load factors for the ships.

"Canada Steamship Lines have always been a leader in using new marine technology. This purchase underscores their confidence in the value of using Offshore's ECPINS for safe navigation," said John Jacobson, president and CEO of Offshore Systems. "They want the latest precision navigation tools, using the unique ECPINS seamless display technology, across their entire ocean-going and Great Lakes fleet. This also opens a way to add emerging technologies like universal automated identification systems capabilities to their systems."

Offshore designs, develops, and markets the ECPINS line of electronic chart navigation systems for vessels. The company has more than a decade of experience providing precise electronic chart systems for Navy, Coast Guard, passenger ships, and other commercial vessels.

For more information browse: http://www.osl.com.

THALES NAVIGATION : A NEW IDENTITY FOR DASSAULT SERCEL NAVIGATION AND POSITIONING (DSNP)

DSNP, the European leader in professional GPS equipment, changes its trade name and introduces a new logo type.

January 2001 - In line with the new communication strategy developed by THALES (pron. ta'les), formerly Thomson-CSF, DSNP has just adopted THALES Navigation as its new name. The company now definitely appears as a member of the THALES group, with the new name also clearly highlighting the company's activities.

As a matter of fact, the GPS / GNSS products from THALES Navigation are dedicated to navigation and accurate positioning for both land and marine environments. Distributed worldwide via a specialized sales network, they are aimed at a wide spectrum of professionals.

For more information, contact:
P. T. Brassard, Sales Manager , Marine Systems Division
Tel: (613) 723-8424 Fax: (613)723-0212 Web: www.bml.ca

MEASURING DEEP GULF OF MEXICO CURRENTS

Houston, Texas, USA, 15 December 2000 - Fugro GEOS Inc, USA, has initiated an ambitious joint industry deepwater current monitoring project in the Gulf of Mexico.

Aimed at assessing the impact of potentially dangerous deepwater currents on offshore exploration and the design of production facilities, the Gulf Lower Layer (GULL) current measurement project began with the deployment of 19 current meter moorings in water depths ranging from 1500m (5000 ft) to 3300m (11000 ft) on the Gulf of Mexico Outer Continental Shelf (OCS).

Until now, strong currents in the deepwater OCS have only been monitored in isolated programmes but it is known that they extend from near the sea floor to about 1000m (300Oft) with little change in direction or speed. During these events the currents are often about one knot but some observers believe they can exceed two knots. The events have been the subject of a Safety Alert from the US Department of the Interior's Mineral Management Service (Safety Alert Number 180: http://www.gomr.mms.gov/homepg/offshore/safety/safealt/SA_180.html) as well as a recent CNN article: http://www.cnn.com/2000/NATURE/11/01/deep.storms.ap/index.html

Analyses of datasets have shown that the events have the characteristics of Topographic Rossby Waves which have been identified in other ocean basins. These are large-scale features that are characterised by little change in speed and direction with elevation above the seabed. They actually intensify as the seabed is approached until the effect of friction at the seabed reduces the speed. However, the sparse existing data does not show what is forcing these waves, nor the extent of their penetration up the continental rise and slope, nor how their character might change from east to west. GULL is scoped to provide a coordinated programme to overcome these problems with data collected simultaneously over a broad area of the northern Gulf of Mexico.

Fugro GEOS is the world's largest commercial oceanographic company and is currently acquiring or analysing meteorological and oceanographic data worldwide including the North Atlantic, the North Sea, the Gulf of Mexico, offshore Brazil, East of Trinidad, offshore West Africa, the Mediterranean Sea, the Arabian Gulf, the Caspian Sea, offshore India, and throughout South East Asia.

For more information contact:
Dave Szabo, Division Director, Fugro GEOS Inc, Houston, TX, USA.
Tel: +1 713 773 5699 Fax: +1 713 773 5905
Email: usa@geos.com Website: http://www.geos.com.
or
Douglas Stewart, Fugro GEOS, Swindon UK.
Tel: +44 (0) 1793 725766 Fax: +1 (0) 1793 706604
Email: uk@geos.com
or
Bob Barton, Barton Marketing Services.
Tel: +44 (0) 1684 892819 Fax: +44 (0) 1684 560006
Email: bartonmarketing@)msn.com

KONGSBERG SIMRAD MESOTECH SM2000 MULTIBEAM SONAR TESTS IN ARCTIC WATERS

January 9, 2001, Port Coquitlam, BC - An SM 2000 multibeam sonar was tested for fish detection capabilities as well as shallow water archeological surveys in Arctic waters during the six month Voyage of Rediscovery that concluded in December 2000.

Dr. Mark Trevorrow, then of the Institute of Ocean Sciences, Fisheries and Oceans Canada, and Bob Asplin, Engineer at Kongsberg Simrad Mesotech, operated the equipment. Dr. Trevorrow has recorded the results in a report along with the findings of two echo-sounders.

The SM 2000 multibeam sonar was used in a forward-looking mode at ranges up to 400 m and was successful in the detection and tracking of herring schools near the Kenai Peninsula, Alaska.

Dr. Trevorrow's report says the SM 2000 was able to detect herring schools to ranges of at least 200 m, providing several orders of magnitude more areal coverage than from a conventional echo-sounder. The report says the data from such a system, when used in conjunction with accurate attitude and navigational instruments and GIS software could potentially provide a powerful technique for assessing the spatial distributions of fish schools.

The report also says that the success of fish and zooplankton detection in this mode was limited by the background scattering from surface and seabed roughness, making the successful use of such systems dependent on locations and weather conditions.

The SM 2000 was also used near Kirkwall Island, in Eastern Queen Maud Gulf near the Adelaide Peninsula, to search for one of two shipwrecks of the Franklin Expedition of 1844-48. This was carried out over a five day period covering approximately 500 km of survey track.

The survey was completed without discovery of a shipwreck. The search was partly hindered by rocky outcroppings and other natural formations on the seabed. The scientists are fairly confident in the thoroughness and accuracy of the survey as they allowed for a 50% survey swath overlap and also successfully tested the sonar first in Cambridge Bay on a well-known shipwreck, the Maud.

Surveying Cambridge Bay, the Maud's echo intensity was comparable to the echo from the rocky shoreline, and shadowed out the shoreline behind it, lending confidence in the ability of the SM 2000 to recognize an unknown wreck in the main survey area.

Overall, testing of the capabilities of the SM 2000 in Arctic waters was limited by time constraints and availability of staff as the focus of the Voyage of Rediscovery was primarily to raise funds for the preservation of the St. Roch by re-tracing the St. Roch's historic circumnavigation of North America more than sixty years ago. Icy conditions along the way were also a barrier.

The report concludes that although opportunities for survey work were limited, the results demonstrate a variety of useful applications of Kongsberg Simrad Mesotech's SM 2000 multibeam sonar for Arctic ecological research and that further, more detailed investigation of particular areas and features should be carried out.

Dedicated to quality and customer satisfaction, Kongsberg Simrad Mesotech Ltd. (KSML) is a world leader in the high frequency acoustic imaging market. Its product line includes multibeam profilers, multibeam sonars, scanning sonars, side scan sonars, profilers and altimeters. Applications for KSML products span the military, fisheries, scientific, and offshore oil industries.

For more information contact:

Michael Harvey
Kongsberg Simrad Mesotech Ltd.
Tel: (604) 464-8144 Fax: (604) 941-5423
Email: vancouver.sales@kongsberg-simrad.com www.simrad.ca

Dr. Mark Trevorrow
Tel: (902) 426-3100, ext. 315 Fax: (902) 426-9654
Email: Mark.Trevorrow@drea.dnd.ca

Jane Thomas, Media Relations
Ullrich Schade and Associates Ltd.
Tel: (604) 669-1180 Fax: (604) 669-3645
Email: jane@usa.bc.ca

HYDROLINK PRODUCES MORE CHARTS

February 22, 2001, Wellington, NZ - Hydrolink has once again been successful in winning a hydrographic charting contract from Land Information New Zealand (LINZ). LINZ releases packets of hydrographic charts each year for tender by accredited hydrographic service providers. This year LINZ released a total of 16 charts for compilation and revision of which Hydrolink won 1 New Chart and 9 New Editions. All charts are for the national folio and will be completed to LINZ/IHO INT paper chart specifications. The charts will be compiled using digital techniques. Hydrolink is a subsidiary of Hydrographic Sciences Australia (HSA) who have been providing similar services to the Royal Australian Navy for some years.

LINZ is pioneering the way world wide in the release of hydrographic services for competitive tender. The fact that Hydrolink has once again been successful demonstrates that private industry can complete such work to a high level of quality, on time and to budget. Hydrolink has consistently been awarded charting work since 1997 when the competitive environment within New Zealand was first established.

For more information contact:
Kevin Smith, Operations Manager
Hydrolink Tel: 64 4 470 6040, Mob: 64 25 972 460

RDI's MULTIPLE ORDERS FROM LEADING LABS

San Diego, CA, February 8, 2001 - RD Instruments Inc, USA, announces multiple orders from two of the world's leading marine scientific establishments.

The orders, for a total of acoustic Doppler current profiling (ADCP) systems are from the Scripps Institution of Oceanography, USA (SIO) and for the United Kingdom National Marine Equipment Pool, hosted by the Southampton Oceanography Centre (SOC), UK.

SIO has purchased six instruments: four 300kHz Workhorse Sentinels, a 1200kHz Workhorse Sentinel with pressure sensor, and a Workhorse Multi-directional Wave Gauge. SIO reports that they purchased the instruments after good experiences with RDI Workhorses in earlier projects. Two of the Sentinels will be deployed on an Environmental Protection Agency project in the Santa Barbara Channel, off California, to provide profiling data in support of oil spill response programs. The initial deployment will be configured in the self-recording mode however, in the final program configuration, profile data will be telemetered ashore in real time.

The other two RDI Workhorse Sentinels are used in a co-operative program between SIO, the University of California at Davis and Oregon State University in a study in Bodega Bay, California, to study fresh water input, phytoplankton transport and layer mixing. SIO chose the Sentinel to gain 100m+ coverage and for the error velocity capability afforded by its unique 4-beam configuration.

The fifth instrument is a Workhorse 600kHz multi-directional wave gauge used on Scripps" Floating Instrument Platform (FLIP). The sixth is a 1200kHz system for use on various projects.

The UK's University of East Anglia bought nine instruments on behalf of the UK National Marine Equipment Pool, hosted by SOC, for worldwide use by marine research departments of British universities and laboratories. The order comprises two RDI Workhorse Long Ranger 75kHz seafloor-mounted, upward looking units; two Workhorse Sentinels with 6000m depth capabilities; two 6000m Workhorse Monitors; and three further Sentinels. The sale was organised by RDI's UK agents, Octopus Marine Systems Ltd.

RD Instruments invented the first commercial Acoustic Doppler Current Profiler (ADCP) in 1981 and has grown to an $20 million company selling a range of instruments to measure currents in ocean and coastal waters, rivers and lakes, ports and harbours. Its latest product is a directional wave gauge using the ADCP. In addition to ADCPS, the company has created Doppler Velocity Logs (DVLS) to track the movement of AUVS, ROVs (remotely operated vehicles) and UUVs (unmanned underwater vehicles) along the bottom of the ocean.

For More Information Contact:
Harry Maxfield,
RD Instruments, 9855 Businesspark Avenue,
San Diego, CA 92131-1101, USA.

Tel: +1 (858) 693 1178
Fax: +1 (858) 695 1459
Email: news@rdinstruments.com
or
Bob Barton. Tel: +44 (0) 1684 892819
Fax: +44 (0) 1684 560006
Email: bbartonmarketinq@aol.com

WEATHER STATIONS FOR SEVEN RIGS

Alton, Hampshire, UK, January 10, 2001 - InstallOcean Ltd, UK, has supplied weather monitoring systems to seven Santa Fe offshore drilling rigs. The systems provide information essential for the safety of day-today operations, including helicopter movements, supply boat unloading and equipment deployment.

The seven rigs are the Santa Fe jack-ups Britannia, GalaxyI, GalaxyII, Galaxy III, Monarch and Monitor and the semi-submersible Rig 135.

Parameters measured by InstallOcean Weather Stations include wind speed and direction, barometric pressure, air temperature, humidity, sea temperature, visibility, cloud base height, wave height and surface currents. On floating rigs and FPSOS the additional parameters of heave, pitch and roll are measured to the CAA's CAP437 guidelines.

The system sensors, which are built and installed to meet European and North American hazardous area requirements, are wired back to the rack-mounted control and display unit which also supplies sensor power.

The system runs on InstallOcean's Weather Windows operating software and is designed for continuous unattended operation with automatic data quality control. Data is provided to the rig LAN for remote displays with automatic updates.

Standard data displays show MetOcean values, with up to nine values per screen, adverse weather alarms, trends every two minutes and system alarms. Data are logged automatically at pre-set intervals.

The Santa Fe installations bring to over 70 the number of InstallOcean systems on offshore exploration and floating production facilities.

For More Information Contact:
Alan Greig,
InstallOcean Ltd, 5 Omega Park, Alton, Hampshire, GU34 2QE, UK.
Tel: +44 (0) 1420 541448
Fax: +44 (0) 1420 541406
Email: iocean@installocean.co.uk
or
Bob Barton. Tel: +44 (0) 1684 892819
Fax: +44 (0) 1684 560006
Email: BbartonMarketing@aol.com

UNIVERSITY PLANS HYDROGRAPHY CENTER

November 7, 2000. Long Beach, Mississippi - A National Center of Excellence in Hydrography is in the works for The University of Southern Mississippi at Stennis Space Center here. To focus on the science of measuring, describing, and charting the world's oceans, the federally funded research enterprise will be operated by USM. Thirty scientists from the United States and Canada gathered at the USM Gulf Park Campus last week (October 30-November 1) to help develop the center's research plan. The USM Department of Marine Science at Stennis is already helping to educate the next generation of hydrographers, professionals who chart the world's oceans and provide information necessary for safe navigation and marine operations by fishermen, sea captains, and the military.

A partnership between USM and the Naval Oceanographic Office launched the United States' only internationally recognized hydrography education program in August 1999. The new center will complement the USM master's degree in hydrographic science and help move nautical charting into the future. Scientists working with USM faculty at the workshop were from the Canadian Hydrographic Service, Naval Oceanographic Office, Naval Research Laboratory, the U.S. National Oceanic & Atmospheric Administration, U.S. Geological Survey, U.S. Army Corps of Engineers, and several universities and private companies. Dr. Jay Grimes, dean of the USM Institute of Marine Sciences, and Dr. James O. Williams, vice president for USM Gulf Coast, welcomed the hydrographers Monday. The Department of Marine Science is part of the USM Institute of Marine Sciences.

For More Information browse:
http://www.ims.usm.edu/.

RACAL SURVEY ANNOUNCES NEW NAME AND EXPANSION IN ABERDEEN

Chessington, Surrey, UK, December 21, 2000 - Work has begun on the construction of a major new centre for Thales Survey (formerly Racal Survey Limited) in Aberdeen. The project will occupy four acres of land adjacent to Dyce airport and will become a focus for Thales Survey's work in the North Sea and Europe. The project will result in the construction of two distinctive new buildings which, with the company name on their roof, will be among the first landmarks seen by visitors arriving at Aberdeen by air.

Racal Survey was established in Aberdeen in the 1970s where it has been providing satellite positioning and survey services for the offshore oil and gas industry. This has grown to include the provision of Remotely Operated Vehicles (R0Vs) for a wide range of underwater construction and survey tasks. The company has now outgrown its facilities at Greenwell Road, East Tullos and the new premises will also bring staff working in small offices in Crombie Road and Greenbank Road, Aberdeen, together under the same roof. The project will permit a 20 per cent expansion of the Aberdeen-based workforce who will enjoy a comfortably modem and practical working environment.

The new building project will involve the construction of 2,350 sq metres of two-storey office accommodation and 1,750 sq metres of workshop space. The workshop building will house a new, more spacious, control centre for the company's SkyFix satellite positioning service with its own emergency back-up generator. The service provides corrections to the US operated Global Positioning System. Working in conjunction with another SkyFix control centre in Singapore, the new Aberdeen facility will broadcast data by satellite so that SkyFix users throughout the world can obtain very high accuracy positioning for a wide range of survey and construction tasks offshore and on land.

The new workshop facilities will also include the construction of a test tank for the company's European based fleet of ROVS. The new tank will measure 12 metres in diameter and will be 9 metres deep making it one of the largest such facilities in Aberdeen. The tank will include an observation window that will add to its status as a valuable new facility that is also expected to be available for use by other companies. An overhead gantry crane with a 25 ton lifting capacity will enable heavy equipment to be moved anywhere within the workshop and loading area and for lowering ROVs into the tank for testing.

The global headquarters of Thales Survey will remain in Chessington, Surrey, but the new building is being seen as a major expansion of the company's commitment to Aberdeen. Speaking of the project, Thales Survey's managing director Brian Wood said; "This is a major investment that confirms our confidence in our own future and in our continued belief in Aberdeen as a place to work. Much of the impetus for this new project comes from the expansion in business that has arisen from the phenomenal growth of the submarine cable industry. Although we remain committed to serving the oil and gas industry, Thales Survey in Aberdeen has demonstrated that it has the capability of serving this new sector. By also establishing ourselves in a market that is independent of the fluctuations of the oil price, Thales Survey has been able to create a more secure future for its employees and for its shareholders.

Thales Survey is part of the Thales Group (formerly Thomson-CSF) which is today a global business. Thales Survey has a global network of business units that provide a complete range of integrated survey services including precise positioning, integrated geosciences, remotely operated vehicle (ROV) manufacture and operation, vessel and vehicle tracking as well as data management services. These are provided to land and offshore industries for oil and gas exploration and construction, telecommunications, surveying, mapping and agriculture.

For more information contact:
Richard Nelson 0208 391 6511
nelsorr@thales-survey.com
www.racal-survey.com

NAVIONICS

NEW RAYCHART 425 USES NAVIONICS CHARTS

Wareham, MA, February 19, 2001 – Navionics, one of the world's leaders in electronic chart manufacturing, announced today that Raytheon's new Raychart 425 chartplotters are equipped to display and support Navionics cartography.

The Raychart 425 provides fast, powerful, Satellite Differential/WAAS navigation in a compact unit that fits in any console. It comes equipped with a crisp, 6-inch display, providing tremendous detail for Navionics' Nav-Chart cartridges. The unit also supports Navionics' Port Services and Tides & Currents data.

NAVIONICS CHARTS NOW FEATURE TIDE & CURRENT DATA

Wareham, MA, February 6, 2001 - Navionics, one of the world's leaders in electronic chart manufacturing, announced today that tide and current data will be incorporated into all North American coastal charts, starting with the January 2001 releases.

Gaining the tide and current data from NOAA, Navionics' engineers designed software that allows a twenty-four hour prediction of tides and currents, including a graphical representation of maximum/minimum tidal heights, maximum/minimum ebb and slack, sunrise and sunset, moonrise and moonset and moon phase prediction.

"Navionics is the only vector charting company that offers tide and current prediction software for stand alone GPS chart plotters. We hope to stay in touch with the needs of boaters and continue providing innovative products such as this for the marine industry," said Lisa Thimas, Vice President, Sales & Marketing.

Tide and current data is available for the Raytheon RC425, and will be available on other plotter models soon.

All of Navionics' worldwide charts are available in the credit-card size Microchart™, the postage-stamp size Nav-Chart™, and Navionics EChart™ formats. Customers can purchase award-winning Navionics electronic charts from any authorized dealer. For a list of dealers, call 1-800-848-5896, or visit www.navionics.com.

Navionics charts are compatible with chart plotters from Furuno, Garmin International, ICOM, Lowrance Electronics, Nexus Marine, Northstar Technologies, Raytheon Marine, Si-Tex Marine Electronics, and other leading electronic chart plotter manufacturers.

For More Information Contact:
Amy Zaffino, Morse-Balegno & Associates
508-778-2536 ext17, amy@morse-balegno.com

NEW DISTRIBUTER FOR W.S. OCEAN SYSTEMS

Alton, Hants, UK, November, 2000 - New distributors for the W.S. Ocean Systems Ltd, UK, range of marine environmental data gathering systems include Ocean Marine Industries Inc for the US East and Gulf Coast territories, Aker Ticaret Elektronik for Turkey, Unique Systems LLC of the United Arab Emirates for the Middle East and Romor Atlantic Ltd for East Coast Canada.

W.S. Ocean Systems is a world leader in the design and manufacture of marine environmental data gathering systems. Based in Alton, Hampshire, UK, it supplies systems to oceanographic institutions, monitoring agencies, universities and environmental consultants. Products include the world-leading NAS-2E in-situ nutrient analyser, the new U-Tow MKII undulating towed vehicle, the "smart" Aqua Monitor water sampler, data loggers and metocean systems.

SMART ENVIRONMENTAL LOGGER

The first marine environmental data logger to enable users with no special training or additional equipment to design a bespoke system arid logging regime is launched by W.S. Ocean Systems Ltd, UK. The control language Eco-Script enables the ESM-1 logger to be used in a wide range of applications with, for the first time in any instrument of this type, infinitely programmable sampling and system control.

The ESM-1 may be deployed within taut-line moorings, on surface buoys or on seabed-mounted package. It is supplied as a stand-alone device or as part of a suite of sensors such as fluorometers, turbidity sensors, CTD, dissolved oxygen and many others, as well as being used to control pumps, valves and other electromechanical devices. Sensor and data acquisition configurations may be changed between deployments and most proprietary oceanographic instruments may be plugged straight into the data logger.

The ESM-1 is also telemetry-enabled and may be configured to transmit synoptic data direct to an office or laboratory. An optional precision pressure sensor enables it to be configured as a very cost effective wave recorder or tide gauge. The W.S. Ocean Systems ESM-1 data logger has a depth capability of 3000m in a package measuring 254mm long by 65mm diameter.

W.S. Ocean Systems is a world leader in the design and manufacture of marine environmental data gathering systems. Based in Alton, Hampshire, UK, it supplies systems to oceanographic institutions, monitoring agencies, universities and environmental consultants. Products include the world-leading NAS-2E in-situ nutrient analyser; the new U-Tow Mk undulating towed vehicle, the "smart" Aqua Monitor water sampler, data loggers and mutation systems.

For more information contact:
Mark Rawlinson, W.S. Ocean Systems Ltd
Tel: +44 (0) 1420 541555. Fax: +44 (0) 1420 541499
Email: info@wsocean.com Web: www.wsocean.com
or
Bob Barton, Barton Marketing Services
Tel: +44 (0) 1684 892819. Fax: +44 (0) 1684 560006
email: BartonMarketing@msn.com

MEASURING CURRENTS OFF LOS ANGELES

San Diego, CA, January 25, 2001 - The US Army Corps of Engineers (USACE) needs to measure ocean currents throughout the water column off Los Angeles. This is part of a project with the Environmental Protection Agency to study the dispersion of dredged materials at two disposal sites.

USACE installed two acoustic Doppler current profilers (ADCPS) from RD Instruments Inc, San Diego, on the seafloor. These instruments "look" upwards to measure currents through several hundred meters and use RDI's patented Broadband signal processing to assure both accurate and precise velocity measurements. USACE/NOAA Pacific Marine Environmental Laboratory chose the RDI Workhorse Long Ranger ADCPs for their Windows-based visualisation software. Only RD Instruments' deepwater ADCPs have four beams which provide the error velocity QA calculation that has been relied on by NOAA for over a decade.

The instruments are recovered every two months and the full deployment will last a year.

The Workhorse Long Ranger self-contained 75kHz ADCP is designed for autonomous deployments of up to six months in water depths to 1500m.

RD Instruments invented the first commercial acoustic Doppler, current profiler in 1981 and has grown to a $20 million company selling a range of instruments to measure currents in ocean and coastal waters, rivers and lakes, ports and harbours. Its latest product is a directional wave gauge using the ADCP. In addition to ADCPs, the company has created Doppler Velocity Logs (DVLS) to track the movement of underwater vehicles.

For More Information Contact:
Darryl Symonds, RD Instruments, 9855 Businesspark Avenue, San Diego, CA 92131-1101, USA.

Tel: +1 (858) 693 1178 Fax: +1 (858) 695 1459
Email: dsymonds@rdinstruments.com
or
Bob Barton. Tel: +44 (0) 1684 892819 Fax: +44 (0) 1684 560006
Email: BBartonMarketing@aol.com

SHELL'S CURRENT DATA TRIALS FOR DRILLING OPERATIONS

San Diego, CA, USA, January 10, 2001 - Trials to obtain current profiles throughout the water column in water depths to 2000 meters are being undertaken by Shell Global Solutions, USA, using systems supplied by RD Instruments Inc, USA.

Drilling superintendents on exploration rigs need real-time information on ocean currents in order to assess present and upcoming stresses on marine risers which may produce vortex-induced vibrations (VIV). In extreme cases these can cause the riser to separate from the blowout preventer (BOP) stack. Other operations, such as the deployment of underwater vehicles and subsea systems also benefit from knowledge of the ocean current regime.

Real-time information in shallower waters is already obtained using RDI's acoustic Doppler current profilers (ADCPS) mounted on rigs and looking downwards through the water column. However, in greater depths - beyond around 1000m it is not possible to obtain the required range and resolution. Shell Global Solutions is therefore using an RDI near-bottom buoy-mounted Long Ranger ADCP to look upwards through the water column and a 38kHz rig-mounted instrument to look downwards through the water column, thus achieving a complete profile of currents from near-surface to ocean floor.

The Long Ranger ADCP and a LinkQuest acoustic modem are both installed in a new Flotation Technologies buoy; the Long Ranger sends data to the rig in real time via the modem.

The data obtained will be used not only to assist day-to-day drilling operations but also provide valuable information for future design engineering plans.

RD Instruments has sold over 2500 ADCPs for work in 50 nations world-wide on rigs and ships, in harbours and in rivers to support offshore drilling, hydrographic surveys, environmental studies and marine civil engineering activities such as dredging and port development.

For More Information Contact:
Darryl Symonds, RD Instruments, 9855 Businesspark Avenue, San Diego, CA 92131-1101, USA.
Tel: +1 (858) 693 1178 Fax: +1 (858) 695 1459
Email: dsymonds@rdinstruments.com
or
Bob Barton. Tel: +44 (0) 1684 892819 Fax: +44 (0) 1684 560006
Email: BBartonMarketing@aol.com

Pacific Region

Hydrographic Surveys

Barge Pender

2000

The Barge Pender was mobilised at Fair Harbour at the end of June for work in Checleset Bay (West Coast of Vancouver Island) in July and August. Three fieldsheets were the result of the two-month effort, completing the most of the modern surveys for the next new chart. Still significant survey effort needed to complete the next chart working towards Brooks Peninsula. There will be no use of the Pender in 2001.

R.B. Young

2000

Georgia Basin:

The first Young patrol was from May 25 to June 21. She left the dock June 2 but spent several days alongside in Victoria and Esquimalt due to vessel equipment failures of one sort or another. Most of the Devil's Mountain and Leech River fault line areas in the Canadian portion of Juan de Fuca Strait have been surveyed. Only Area 1 in Georgia Strait has been surveyed due to time spent in drydock in Vancouver for major repair to the port engine shaft cooling system. Very large sound speed errors were discovered in the data, which has been shipped to Eduoard Kammerer at UNB for analysis. The Young still has significant bubble wash-down problems in rougher weather. Patrol three, September 14 to October 11 will be used to try and complete year one of this project. Bill Hinds is investigating a towed-body, underway sound-speed-profiling solution for this patrol.

2001

Q Routes

The Young is scheduled to depart for Queen Charlotte Sound on July 20th, with CHS and DND staff. Additional areas in Caamaño Sound, Chatham Sound and MacIntyre Bay will be surveyed before returning to start work in outer Juan de Fuca Strait.

Stewart

While in the Chatham Sound area doing work for DND, two days or so will be used to travel to Stewart to survey the areas in-filled by sedimentation from major river systems emptying to the head of the inlet. There are some serious concerns about the amount of in filling that has occurred in this Inlet since the last surveys more than 100 years ago.

Puget Sound

In exchange for the Rainier surveying Bowie Seamount for Oceans (Ken Halcro will be aboard as a CHS observer), the Young will survey in Admiralty Inlet, south of Whidbey Island for NOAA. Oceans has agreed to help pay for ship time to do this work. Two NOAA officers will be rotating aboard the Young as observers while in US waters.

Revisor

2000

Nanaimo Harbour

New soundings alongside the Assembly wharves were obtained due to reported shallower than charted depths.

MEHS Surveys

EM3000 and QTCView data has been obtained in Northumberland Channel before and after a trawl was dragged over the area. The QTCView data has been passed to Ralph Loschiavo for processing. A Korean biologist is planning a visit to IOS at the end of July to learn how we are using these complimentary systems for trawl impact assessment. Other aquaculture sites near Port McNeill have been surveyed using the same equipment setup.

Port Alice

The wharf at Port Alice has been resurveyed using the EM3000 in order to disprove a doubtful shoal sounding from the original (1966) stretch-line and sextant survey. The new survey data will completely supersede the old source.

2001

Georgia Basin

The Revisor will be used for the inshore portions of this project.

Steveston Jetty

This will be a continuation of the work done in March with the QTCView aboard the Otter Bay. The Revisor will collect simultaneous QTCView and EM3000 data to show the condition of the jetty below the water surface. This work is being done for PWGSC.

Boundary Bay

The work started in January 2000 is to be completed once the new navigational aids have been established to mark the existing channel. Two shoal areas remain to be examined.

Vancouver Harbour Navigational Aid positions
This work may be done by truck or using the VPC boat if available.

Chart 3490 – Fraser River

The revisory survey will address all changes to the chart since the last update of this area. Some of this project may be done by truck. PWGSC is interested in having the shoreline remapped using new aerial photography.

Other

Bowie Seamount

The NOAA ship Rainier will survey Bowie Seamount for Oceans between July 27 and 31. Ken Halcro will be aboard as a CHS observer. In exchange, CHS will survey in Puget Sound with the Young in the fall.

Tidal Survey group

Much work is still needed at Port Hardy due to inadequate maintenance by WSC. The Kelsey Bay gauge site needs to be removed and put back to its original state ASAP. Neil takes over in September when Denny moves to Geomatics Division to fill in as Acting Tides and Currents Analyst. Neil will train Brian Port and Al Smickersgill in Tidal methods for about four weeks each.

Radarsat

RadarSat I imagery of the south-west Queen Charlotte Islands has been processed by Canada Centre for Remote Sensing (CCRS) to optimise both land and water features. TRIM files have been upgraded and mosaicked to cover the image area. Edge detection and vector extraction of high and low-water lines and georegistration must be done before an assessment of the utility of the data for shoreline mapping can be made. A poster was presented at CHC2000 showing the results to date.

AVCAN

The AVCAN Coastal Remote Sensing Development project was run in 2000 with the low-water flights over Patricia Bay and Sidney. Dave Thornhill received training on the data acquisition and processing systems at that time.

Esquimalt

It was determined that the EM3000 data collected for DND in 1998 and 1999 showed some changes from how things are presently charted. Processing of the data has been completed, with some learning curve problems experienced with the new HIPS s/w and working over the network with very large files.

Sidney

The majority of the fieldwork is complete and most of the inset field sheet has been compiled. The data collected this year to supersede the poor-quality 1963 digitized field sheet has yet to be processed. Staff will work on this as time permits.

Victoria

Victoria Harbour data processing is on hold until Esquimalt and Sidney processing and field sheet compilation is complete. Positions for some new and altered navigational aids are to be obtained for construction of a patch for Chart 3415.

Geomatics Engineering

The Division provided support to field parties by retrieving and updating existing digital field sheets and TRIM files as well as readying documents and scanning plans for revisory investigations. Nautical Publications was supported by cataloguing documents and creating maintenance reports on CHSDIR as well as providing digital source data (field and TRIM) for the compilation of New Charts and New Editions. A major effort in this regard has been the creation of digital source data (NAD83) for a new chart of Dixon Entrance. In addition, all in-coming field data were checked, assessed and archived.

The utility of CHSDIR in a production environment continues to improve. Training sessions were given to provide users with up-to-date information on the use of CHSDIR. In support of easier and more streamlined access to data in HDC a graphical field sheet index was created. Work on this index continues. Work also continues on the retrieval and preservation of our older digital data sets of hydrographic and oceanographic data.

Throughout the year Geomatics Engineering played a key role in software support and assisted with the migration from the UNIX environment to NT. In support of CHS requirements for the SDB, data archiving and data backup, a multi Tbyte capacity hierarchical storage management (HSM) and backup system was acquired and installed. The SDB was installed in this Region in January 2001.

The Division produced the 2002 editions of the Tide and Current Tables (7 volumes) and responded to numerous requests for observed or predicted tide and current information. Work continued (with MEDS) on the migration of Tide and Current analysis and prediction software programs and tools to the PC platform. This region played a leading role in the development and testing of the CHS tidal prediction WEB site and in the development of the new NDI Digital Tide Tables. The Division was also responsible for maintaining the national data set of verified tidal harmonic constants.

In support of navigation, engineering requirements, and emergency response model generated predictions of water levels and currents in the Fraser River were produced. Operational readiness was maintained for oil spill response, search and rescue, and decision making in the event of tsunami or storm surges.

Canadian Hydrographic Service
service hydrographique du Canada

Activities in Client Liaison and Support

The sales and distribution of charts and nautical publications were good, but did not set any records. Of note, implementation of the Direct Order entry system developed in Pacific region was ported to Ottawa. This enables Dealers to order product over the Internet, and directly feeds into the Traverse Accounting system. The International Map Trades Association conference occurred in San Antonio, Texas. It was an opportunity to sit with other mapping agencies from around the world and realize we all face similar problems. Severe financial restraints have reduced Pacific Region Boat Show attendance to the Vancouver International Show, and partial support at the Seattle Boat Show. CHS shared a booth in the Vancouver Show with Fisheries and Oceans personnel for the first time. A new Chart Catalogue was completed, and the relationship with H&R Nautical Ventures to produce a "nautical map set" of the waters from Sooke to Nanaimo continues to work well, and led to a New Edition.

Effort was expended to assemble a data set for non-navigation users. Interaction with the Oceans sector and a contract with LGL Limited assisted this. Digital depth data for the waters off the BC coast originally acquired by this region was discovered at the National Geophysical Data Centre, and a CDROM was purchased. Work on the high water and low water coastline has proceeded, but not as quickly as anticipated. A poster of the combined bathymetry and topography off the BC coast to 200 miles was produced for the Oceans sector. Also for Oceans sector, all information on marine cables and pipelines in BC are being gathered and displayed on three plots.

The installation at Second Narrows, BC to measure currents and water levels had major progress this year. The hardware is in place, and it is hoped that the programming will be complete by May. This should provide better information for the routing of commercial transportation.

A new projector, and a replacement control centre was implemented for the IOS auditorium. As the year ends, a system to control the lighting and better integrate the audio-video sources is being procured.

In terms of outreach, there were two major initiatives. Edu-Tech 2000, an event to expose high school students to possible careers in advanced technology, occurred in October. Approximately 40 businesses and 2000 persons visited the two-day biannual event. The second outreach activity was organizing displays for the Sidney Marine Museum. IOS staff created displays in a half dozen subject areas, and received positive comments from the local MP who happened to visit.

Good progress was achieved on Acoustic Seabed Classification. The collaboration with Quester Tangent continues well. In exchange for enhanced product, the Sonar Systems group designed new analogue front-end electronics for the company. Also, the group was the first user of the new processing software *IMPACT*. Trawl impact multibeam and classification surveys for fisheries science improved techniques and led to new understanding. The group worked with Imagenex to convert their sidescan data to the standard XTF format. The data can now be analysed in CARIS SIPS. The effectiveness of seabed classification is such that it is in demand for aquaculture site examinations for environmental damage, and habitat investigations for crustaceans, shellfish and groundfish. A paper presented in France was very well received. A research sounder development required a software implementation of a Hilbert Transform. Finally, the Canadian Marine Acoustic Remote Sensing (C-MARS) centre at the University of Victoria was established. It is a group of local academic, industry, and government workers who will collaborate to improve marine acoustic techniques with a focus on acoustic seabed classification.

Work on eddies off BC continued. A conference in San Diego was attended to discuss life after El Nino. EPOC (Eastern Pacific Oceanographic Conference) was organized and 100 researchers attended. As the year ends, the Hydraulic Applications group consisting of Bill Crawford and Josef Cherniawski are transferring to the Ocean Science and Productivity group. However, their close interaction with CHS will continue.

A high level of technical support continued to be provided to CHS, including many of the previously mentioned projects. One individual is progressing through the Microsoft Certified Software Engineer courses and examinations. Computer support is provided primarily through a very able casual employee.

FEMME2001, a biyearly gathering of international expert users of Kongsberg Simrad multibeam echosounders occurred in Victoria. CL&S staff provided significant assistance.

On the human resource side, most members of Client Liaison took Early Conflict Resolution and Verbal Judo. The objective of these courses is to learn listening skills and issue appropriate responses to achieve a desired goal with a minimum of friction.

Many members of CL&S attended GIS 2001 in Vancouver. At that meeting, a major first announcement of the recommendations of a data policy for Canada was made, through the GeoConnections organization. GeoConnections is part of Government On-Line, and promises to eventually lead to a reorganisation of government along logical groupings of services. In the short term, GOL is focussed on getting all government information on line by 2004.

Central and Arctic Region

Hydrographic Surveys in 2001

John Medendorp will be the Hydrographer-in-Charge (HIC) of a survey on the eastern side of Georgian Bay from the CCGS Griffon, with four single-beam survey launches and one multibeam

(MB) launch. This summer they will be working north of Parry Sound in the area offshore from Pointe au Baril to acquire data for new chart 2243. The survey will also conduct a short, shore-based MB survey of Parry Sound Harbour to correct positioning problems noted with data on the ENC chart and will ground truth the OBM shoreline proposed for new chart 2275.

Bob Covey will be the HIC of the Revisory survey with two single-beam survey launches, one MB launch and four vehicles. Their primary role is to investigate any queries and to collect data on new or changed features to update charts, ENCs and publications that are in production for new editions. Due to low water levels in the upper Great Lakes, some small craft channels will be surveyed for CCG. In addition, they will conduct MB surveys in Lake Erie and on the St. Lawrence River in a partnering arrangement with DOE and university scientists.

Paola Travaglini will run a project to train additional hydrographers as MB launch operators and MB data processors. Most of the training will be done locally in Hamilton Harbour, which will add to our data set for a new edition of the chart. Paola will also be in charge of a short, shore-based MB survey in Georgian Bay off Tobermory. This project will demonstrate the potential of multibeam data by surveying an area in Fathom Five National Marine Park. This project is in partnership with Parks Canada, Natural Resources Canada and National Defense and may result in a five-year project to MB survey the entire Park area between Tobermory and Manitoulin Island.

There have been discussions about summer Arctic surveys with the Territorial Governments and CCG, but plans are not yet finalized. We are proposing a joint science/hydrographic program aboard the CCGS Sir Wilfrid Laurier with Andrew Leyzack as the HIC. There would be one launch and the ship to collect data on an opportunity basis in the western Arctic between the Beaufort Sea and Taloyoak. In addition, an eastern Arctic survey is proposed, on an opportunity basis from the icebreaker assigned to the Hudson Strait area, to survey Nunavut communities (Cape Dorest, Hall Beach, Igloolik, Repulse Bay, Lake Harbour, Iqaluit) to improve charting for marine re-supply. Jon Biggar will be the HIC on this project to carry on with surveys started last year. Both these surveys will depend on finding sufficient funds to cover incremental costs.

Charting in 2001

Production of S-57 Electronic Navigation Charts (ENCs) continues and full coverage of the Great Lakes/St. Lawrence System will be available for the 2001 navigation season. The effort of the ENC Division will now turn towards upgrading these files to current standards so that they will have a common content, data coding and appearance. In addition, large-scale inset will be incorporated into the main body of the ENC and the files will be updated from Notices and the latest editions of the paper chart. The Director, Julian Goodyear, and Brent Beale are both involved in the IHO Colours & Symbols Maintenance Working Group for EDCIS and will be working this year to address clients' concerns about the Presentation Library and Colours & Symbols for ECDIS.

There are three new chart of Hudson Bay in production, 5642 - Whale Cove, 5630 & 5631 – from Eskimo Point to Chesterfield Inlet, that will be completed this year. Production of two new charts in the Arctic, 7736 - Simpson Strait, 7739 - James Ross Strait, will soon be started. New editions of 35 Mackenzie River charts are ready for the 2001 navigation season. Several Great Lakes charts, 2021, 2110, 2120, 2204, 2245 and 2299, are in production for new editions. A new edition of chart 5505, Broughton Island to Belanger Point in Hudson Bay, will be available for this summer. New editions of 11 Lake of the Woods charts, to incorporate new survey data and CCG navigational aids changes, will be completed by the end of this year. Sailing Directions unit is working on new editions of the Hudson Bay, Rideau Canal – Ottawa River and Great Slave – Mackenzie volumes. There are several more charting projects on the books that will depend on resources being available.

Training

Over this winter, the Region has been converting from UNIX to NT workstations. A CARIS NT course was held onsite for most survey and chart production staff, ENC staff had CARIS HOM training and survey staff had training on the latest version of CARIS HIPS for NT. The Source Database server was setup and user and administration training was delivered.

Sean Hinds continues as the National Coordinator to implement ISO 9000 in CHS and in addition he is the Regional coordinator. There have been several courses and meetings over the winter for ISO, performance measuring, audit teams, etc. The Region is now working under our ISO documentation with a goal for certification later this year.

CHS Staff

Last summer, Ed Lewis, Manager Technical Services, accepted an assignment as the Regional Director Informatics for two years. Keith Weaver is presently the acting Manager. About the same time, Bruce Richards accepted an assignment until the end of 2001 with the Regional Small Craft Harbours office. Rick Sandilands has taken over his previous assignment as Manager, Hydrographic Planning. Two Term employees, Ann-Marie Broussault and Matt Down, have resigned for new careers outside the government.

In December 2000, 25-year service awards were presented to Mike Bennett, Al Koudys and Mike Powell and 15-year service awards were given to Terese Herron, Tony Natolino and Mike Read. Over the past several months several staff, led by co-chairs Mike Bennett and George Fenn, have been planning for the 2002 Canadian Hydrographic Conference, scheduled for May 28-31, 2002 in Toronto.

Canadian Hydrographic Association
association canadienne d'hydrographique

Pacific Branch

Syd Wigen

We are sad to report the passing of Syd Wigen, on Saltspring Island, August 20, 2000, after a 14 year struggle with Parkinson's disease. Survived by his wife Nancy, 5 children, 5 step-children, and 17 grandchildren.

A civil engineering graduate of UBC and a member of the Association of Professional Engineers and the Canadian Institute of Surveying, Syd served with the Canadian Hydrographic Service from 1945 to 1984, heading the Tide and Current Survey for the Pacific Coast and Western Arctic and later was the Tsunami Advisor for Canada hosting the International Tsunami Symposium in Victoria in 1985. His work took him to the USSR, USA, China, Chile, The Philippines, Peru, Australia and Japan, including working for the UN at the University of Hawaii developing the Pacific Tsunami Early Warning System between 1975-77. He was an active member of the community and church. One of his greatest joys in life was music, singing with choirs in Honolulu, Victoria, and Saltspring.

The CHA Pacific Branch executive for 2001 was unchanged from 2000. James Wilcox was re-elected Vice President for a second term, with Sherman Oraas, Alex Raymond, Brian Schofield, Al Smickersgill, and Alan Thorn rounding out the Executive. Branch membership for 2000 stands at 63 full memberships (including 2 life members and 1 branch member) and 1 sustaining member.

Doug Cartright of CHS Pacific Region presented a slide show of his "Voyage aboard the Replica Endeavour" at the B.C. Maritime Museum in Victoria, in February 2000. Doug signed on as crew on this voyage from Hawaii to New Zealand during December 1999. A social gathering followed at Swan's Pub.

A commemorative plaque for the *C.S.S. Wm. J. Stewart* was designed and manufactured using CHA funds and efforts. The *"Willie J"*, the CHS and the CHA now have a permanent "home" on the Victoria waterfront. The inscription reads: *"CSS Wm. J. Stewart, The flagship of the Canadian Hydrographic Service was based in Victoria Harbour from 1932 to 1975. This plaque is dedicated to those who have served on the 'Willie J' and to all who continue to chart the British Columbia Coast. Donated by the Canadian Hydrographic Association."* The CHA crest accompanies the inscription. In September a dedication of the plaque and an associated commemorative luncheon at the Queen Mary Restaurant in Victoria were held. Former shipmates shared anecdotes and memories of the *Willie J's* days as a working ship. At the end of the dedication an opportunity was given for all those in attendance to ring the ship's bell in memory of a former shipmate or a family member who served on the *"Willie J"*. The *Stewart* has been re-named *Canadian Princess* and has served as a floating hotel and restaurant in Ucluelet, B.C. for the past 25 years.

In February, 2001, Rob Hare presented a paper at the FEMME conference in Victoria on "Multibeam Surveys of Georgia Strait". [Editor's note: See Rob's paper on page 24].

The CHA curling bonspiel for 2000 was held in March, won by the team of Willie and Marg Rapatz and Mike and Barb Bolton. Congratulations! Participation was down from previous years for this event, and it was decided to combine efforts with the GAC (Geological Association of Canada) Pacific Branch, for 2001. This bonspiel was recently held in March 2001, and proved to be very successful. The winning team was Ray Yole (GAC), Steve Taylor (IOS) and Brian Schofield (CHA). More congratulations!! The other social event for this past year was an evening of 10-pin bowling, attended by approximately 30 persons. More bowling events have been planned for the coming year.

The CHA student award winners in 1999 and 2000 were as follows:

- -1999 UVIC Pacific Branch bursary to Stephanie Beitel, Geography Co-op.
- -1999 BCIT Pacific Branch bursary (no award presented).
- -2000 UVIC Pacific Branch bursary to Nathaniel Blake, Geography Co-op.
- -2000 BCIT Pacific Branch bursury to Martin Schael, Geomatics Technology.

Brian Wingerter of CHS Pacific (Nautical Charts and Publications) spent May to December involved with nautical chart production in Laurentian Region of CHS. Ken Halcro (CHS Hydrography) returned from the University of Victoria after graduating with a Bachelor of Science in Computer Science. Doug Cartright is currently on education leave at the University of New Brunswick, undertaking a Masters in Geodesy and Geomatics Engineering, with the Ocean Mapping Group at UNB. Ken Halcro served as a CHS observer aboard the NOAA ship

Rainier on surveys of Bowie Seamount in Puget Sound during the summer of 2000. Doug Cartright also served in a similar capacity on the Rainier during 1999.

Ron Bell, Manager of CHS Nautical Charts and Publications, retired in February 2001 after 38 years with the CHS. Ron began his career in Ottawa in 1963, and was quite involved with the CHA, having served on the executive several times. Good luck and best wishes Ron. As has become tradition, Ron will receive a free CHA membership for 2001.

There was a lot of activity on the "birth" front for CHA members in 2000. Reona Wilcox, born in January to Linda Burgess and James Wilcox (with a 2nd one coming in July 2001). Evan Wills, born in April to Patti Parkhouse and Peter Wills. Espen Lyngberg, in July to Kathy Logan and Knut Lyngberg, Colleen Schofield, in August to Cathy and Al Schofield, and also in August, James Crowley, born to Shirley and Vern Crowley.

Hans Walter Pulkkinen

We are sorry to report the death of our colleague and friend Hans Pulkkinen. He died on Sunday January 28, 2001, in Ottawa, at the age of 90. Hans spent many years exploring and surveying the Canadian Arctic after several years in the Russian Arctic. Hans was a field hydrographer with a long career with the Canadian Hydrographic Service. During his career with the CHS he spent many years on ship based surveys, primarily in Eastern Canada and the Arctic. Hans loved the Arctic and was justifiably proud of his contribution to northern charting and exploration.

During the last few years of his career he was assigned full time to the office of the Polar Continental Shelf Project where his work was devoted exclusively to Arctic activities.

Our sympathies to his family and to CHS staff who have lost an admired colleague.

Ed Lischenski

It is with deep sorrow, our family announces the passing of Ed on Saturday, March 3, 2001, in Winnipeg, Man. He is survived by his son, Boyd (Lori); daughter, Rae (Rémi); mother, Rose; sisters, Rosalie (Stuart) and Joyce (Ed). Ed was born in Pine River, Man., February 13, 1935. He joined the Navy in 1952, and served in Nova Scotia and Esquimalt. He then joined the Federal Public Service in 1956, and started with the Department of Mines and Natural Resources, spending the next 36 years with Canadian Hydrographic Service. Ed considered himself fortunate to spend 18 of those years at the Bedford Institute of Oceanography. Ed had many friends in Nova Scotia. He was always quick to help them with their home renovations and carpentry. He was a good carpenter and a wonderful cook. He was also a member of the Brunch Club. Ed loved the ocean and enjoyed his years in Nova Scotia. As his daughter, I remember fondly his enthusiasm for Dartmouth Natal Day; the days he enjoyed at Malagash and of course our special visits to Grand Desert.
(The Halifax Herald Limited, Saturday, March 24, 2001)

Ottawa Branch

We are very happy to announce the re-activation of the Ottawa Branch, which began in January 2000. The brave souls helping to keep the CHA alive in Ottawa include, David Gray as Vice President, Ilona Monahan as secretary and Jennifer Ross as treasurer. We are also receiving lots of assistance from Paul Holroyd, Marilyn VanDusen, Sheila Acheson and Ralph Renaud.

We'd like to congratulate one of our members, LouAnne Szabo and her husband John on the arrival of their second child. Jake John Szabo who was born Tuesday November 14, 2000 around 4:30 p.m. weighing in at 9lbs 9oz. Congratulations LouAnne!!

Canadian Hydrographic Association
association canadienne d'hydrographique

The CHA would like to send a warm welcome out to Kevin Wisener, the newest member of the Marketing team at CHS. His first big project was the Ottawa Boat Show. The CHS appeared with a brand new kiosk at Landsdown Park and conducted a survey to assess customer satisfaction with our products and to determine the local market. The results were quite interesting. For those interested in finding more out about the results of the survey Kevin can be reached at wisenerk@dfo-mpo.gc.ca. A big thank you to all the volunteers who participated and manned the kiosk.

We hosted a successful Christmas Party at 615 Booth Street, which was attended by CHA members and CHS staff. A great buffet was enjoyed and many door prizes were awarded. Thank you to those who helped set up, decorate and clean up. We also enjoyed a potluck lunch during the holiday season where we got to sample many different cooking styles of CHA members and CHS staff. It appears we have many great chefs in our midst.

David Gray was gracious enough to hold 4 lunch-hour viewings of the A&E production "Longitude" starring Jeremy Irons and Michael Gambon. "Longitude" was an adaptation of the best-selling true story of the lone genius who solved the greatest scientific problem of his age. All those who attended were captivated by this interesting and informative presentation.

The CHA were a proud sponsor of the CHS golf tournament, which was held in August 2000. We are looking forward to support the tournament in 2001. On a more current note the CHA has been organizing a curling tournament, which is going to be held in later March, 2001. A record number of participants have already signed up to partake in the curling tournament. There is also CHA Bar-B-Que and a bowling tournament in the works for the upcoming year. Notification of these events will be sent out once a date has been established.

The Friends of Hydrography meet in Ottawa every Tuesday. They are a small group of retired Canadian Hydrographic Service employees who believe there is a need to record and preserve the historical highlights of Canadian hydrography. They are also interested in promoting the efforts of the hydrographic community with projects that do not fall within the bounds of CHS work activities. Their web site http://www.canfoh.org/ is their main media for publishing information. The site is still in its early stages and some parts are still under construction. They are looking for comments and suggestions and can be emailed at canfoh@hotmail.com.

Prairie Schooner Branch

The PSB agreed to sponsor the Association of Canada Lands Surveyors Offshore Workshop on 8 March 2001 in Halifax for $1500.00.

KIS2001, The International Symposium on Kinematic Systems in Geodesy, Geomatics and Navigation will be held in Banff, Canada, during the period June 5 to 8, 2001. The symposium is organised by the Department of Geomatics Engineering of the University of Calgary. The Convenors are Dr. Gérard Lachapelle (lachapel@geomatics.ucalgary.ca) and Dr. M. Elizabeth Cannon (cannon@geomatics.ucalgary.ca).

The individual members continued to pursue their careers in 2000.

John Brigden carried out Nav QC duties supervising acoustic network calibrations for template placement operations at Terra Nova, and in Nav QC on a seismic vessel offshore Newfoundland.

Bruce Calderbank spent the spring and summer offshore Nova Scotia as a Nav QC on a couple of seismic vessels, and then worked as a Nav QC north of Darwin and on the North West Shelf Australia on another seismic vessel. Bruce continued his voluntary work as Chairman of the ACLS CPD Committee and as a member of the ACLS Offshore Issues Committee.

Mike Chorney completed his secondment to SOEP as the Offshore Logistics Co-ordinator on the Thebaud platform offshore Nova Scotia, and then started as well logistics co-ordinator for Shell Canada's east coast programme in 2001.

Alex Hittel continued expanding All-Can Engineering & Surveys, with work in Northern Alberta and elsewhere.

Paul Sawyer provided engineering and construction management services to a construction consortium in Colombia. The consortium, which consisted of two South American companies and one Canadian company, were provided with an EPC (engineer, procure, construct) contract with Intercor, a coal mining and exporting subsidiary of Exxon Minerals, to construct a 4 million tonne per annum upgrade to the mining operations. The engineering and procurement began in 1998 with the construction ground-breaking starting in late 1999 and continuing through the fall of 2000. Spending the better part of fourteen months in a Latin country was a very interesting and exciting opportunity and most enjoyable.

David Thomson continued expanding the renamed Challenger Geomatics, with work in Northern Alberta and elsewhere.

Wendy Watson of Point Inc was involved with development release of 5 GPS based products for surveying and mapping.

Frank Wisker continued as the marketing representative for Ashtech.

Central Branch

SOCIAL EVENTS

•AGM Our AGM on 7th December 2000 was the 11th Annual General Meeting and Dinner of the CHA, Central Branch. The committee worked hard to make this an enjoyable evening for our members and guests. We would like to thank everyone who contributed to make this evening a success. Members are encouraged to offer new ideas or suggestions for future meetings. Special thanks to our speaker, Captain Prothero, and to the Mimico Cruising Club for once again making their facility available to us.

H2O Organizers (from left): *Brian Power, Jacqueline Miles and Earl Brown*

•H_2O On February 24, 2001, Central Branch hosted the very successful 30th Annual H2O Bonspiel. Once again, the event was held at the *Grimsby Curling Club*. A record 64 curlers participated in the bonspiel and all reports indicate that everyone had a fine time. The curling ice was excellent, the food was superb, the drinks were cold and the comradery was great.

The organizers of this year's event, Jacqueline Miles, Brian Power and Earl Brown, wish to thank all the curlers who made the day a lot of fun. As well, we wish to thank our sponsors for their generosity. This year's prize table had an excellent selection of goodies for all curlers. Our sincere thanks to the sponsors.

This year, for the first time, the First Place trophy was won by a team from out of town. We are pleased to report that our colleagues in the Canadian Coast Guard, from Sarnia, are this year's winners. Congratulations to Skip, Al Beaucage, Vice, Rick Kiriluk (import from Burlington), Second, Ken Brant and Lead, Brian Palmer. The Sarnia residents have already committed to returning next year to defend the trophy. The bonspiel next year will be held on February 23, 2002, at the Grimsby Club so mark your calendar now. We are also pleased to report that last year's winning skip, Brad Tinney, returned this year all the way from Sarnia, but unfortunately was unable to defend his record.

The Beaucage Team: the winners!
From Left: *Ken Brant, Al Beaucage, Rick Kiriluk and Brian Palmer*

Congratulations are also extended to the Second Place winners, Tim Pascoe as Skip, Greg Thiel as Vice, Dave Large as Second and Mark Smithson who played Lead.

The Roll-Off, introduced last year, where each team member draws one rock to the house, was modified this year. This year the Roll-Off points were added to the game scores to determine each team's final score.

H2O SPONSORS

Algoma Central Marine
Applied Microsystems Ltd.
Canadian Coast Guard
Canadian Hydrographic Association- Central Branch
DFO-**Canadian Hydrographic Service**- Central and Arctic Region
CARIS
Coastal Oceanographics Inc.
Emma's Back Porch
DFO-**Fish Habitat Management**- Central and Arctic Region
Kongsberg Simrad Mesotech
Knudsen Engineering
Marshall Macklin Monaghan
McQuest Marine Sciences
DFO-**Small Craft Harbours**- Central and Arctic Region
Smurfit - MBI
Stanley Tools
State Farm Insurance
Upper Lakes Group Inc.

•BBQ The 2000 CHA Central Branch Barbecue was held on July 8th at the Janzen residence, in Grimsby. The weather co-operated nicely, greeting the approximately 25 attendees with a warm, sunny day for the event, and by all accounts, the participants thoroughly enjoyed themselves.

In addition to the standard fare of hamburgers, hotdogs, and refreshments, the participants brought along a wide variety of fantastic salads and desserts – no one left hungry. Tim enjoyed hosting the event and looks forward to doing so again next year. The event also served as the beginning of ticket sales for the Garmin hand-held GPS receiver, which is to be drawn for at the AGM.

MEMBERSHIP

Central Branch welcomed new member: Kirsten Greenfield, Public Works and Gov't Services Canada. Peter C. Bloté has transferred to Prairie Schooner Branch. Our Central Branch membership to date stands at 77, including our Sustaining Member Kongsberg Simrad Mesotech Ltd. Central Branch is honoured to include several special people in its membership rolls: Earl Brown, Tom McCulloch and Ab Rogers, Life Members; George Macdonald, Honorary Member; and Steve Ritchie, International Life Member. These people have contributed greatly to CHA over the years.

INTERNATIONAL MEMBERS

Central Branch of the CHA administers the International Members on behalf of the National Office. This committee helps to maintain contact with the 15 International members of the CHA and ensures they have an opportunity to voice opinions and take part in CHA activities. We encourage communication between our far-flung members with help from Larry Robbins, who is an International Member in New Zealand. All International Members receive the Central Branch NewsLetter to keep in touch between issues of the CHA Journal *Lighthouse*. We are glad to welcome George Pugach as an International Member this year. George was formerly Vice-President of CHA Prairie Schooner Branch and represented CHA at the recent Oil & Gas Conference in Baku, Azerbaijan.

NEWSLETTER

Since 1987, Central Branch has produced a regular NewsLetter to help us keep in touch with our Members. The committee mails the NewsLetter as soon as possible after each business meeting to distribute minutes and news of coming events. The summer and fall issues are larger and have more space for news and other interesting items. Including the coming December issue, we will have had seven NewsLetters this year. Circulation is about 110, with copies going to the other Branches and to our Sustaining Members as well as other interested people around the world.

The NewsLetter carries messages from our National President and our Branch Vice-President and offers a forum for individual members to share their news and views. Our thanks go out to all those who contributed articles this past year, with special thanks to Larry Robbins, our regular International Columnist. Larry's column helps our International Members keep in touch and, incidentally, helps to remind us of the special strengths they bring to the CHA.

Central Branch maintains a web site that includes the NewsLetters and lists of Central Branch Executive members, Committee members and the membership. It also provides links to members who have email addresses, information on Lighthouse abstracts, and awards offered by CHA. All comments, suggestions and submissions are welcome to help build a more exciting site.

LIGHTHOUSE

Lighthouse Edition 58 is undergoing layout and should be at the printers at this time. Thank you to everyone who contributed to this edition. Edition 59 will feature some changes, the most prominent being a facelift (new cover). Please search through your photos for your favourite lighthouse photo and send it to the Editor along with a brief description.

GERRY WADE LIBRARY

There wasn't much activity by the Gerry Wade Library committee this year. There was some correspondence from a student expressing interest in the Gerry Wade Essay Award. The author was informed that the award had been discontinued, but was asked for a copy of the essay for possible publication in Lighthouse, and was referred to Barry Lusk and the CHA Academic Award program. While the library material continues to grow in volume, so does the task of housing it. Tim has still not been able to locate a suitable bookcase to store and display the material, but now has a good lead on where such an animal can be purchased.

HERITAGE LAUNCH

The Admiralty Launch *Surveyor* and her crew started their season on April 14th with a fundraiser, lunchtime BBQ at Canada Centre for Inland Waters, Burlington. The proceeds from this year's fundraiser were donated to a local Burlington couple who lost their possessions to a house fire. A week later, over the April 21-23rd weekend, the Launch and a few crew members participated at the Upper Canada Trade Fair, a gathering of 19th C sutlers and reenactors, in Odessa Ontario. On June 9th, *Surveyor* became the latest addition to the fleet at Discovery Harbour, Penetanguishene when ownership of the Launch was transferred to the Marine Heritage Association. For most of June and July, under the management of Discovery Harbour staff, *Surveyor* served as a training vessel for local students.

During Canada Day weekend, June 30th to July 2nd, we sounded the way into the beaches east of Toronto as a landing vessel from the topsail schooner, *HMS Tecumseh*, in a reenactment of the American Invasion of 1813. Later that month, a number of crew members made their way east to participate in Tall Ships 2000, July 20 to 24th, Halifax, Nova Scotia. Most of our crew were billeted aboard *CSS Acadia*, a former Hydrographic Service vessel, now an exhibit at the Maritime Museum of the North Atlantic. Thanks to CHS Central and Arctic Region, a house flag (flown by *Surveyor*) showing the CHS crest was sent to the Maritime Museum as a gesture of thanks for their support as a base of operations during the event. Many thanks also go out to the hydrographers and friends down Halifax way for their camaraderie and help under sail and behind the oars.

The city of Sarnia, Ontario hosted a second Tall Ships event during the weekend of August 18 to 20th. The *Surveyor* and crew were there to represent Fisheries and Oceans and a hydrographic reenactment, narrated by Leigh Morrison, was given to the visiting public. The season wrapped up with a return to the Faire at the Forks, Chatham on September 29. As in the past, the event was attended by busloads of elementary school children (approximately 5000) to whom our crew entertained and answered questions about hydrography.

Thank you to those who once again gave of their time and efforts to help prepare the *Surveyor* for sea, to sail, row and staff the displays. Thank you also to DFO Science, CHS and the Marine Heritage Association (MHA), whose support has kept *Surveyor* and our program ship shape. It is our hope that through our new relationship with the MHA, we will be able to sustain *Surveyor* and reach a larger audience through their *Living history* program at Discovery Harbour while continuing to demonstrate the role of hydrography in Canadian history. As always, we encourage you to come out and join us, you're always welcome aboard.

SEMINARS

January: The first meeting of the year 2000 included a presentation on Discovery Harbour by Mr. John Barrett Hamilton, general Manager, Huronia Historical Parks. The meeting was held at the Duller/Morrison residence in Burlington.

February: The gathering spot for the second meeting was at Dan Dexel's house. The seminar consisted of a video presentation of the *Surveyor* in Halifax for the 250th anniversary celebrations in the summer of 1999.

March: A presentation from Mr. Dave Monahan on the United Nations Convention on Law of the Sea (UNCLOS) at the Weller's residence marked the third meeting of the year.

July: On July 8th the fourth meeting of the year was held at Tim Janzen's residence in Grimsby and included the Central Branch Summer BBQ where a good time was had by all.

October: Mr. Frank Zeritsch co-owner of Thirty Bench Vineyards and Winery hosted the meeting. He was also the invited guest speaker, explaining the history of the winery and some insights on the creation of their wine.

November: The speaker was Mr. Jim Berry, Central Branch member and Project manager with the Toronto Region Conservation Authority (TRCA). An informative talk and slide show was presented by Jim on TRCA activities. This last meeting was hosted by Brian at the Power residence.

Thank you to all the hosts and speakers for their time and presentations. And thank you to Sean Hinds and all the other members for their efforts in finding speakers and meeting locations.

AGM Guest Speaker

Captain Doug Prothero is the founder and President of the Great Lakes Schooner Company. He has completed a BA and Graduate Studies in Maritime History and is a Transport Canada Certified Master.

The *Kajama* (kai-ama) was launched as the *Wilfried* in Rendsburg, Germany in 1930, and traded under sail for nearly 70 years. She was a familiar ship in ports from Northwest Spain, through Western Europe, and as far north as Norway and Russia. In 1999, *Kajama* was delivered transatlantic by *Great Lakes Schooner Company* and restored to her original profile. Starting with a search throughout Scandanavia, a refit in Denmark, a very complicated delivery from Europe, and an efficient 10-month restoration in Canada.

The Schooner Kajama

The *Kajama* is a 164-foot, three-masted, gaff-rigged schooner, steel-hulled cargo vessel with a wineglass stern. She is currently operated by the *Great Lake Schooner Company* as a charter boat. Her burthen can comfortably accomodate parties of up to 225 people in a spacious single dining room (1,006 square foot, open and airy venue with natural lighting and ventilation through massive skylights).

THE CANADIAN HYDROGRAPHIC ASSOCIATION AWARD
LA BOURSE DE L'ASSOCIATION CANADIENNE D'HYDROGRAPHIE

(est. 1992 / établie en 1992)

$2,000 for a "Deserving Student" / 2000$ pour un étudiant méritant

1. The applicant must be a full time student registered in an accredited survey science program (the program must have a Geographic Information Systems, Cartographic, Land or Hydrographic Survey component) in a university or technological college anywhere in Canada. The Administrator of this award will determine the eligibility of the program for the award.

2. The award will be available only to students who are in their second year of study in the degree or diploma program (under graduate) that conforms to the basic subject topic. The applicant will be required to submit a transcript of his/her first year marks at the time of application. The marks must indicate an upper level standing in the class and under no condition less than 70%.

3. The award will be presented to an applicant who can demonstrate a bona fide financial need, coupled with an above average academic performance as stated above.

4. The applicant will be required to write a short paragraph explaining his/her financial need in a clear, concise manner on the application form or, if necessary, attached piece of paper. The importance of this aspect of the application is emphasized.

5. The award application will be submitted to the Administrator of Canadian Hydrographic Association Award Program by June 30 each year and to the address in item 11 below.

6. The value of the award is $2,000. There is one award only each calendar year.

7. The successful applicant will be issued with a special Hydrographic Association Certificate, duly framed, at the time the award is made. He/She will also receive a medallion with the Hydrographic Association Crest and have his/her name mounted on a perpetual winner's plaque. A picture of the plaque duly inscribed will be mailed to the winner along with the $2,000 cheque during the second week of July.

8. The applicant must submit one letter of reference from a official of the university or college where the applicant spent the previous year. This letter of reference must include the address and phone number of this official.

9. An individual student may receive the award once only.

10. The successful applicant's letter of appreciation will be published in the next issue of our professional journal "Lighthouse".

11. Application will be made on the form supplied, which is available from your school's awards office, and sent to:

Critères d'admissibilité:

1. Le candidat doit être un étudiant inscrit à plein temps à un programme reconnu en sciences géodésiques (ce programme doit inclure les systèmes d'informations géographiques, la cartographie, les levés terrestres et hydrographiques) dans une université ou un collège au Canada. L'administrateur de cette bourse déterminera l'éligibilité du programme pour la bourse d'études.

2. La bourse s'adresse seulement aux étudiants qui seront à leur deuxième année d'étude dans un programme menant à un diplôme collégial ou de premier cycle universitaire conforme aux sujets de base. Le candidat doit soumettre une copie de son relevé de notes de sa première année avec sa demande. Les notes doivent être supérieures à la moyenne et avoir une moyenne inconditionnelle supérieure à 70 %.

3. La bourse sera remise au candidat qui, de bonne foi, peut démontrer ses besoins financiers et qui respecte les performances académiques exigées ci-haut.

4. Le candidat devra écrire un court texte, d'une manière claire et concise, démontrant ses besoins financiers sur le formulaire de la demande ou, si nécessaire, sur une lettre jointe. Une grande importance est accordée à cet aspect de la demande.

5. La demande doit être soumise à l'administrateur du programme de la bourse de l'Association canadienne d'hydrographie au plus tard le 30 juin de chaque année à l'adresse mentionnée à l'article 11 ci-bas.

6. La valeur de la bourse est de 2000 $. Il n'y a qu'une seule bourse remise à chaque année civile.

7. Le récipiendaire recevra un certificat spécial de l'Association canadienne d'hydrographie, dûment encadré . Il recevra aussi un médaillon à l'effigie de l'Association canadienne d'hydrographie et son nom sera ajouté sur la plaque des gagnants. Une photo de la plaque gravée sera postée au gagnant avec un chèque de 2000 $ au cours de la deuxième semaine de juillet.

8. Le candidat doit soumettre une lettre de référence d'un représentant de l'université ou du collège où il a suivi son cours l'année précédente. Cette lettre de référence doit inclure l'adresse et le numéro de téléphone de ce représentant.

9. Un étudiant peut recevoir la bourse qu'une seule fois.

10. Une lettre d'appréciation du récipiendaire sera publiée dans l'édition suivante de notre revue professionnel "Lighthouse".

11. La demande devra être faite sur le formulaire prescrit, lequel est disponible aux bureaux de vos écoles, et envoyée à :

Barry M. Lusk, Manager / Administrateur

Canadian Hydrographic Association Award Program / Bourse de l'Association canadienne d'hydrographie

4719 Amblewood Drive, Victoria, B.C. V8Y 2S2

email/ Courriel luskbm@telus.net Fax : 250 658 2036 Web site: chswww.bur.dfo.ca/dfo/chs/cha

members membres

INTERNATIONAL MEMBERS OF THE CANADIAN HYDROGRAPHIC ASSOCIATION

Membership in the Canadian Hydrographic Association is open to anyone interested in maintaining a link with hydrography in Canada. People who live or work in other countries or who are not conveniently located to existing CHA branches can become international members with the same rights and privileges as other members.

As authorized under the CHA by-laws, the National President has arranged for Central Branch to continue administering the International section of the CHA membership. Under this arrangement we endeavour to ensure that all international members receive the same level of service. International members may also join the branch of their choice.

International Membership is $30.00 (Canadian) per year, or the equivalent in Sterling or US currency. This includes a personal membership certificate suitable for framing along with annual update seals as well as copies of our journal Lighthouse each spring and fall.

Each internatioanl member also receives the Central Branch Newsletter. This helps our far-flung members keep in touch between issues of our journal and also offers a forum for members to share views and concerns.

Commander Larry Robbins of the Royal New Zealand Navy is our international correspondent for the Newsletter and writes a regular column with items of interest to international members. Drop snippets of news to him at: 42 Knights Rd., Rothesay Bay, Auckland 1311, New Zealand, Tel/Fax (+64) 9 410 2626. All scraps are very welcome! And if you have special news or views you are most welcome to write something longer for the newsletter or Lighthouse. Letters to the Editor are also welcome.

International Members of the Canadian Hydrographic Association

Reha Metin Alkan	*Turkey*
Capt. F. Angelini (ItN)	*Italy*
Peter Barr	*Australia*
Geunter Bellach	*Thailand*
Fosco Bianchetti	*Italy*
Giuseppe Biscontin geom	*Italy*
Gary Chisholm	*New Zealand*
Luis Leal de Faria	*Portugal*
James P. Detar	*Italy*
Ron Dreyer	*West Indies*
Nick Emerson	*Hong Kong*
Randall J. Franchuk	*U.S.A.*
Ronald Furness	*Australia*
George Goldsteen	*Australia*
Adam J. Kerr	*United Kingdom*
Karl Kieninger	*U.S.A.*
Peter Knight	*New Zealand*
Universiti Teknologi Malaysia	*Malaysia*
Charles David Meador	*U.S.A.*
Rear Admiral Steve Ritchie (Retíd)	*Scotland*
Cdr. Larry Robbins	*New Zealand*
Reid Sandford III	*U.S.A.*
Paul Sanson	*France*
Kevin Smith	*New Zealand*

HINTS TO AUTHORS

Lighthouse publishes material covering all aspects of hydrography.
Authors submitting manuscripts should bear the following points in mind:

1. A hardcopy complete with graphics including tables,figures, graphs and photos.
2. Digital files, one with text only and a separate file for each graphic (tables, figures, photos, graphs) in its original form or in .tif format (300 DPI). Photos may be submitted separately to be scanned. These may be submitted via E-mail or on CD ROM to the Editor.
3. Papers should be in either English or French and will be published without translation.
4. An abstract, information about the author(s) and contact information should be included.

rates tarifs

POSITIONING / EMPLACEMENTS

The acceptance and positioning of advertising material is under the sole jurisdiction of the publisher. However, requests for a specified position will be considered if the position premium of $25 has been included in the insertion order.

L'approbation et l'emplacement de l'annonce sont à la discrétion de l'éditeur. Cependant, toute demande d'emplacement spécifique sera considérée si une prime de 25 $ est ajoutée à la demande de parution.

MECHANICAL REQUIREMENTS EXIGENCES MÉCANIQUES

Advertising material must be supplied by the closing dates as camera-ready copy or film negatives (Colour ads must be film negatives). Copy preparation, including colour, bleed and photos will be charged at the printer's cost plus 10%. Proofs should be furnished with all ads.

Single-page inserts will be charged at a full page body rate. Material must be supplied by the client. Page size must conform to the single page insert trim size (below).

L'annonce publicitaire doit être un prêt à photographier ou sur film négatif (les couleurs supplémentaires doivent être sur film négatif) et être fournie aux dates de tombée. La préparation de copie couleur, à fond perdu et de photos sera chargée au tarif de l'imprimeur plus 10%.

Les épreuves devraient être fournies avec tous les suppléments. Les insertions d'une page seront chargées au tarif d'une pleine page. Le matériel devra être fourni par le client.

DIGITAL REQUIREMENTS EXIGENCES NUMÉRIQUES

Ad material may be submitted in digital form, if colour .tif format and if black and white .pdf format.

L'annonce publicitaire peut être soumis sous forme numérique en for-mat .tif pour la couleur et en format .pdf pour le noir et blanc.

PUBLICATION SIZE DIMENSIONS DE LA PUBLICITÉ

Publication Trim Size/ Dimension de la revue:	8.5"	x 11.0"
Live Copy Area/ Encart libre:	7.0"	x 10.0"
Bleed Size/ Publicité à fond perdu:	8.75"	x11.25"
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1/2 Page/ Demie-page:	6.875"	x 4.75"
or/ ou:	3.375"	x 9.75"

PRINTING / IMPRESSION

Offset screened at 133 lines per inch.
Internégatif tramé à 133 lignes au pouce.

CLOSING DATES / DATE DE TOMBÉE

LIGHTHOUSE is published twice yearly in Spring and Fall. The closing dates are March 15th and October 15th respectively.

LIGHTHOUSE est publiée deux fois par année, au printemps et à l'au-tomne. Les dates de tombée sont le 15 mars et le 15 octobre respectivement.

RATES / TARIFS

All rates are quoted in Canadian Funds. Sustaining Members receive a 10% discount.

Tous les tarifs sont en devises canadiennes. Les membres de sou-tien ont droit à un rabais de 10%.

	B &W/N & B	Colour/Couleur Une/Spot*	Four/Quatre
Outside Back Cover *Couverture arrière*	NA/SO	NA/SO	$1025
Inside Cover *Couverture intérieure*	NA/SO	NA/SO	$825
Body, Full Page *Pleine page*	$275	$375	$675
Half Page Demie-page	$200	$300	$675
Single-page Insert Insertion d'une page	$275	$375	$675
Professional Card Carte d'affaire	$125	$225	NA/SO

*Spot Colour (Orange, Red, Blue)/Une couleur (orange, rouge, bleu)

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Les tarifs sont assurés aux termes des contrats publicitaires jusqu'à concurrence d'un an. Les annulations ne sont pas acceptées après la date de tombée.

All advertising material should be directed to:
Tout le matériel publicitaire doit être acheminé à:
Advertising Manager/ Directeur de la publicité

LIGHTHOUSE
P.O. Box 5050 867 Lakeshore Rd., Burlington, ON L7R 4A6
Telephone (905)336-4558 Fax (905)336-8916
E-mail lighthouse@car.dfo-mpo.gc.ca

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Valeport tide gauges are in use in ports & harbours throughout the world, either as permanent installations for port operations, or at temporary sites for hydrographic and dredging surveys.

- Range of instruments and configurations to suit a variety of requirements and budgets
- Optional meteorological sensors
- Multigauge network systems
- Data telemetry options

WAVE RECORDERS

Powerful onboard processing and large memory capacities make the Valeport range of wave recorders ideal for use in all shallow water applications, where either logged or real time wave data is required.

- Real time output of all wave parameters
- Up to 32Mbyte memory
- Highly configurable sampling regimes
- Processing software included

Contact us for more information on these world leading products, and on our other ranges, including Current Meters, CTDs and Multi-parameter Loggers

McQuest, 489 Enfield Road, Burlington, Ontario L7L 2X5
Tel: (905) 639 0931 Fax: (905) 639 0934
e-mail: email@mcquestmarine.com Web: mcquestmarine.com

Valeport Ltd, Townstal Industrial Estate, Dartmouth, Devon, UK. TQ6 9LX
Tel: +44 (0)1803 834031 Fax: +44 (0)1803 834320
e-mail: sales@valeport.co.uk Web: www.valeport.co.uk