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LIGHTHOUSE

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Spring Issue	March 1 / 1er mars	Édition du printemps
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Message from the National President / Mot du Président national

Hi !

While CHA continues to excel in its' many objectives and activities, I would like to focus at this time on the broad topic of "information exchange" something to which CHA is no stranger.

During '93 CHA accomplished or participated in five major information exchange events.

We :

- *conducted a workshop on "Geomatics and the Marine Environment" in conjunction with the Geomatics Industry Association of Canada;*
- *assisted the Canadian Hydrographic Service and Canadian Institute of Geomatics at the joint CHS/CIG Surveying and Mapping Conference in Toronto in June, by staffing the registration desk as well as performing many ancillary tasks;*
- *completed the construction of a 1792 Heritage Hydrographic Launch and conducted many historical re-enactments demonstrating 1790's hydrographic surveying methods. The Launch was crewed by Central Branch members who were accompanied by other CHA Branch members and non-CHA members at marine events within Canada and the United States;*
- *finalized with the Canadian International Development Agency, Management for Change Program, the third phase of the Malaysia Hydrographic Training project; and*
- *awarded the **FIRST** CHA Academic Award to Darren Colford at the College of Geographic Sciences, Lawrencetown, Nova Scotia.*

All these "information event" activities demonstrate the vitality of the CHA and that we are building for tomorrow. A tomorrow which through the efforts of many, but perhaps foremost the efforts of the CHA Academic Awards Committee chaired by Barry Lusk, CHA will continue its' tradition of exchanging information and developing knowledge.

At the outset I focused on five major information events, I would like to close by redefining "major information events" as events which involve you and your Branch and encourage you to make the most of the coming months with CHA.

Regards

Dave

First CHA Academic Award

CHA President Dave Pugh presenting the first CHA Academic Award to Darren Colford, College of Geographic Sciences, Lawrencetown, Nova Scotia

1992 Lighthouse Awards

Best Non-Technical Paper:
Dr. Fosco Bianchetti
"The ECDIS Paradox"
(Fall Edition)

Best Technical Paper:
Peter R. Milner and James L. Galloway
"A Field Evaluation of the KAE Fansweep - A Portable, Shallow-Water, Multi-Beam Sonar System"
(Spring Edition)

The Canadian Hydrographic Association / L'Association canadienne d'hydrographie

Academic Award / Bourse d'étude

(established / constituée en 1992)

Rules for eligibility:

1. The applicant must be a full-time student registered in an accredited program related to Hydrography (these programs include, Geomatics, Geography, Cartography or Survey Sciences) in a university or technological college in Canada. The CHA Academic Award administrators reserve the right to determine applicability of the program.

2. The award will be available only to students who have completed at least one year of instruction in the program.

3. The applicant will be required to write a 500 word paper on the relationship of their academic work to hydrography.

4. The applicant will be required to write a short paragraph explaining how this financial award will assist them in their academic career.

5. The awards applications must be submitted to the CHA Academic Awards Manager by the end of June of the applicable year. The award will be given by September 15th of the same year. All officials from the academic institutes of students submitting applications will be notified by mail of the results.

6. The value of the award will be $ 2000.00.

7. The successful candidate will receive a special Canadian Hydrographic Association certificate.

8. The successful candidate will be requested to write a letter of appreciation to the CHA for publication in "Lighthouse".

9. The award will be presented to an individual only once.

10. At the time of application, the applicant will be required to submit an official transcript from their academic institute indicating their previous year grades.

11. The applicant must submit one letter of reference from an official of the university or college at which the applicant spent the previous year. The letter of reference must include the address and phone number of the official.

12. Applications must be made on forms supplied by, and submitted to:

Barry Lusk,
Academic Awards Manager,
CHA Academic Awards Program,
9860 West Sannich Road,
Sidney, B.C.
V8L 4B2.

Critères d'admissibilité:

1. Le postulant doit être un étudiant à plein temps, inscrit à un programme reconnu dans le domaine de l'hydrographie (comme géomatiques, géographie, cartographie ou sciences des levés) à responsables de la bourse d'étude seréservent le droit de décider si le programme est conforme.

2. La bourse ne sera disponible qu'aux étudiants ayant complété au moins une année de formation dans un programme avec diplôme ou licence relié à l'hydrographie.

3. Le candidat devra présenter un travail de 500 mots portant sur la relation entre sa formation scolaire et l'hydrographie.

4. Le candidat devra présenter un court paragraphe expliquant comment cette bourse aidera à son état d'étudiant.

5. Les formulaires d'inscription pour une bourse doivent être soumis au directeur aux bourses d'études de l'ACH d'ici la fin juin de l'année concernée. La bourse sera versée avant le 15 septembre de la même année. Les responsables du corps enseignant d'un établissement dont des membres ont postulés recevront les résultats par la poste.

6. Le montant de la bourse est de 2000 dollars.

7. Le candidat sélectionné recevra un certificat spécial de l'ACH.

8. L'étudiant qui reçoit la bourse devra remercier l'ACH par lettre, lettre qui sera publiée dans «Lighthouse», revue de l'ACH.

9. La bourse n'est remise qu'une seule fois à une personne.

10. Le postulant devra fournir au moment de la demande, une copie officielle provenant de l'établissement d'enseignement des notes obtenues lors des années précédentes.

11. Le postulant doit présenter une lettre de référence d'un représentant de l'université ou du collège où il a passé la dernière année. Cette lettre doit porter l'adresse et le numéro de téléphone du représentant.

12. On doit utiliser les formulaires fournis et les faire parvenir à:

Barry Lusk,
Directeur aux bourses d'études,
Programme de bourses d'étude de l'ACH,
9860 West Sannich Road,
Sidney (C.-B.)
V8L 4B2.

Letters to the Editor / Lettres au rédacteur en chef

Greetings from The Hydrographic Society

It is a great honour and privilege to extend greetings to our sister society - the Canadian Hydrographic Association - on the occasion of the CHA Annual General Meeting in Toronto on June 9, 1993.

Our two organizations have a good history of close relationship which I am sure will increase and expand as we go forward to the 21st century.

We look forward to welcoming CHA members to our Ninth Biennial International Symposium, Hydro '94. This event is being organized by the United Kingdom Branch and will be held in Aberdeen, Scotland 13-15 September, 1994.

I shall be retiring as President at our next Annual General Meeting in October, and look back, with great pleasure to the highlight of my two year tenure of Office - my attendance at "Geomatics in the Marine Environment" and the Surveying and Mapping Conference in Toronto. It is a pleasure to have enjoyed your warm welcome and generous hospitality.

Thank you very much, et je vous remerci.

Geoffrey Haskins
President
The Hydrographic Society

CHA Academic Award

Dear Sirs:

Thank you for awarding me the first annual scholarship, valued at $2,000.00, from the Canadian Hydrographic Association.

This prize will ease my financial worries a great deal in the coming year. I hope future recipients appreciate your generosity a much as I do.

It goes to show that hard work does pay after all. Again, thank you.

Sincerely Yours

Darren Colford
Doaktown, New Brunswick

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A Public/Private Sector Alliance for the Production and Distribution of Electronic Charts

by B. F. Terry and N. M. Anderson

The time has come for private industry and government hydrographic agencies to work together more closely in the development and production of electronic charts.

This paper discusses the need for close co-operation and describes the formation of a new co-operative venture: Nautical Data International Inc. This company was formed to work with the Canadian Hydrographic Service and to use official hydrographic survey data to customize and market electronic charts for clients in Canada. The company also plans to pursue similar joint ventures with industry in other countries.

Une alliance des secteurs public et privé pour la production et la distribution des cartes électroniques

par B. F. Terry et N. M. Anderson

Le temps est venu pour l'industrie privée et les agences hydrographiques gouvernementales de travailler plus étroitement ensemble au développement et à la production de cartes électroniques.

Cet article traite du besoin plus étroit de coopération et décrit la formation d'une nouvelle entreprise de coopération: Nautical Data International Inc. Cette compagnie a été formée pour travailler avec le Service hydrographique du Canada afin de standardiser les données hydrographiques officielles et de commercialiser les cartes électroniques pour des clients au Canada. La compagnie prévoit aussi établir des partenariats similaires avec l'industrie dans d'autres pays.

A Modern Quantification of Historic Hydrographic Data Accuracy

by R. Hare and D. Monahan

The demand for digital, geo-referenced hydrographic data for Electronic Chart Display and Information Systems (ECDIS) is forcing the Canadian Hydrographic Service to digitize historic hydrographic documents, as a way to supplement the data collected by modern digital surveys. With publicly-available Differential GPS, mariners now have at their disposal positioning that is more accurate than what was used to collect the data on these historic documents. In order for mariners to perform reliable risk assessment with an ECDIS, the accuracy of the data created by digitizing historic documents must be known. This paper discusses error sources in data collection, representation and digitization and some of the approaches used to quantify digitized historic data accuracy. Results and problems encountered to date are presented along with suggestions for automating accuracy quantification.

Une quantification moderne de la précision des données hydrographiques historiques

par R. Hare et D. Monahan

La demande de données hydrographiques obtenues par référence géographique pour les systèmes électroniques de visualisation des cartes marines (SEVCM) force le Service hydrographique du Canada à chiffrer des documents hydrographiques historiques pour ajouter aux données recueillies au moyen des relevés numériques modernes. Avec le positionnement par mode différentiel disponible pour tous, les navigateurs peuvent maintenant trouver leur position avec plus d'exactitude qu'avec ces documents historiques. Pour que les navigateurs puissent bien évaluer les risques avec un SEVCM, l'exactitude des données créées en chiffrant les documents historiques doit être connue. Ce document expose les sources d'erreurs dans la collecte, la représentation et le chiffrage des données, ainsi que certaines des approches utilisées pour quantifier l'exactitude des données historiques. Les résultats et les problèmes sont présentés avec des suggestions pour automatiser la quantification de l'exactitude.

An Analysis of Captain Cook's Longitude Determinations at Nootka, April 1778

by N. A. Doe

The longitude determined in 1778 for Nootka, British Columbia, has an unusually large error. Captain Cook and his two astronomer assistants were careful observers so how could any mistakes have been overlooked?

This paper discusses the methods used by navigators and astronomers before the days of accurate time signals. The author reports on his analysis of the early computations and his efforts to recalculate the position of Nootka using the original data recorded by the three observers in 1778.

Une analyse de la détermination de la longitude par le capitaine Cook à Nootka en avril 1778

par N. A. Doe

La longitude établie en 1778 à Nootka, Colombie-Britannique, comportait une grande erreur inusuelle. Comment se fait-il que le capitaine Cook et ses assistants astronomes ne se sont pas aperçus de l'erreur puisqu'ils étaient de fins observateurs?

Cet article présente les méthodes utilisées par les navigateurs et les astronomes avant l'arrivée de mesures précises du temps. L'auteur rend compte de son analyse des calculs et de ses efforts pour recalculer la position Nootka en utilisant les données originales enregistrées par les trois observateurs de 1778.

The ASIA Tragedy

by M. J. Casey

In September 1882, the steamer ASIA sank in a storm in Georgian Bay (Lake Huron). With the loss of the ship and all but two of the 120 people on board, this was the worst Canadian shipping disaster of the times. There was much speculation on the cause of the tragedy.

This article, first published in Lighthouse Edition 12 (1975), discusses the sinking of the ASIA and shows how this event focussed public attention on the need for a large scale charting program and thus led to the founding of the forerunner to the Canadian Hydrographic Service the following year.

La tragédie du Asia

par M. J. Casey

Lors d'une tempête, en septembre 1882, le navire à vapeur ASIA coula dans la Baie Georgienne (Lac Huron). La perte de ce navire et de ses 120 passagers, sauf deux, constituait le pire désastre maritime canadien du temps.

Cet article, paru d'abord dans l'édition 12 (1975) du Lighthouse, relate le naufrage du ASIA et montre comment cet évènement attira l'attention du public sur le besoin d'un programme de cartographie à grande échelle qui conduisait, l'année suivante, à la fondation de ce qui devait devenir le Service hydrographique du Canada.

A Public/Private Sector Alliance for the Production and Distribution of Electronic Charts

by

Brian F. Terry and Neil M. Anderson

> "Undoubtedly the main shortcoming at present is the database or electronic nautical chart. The development of this database is very clearly the responsibility of national hydrographic offices."
>
> —Adam Kerr, Chairman - IHO Subcommittee on ECDIS, January 1992.

> "What became very clear [at the SMM'92 exhibition] ... is that electronics manufacturers have tired of waiting for the hydrographic community ... and, in the absence of official charts, are forging ahead on their own."
>
> —Ocean Voice, January 1993.

Introduction

The development of electronic chart technology has now been unfolding for more than a decade. Many Hydrographic Offices (HO's) have undertaken electronic chart projects and in cooperation with the International Hydrographic Organization (IHO) have been developing plans to meet the future needs of the growing electronic chart industry. In the meantime the electronic chart manufacturers have had to produce electronic chart data for their particular systems from existing paper charts.

It has become increasingly apparent over the last few years that neither the public nor the private sector can independently meet the needs of this industry along the same lines that paper charts were supplied to the mariner. On the one hand, electronic chart systems are not standardized for the use of electronic chart data and it is unlikely that this will be the case for the foreseeable future. Data must be processed and customized for the particular systems and/or for specific applications. These requirements can best be met by the private sector which is market oriented and allows for a variety of value-added processing companies to compete to provide these services. On the other hand, the responsibility for the collection, management and distribution of hydrographic information - including nautical charts - is the responsibility of government HO's. Their principle concern is safety of the mariner; they must also ensure that qualified hydrographic information is processed and made available to the mariner in the most expeditious way. Furthermore, electronic chart production requires access not only to the data now contained on the standard nautical chart, but also to the source data used to compile the charts. Therefore, it has become increasingly clear that some form of public/private partnership would be the best way to meet the needs of this emerging industry.

Background

At the ECDIS '93 conference in Baltimore, U.S.A., there were more than ten electronic chart systems on display and over the next few years there will be many more systems entering the marketplace. Some are vector based, others are raster based and there are some hybrid systems. Some are simple low-cost systems while others are more expensive and form part of an integrated bridge system. The development of these systems is possible because of the dramatic improvements in enabling information technologies including computers, high resolution graphics, large volume data storage systems, and particularly the two key technologies Global Positioning System (GPS) and Geographic Information Systems (GIS).

All of the electronic chart systems represent innovative new approaches to the display and use of navigation information. Innovation is the driving force and will continue to be so for many more years.

In a paper on hydrographic technology delivered at the 1991 CHS conference in Rimouski, Québec, N. Anderson described the three distinct stages of growth of an industry from the introduction of innovative new technology to its maturity and common use in society. At that time, electronic chart technology was clearly still within the early innovative stage of development, characterized by innovation, excitement, experimentation and instability. This is the period of the early adopters, those who are attracted to new ideas, driven by curiosity and like to experiment. This is also the period when many companies arrive quickly on the scene only to disappear with equal suddenness, often because there is not yet a mature infrastructure or market.

The second stage shifts the focus away from the technology itself to the enhancement of the enabling technologies and the supporting infrastructure necessary to realize the full potential of the new technology. This stage requires investment, usually from governments, to support the building of infrastructure. Unfortunately, while this support is needed, there is generally no wide public acceptance of the technology nor is there yet a strong market demand. This is the current stage of the electronic chart industry.

It is during this period that cooperation between the public and private sectors is critical; in the case of hydrography, international cooperation is equally important. Strategic alliances that bring together companies, governments and countries with complementary skills are required to fully develop this stage of growth. Virtually all industries have had these alliances for financing, developing standards and regulations, training and education as well as for cooperative pilot projects. All are important in this period. While innovation and experimentation highlight the first stage, improved common services characterize the second stage.

Several projects have already been carried out that lead towards the development of these services. The Norwegian Hydrographic Service has led the way on several of these projects and has already begun work on developing a concept for a worldwide distribution network for electronic charts. This concept is being supported by many of the member states of the IHO. The IHO is also very involved in the development of standards and many HO's have begun to convert their graphic data to electronic chart data.

The Electronic Chart Consortium

In 1990 a group of public and private organizations in Canada and Norway formed a consortium to review the current developments in electronic charts, to assess the needs of the emerging industry for an electronic chart infrastructure, and to assess the business opportunities in creating that infrastructure. One of the conclusions of this work was the recognition that there would be a continuing need to customize software and data for the variety of systems that were becoming available in the marketplace. Furthermore, a computerized version of the conventional paper chart would not be adequate to exploit the opportunities in information technology that make it possible to customize software and digital data to better meet the needs of a variety of users.

It was also concluded that cooperation would be needed between the public sector, i.e. the HO's which have the responsibility and mandate for hydrographic information, and the private sector, which is best positioned to respond to the demands of the marketplace.

In other words, the private sector needs full access to qualified data beyond what is available on the paper nautical chart in order to meet the needs of the emerging electronic chart industry. And the HO needs to ensure that there are comprehensive quality assurance procedures followed not only within their own organizations, but throughout the value-added stream of processing from the collection of the data through to use by the mariner.

Canadian Electronic Chart System Producers

In Canada two companies producing electronic chart systems have very different data requirements for their respective systems. Offshore Systems Ltd. (OSL) produces ECPINS, a vector based system, and has been creating electronic charts designed specifically for that system. Matrix Technologies Inc. produces Infonav, a raster based system, and is producing electronic charts also specifically designed for its system. At present this is the approach necessary for all electronic chart system producers because the required data is not readily available from the HO's.

These two companies have come together to form a new company, Nautical Data International, Inc. (NDI), to address their common need for electronic chart data, and the needs of the industry in general. Over the past several months, NDI has worked with the CHS to develop a public/private sector alliance that will address the issues outlined in this paper. The parties have entered into a legal agreement that reflects their commitment to cooperate in the production and distribution of electronic charts in a way that will meet the changing needs of the marketplace and maintain continuous quality assurance throughout the chart creation and delivery process.

Nautical Data International, Inc.

The objectives of NDI will be to address the following needs:

- the immediate need of manufacturers for customized electronic chart data;
- the immediate need of hydrographic offices to create and distribute official data; and
- the growing need of the computerized mapping industry for digital nautical data.

As the worldwide marketing and distribution vehicle for CHS standard and customized data products, NDI will have as its goals:

- efficient distribution of CHS Electronic Navigation Chart (ENC) products and raster chart products, in standard and customized formats;
- acceleration of database development in Canada;
- increased R&D in electronic chart database technology; and
- collaboration with others in the Canadian electronic chart industry to stimulate industry growth.

On the international level, NDI will seek to replicate this Canadian model with other HO's, and will pursue strategic alliances and joint ventures with industry in other countries.

<u>The mission of NDI will be to provide high quality data products, services and technology to users of digital nautical data on a worldwide basis.</u> To this end, NDI will be active in the following areas:

- marketing and distribution of data products and associated technology;
- delivery of services, including data creation services; and
- R&D for the development of new or improved products, services and technology.

The Benefits

As an alliance between manufacturers with a vested interest in the availability of electronic chart data and a full appreciation of how it is used operationally, and a hydrographic office with a mandate to ensure the availability of quality data to support safe navigation, NDI offers significant benefits to the electronic chart community:

To System Manufacturers and Users:

- NDI will contribute to the timely availability of standard and customized data products and product updates to support the use of electronic chart systems.
- The data products provided by NDI will be of high quality, certified by the CHS in the case of standard data products, and produced under a quality system developed jointly with the CHS in the case of reprocessed or customized products.

To the CHS:

- The CHS will obtain a necessary, effective means of having its digital data distributed around the world, under terms and conditions which CHS establishes and approves.
- The CHS will derive revenue flow based on licenses and royalties. This revenue may be used to accelerate the pace of database development in Canada.
- CHS staff development efforts will be enhanced in that staff will gain knowledge and private-sector experience through participation in NDI business activities and projects.

To the International HO's:

- NDI provides an effective mechanism for the exchange and distribution of data under bilateral agreements.
- NDI will actively pursue alliances with international HO's

to extend the benefits it provides the CHS to other countries.
- The results of NDI's R&D efforts, e.g. in chart updating methods, will have application worldwide.

To the Canadian Electronic Chart Industry:
- NDI will provide an infrastructure to help maximize the further development of Canada's recognized expertise in electronic chart technology.
- NDI will seek to avail itself of existing Canadian expertise in all aspects of its operations.

To the International Electronic Chart Industry:
- NDI will seek strategic alliances and joint ventures related to database creation, data licensing and distribution, and collaborative R&D.

Conclusion

The electronic chart industry is now entering the stage of growth where its rate of growth will be limited more by the lack of a supporting infrastructure and important enabling technologies than by the electronic chart technology itself. Co-operation is more important than competition in building the common infrastructure. It requires long-term investment and the development of common standards, and must be designed to be readily available to all who need to access the infrastructure for the development of goods and services.

NDI is another step toward the development of the electronic charting infrastructure in Canada. It is not, of course, the only one. NDI seeks to cooperate in other initiatives nationally and internationally through business agreements, licenses, and joint projects that will expedite the development of a world-wide service for the production and distribution of electronic charts.

About the Authors

Brian Terry is the President and CEO of Nautical Data International, Inc.
Neil Anderson is the Director of Industrial and Organizational Development with the Canadian Hydrographic Service in Ottawa.

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A Modern Quantification of Historic Hydrographic Data Accuracy

by

R. Hare and D. Monahan

Introduction

The integration of precise positioning from Differential Global Positioning Systems (DGPS) with geo-referenced bathymetric data from a Geographic Information System (GIS) in the Electronic Chart Display and Information System (ECDIS) makes navigational risk assessment possible. It has been suggested that a major environmental disaster might have been avoided if such technology had been implemented aboard the Exxon Valdez in Prince William Sound, Alaska, in 1989. For reliable risk assessment to be possible, not only is a knowledge of the accuracy of the vessel's position, draft, velocity and maneuverability necessary, but also the accuracy of the data underlying the ECDIS. The Public Review Panel on Tanker Safety and Marine Response Capability [1] recommended that the Canadian Hydrographic Service (CHS) certify the accuracy of such data.

Since a large amount of existing hydrographic data is still in analogue form, digital survey collection must be supplemented by digitized historical hydrographic documents, to produce the digital data base underlying the ECDIS in a timely manner. It is only with the timely production of digital data that the risks of another disaster like the Exxon Valdez spill can be reduced. The time and expense of complete digital re-survey have forced the CHS to digitize historic field sheets and charts to produce this digital data. The digital data quality assessment project was begun in 1992 in an attempt to find ways of quantifying digitized historic hydrographic data. The following presents a small part of this project.

Background

There are several different types of data on nautical charts, but perhaps none so important as the bathymetry over and around which the mariner must navigate. Knowledge of the position and least depth of shoals and wrecks, the position of least depth contours for vessels with large draft, and the position, shape and height of drying areas and high-water rocks is important from a navigational risk-assessment point of view. Equally important is a knowledge of how well the position and depth has been determined. Data types may be categorized as: point features (e.g. pinnacle shoals, soundings), linear features (e.g. contours, coastline, low-water line) and polygonal features (e.g. drying areas, high-water rocks).

When considering the quality of bathymetric (or any) data, it is prudent to define some important terms. Precision is a term usually used to refer to the distribution of random measurement errors while accuracy is used in the context of where the mean value (our best estimate of the position and depth) lies in relation to the truth. Truth is loosely defined here to mean the coordinates (latitude and longitude) in a defined geographic reference frame (e.g. World Geodetic System 1984 or WGS 84) and depth (or height) below (or above) chart datum at the time the data is being used. The currency issue will not be dealt with in this paper but is given a thorough treatment by Velberg [11]. Reliability of data is usually taken to mean the assurance that the quoted accuracy has been met but can also mean that no hazards have gone undetected in the surveyed area.

It is not surprising that precision is most often associated with the measurement capabilities of the systems used to collect the data and that accuracy refers to the final geographical location of the feature with respect to some global reference system. Precision and relative accuracy are usually associated with one another and were a most important aspect of paper chart quality, since mariners positioned themselves with respect to charted features using relative positioning methods. DGPS however can provide the mariner with the capability of positioning himself in a geographic reference frame (WGS-84) with an absolute accuracy of better than 10 metres (95%) in harbours and approaches. [7]

Ways that precision and reliability of data have been portrayed on CHS paper charts in the past are:

- sloped soundings representing data from a less reliable source (up to about 1983);
- upright soundings representing data from a less reliable source (from 1983 to present);
- density and pattern of soundings indicating larger scale surveys, track soundings or ruggedness of area;
- source classification diagrams showing limits of surveys, scale and line spacing used; and
- supplemental text such as PA (position approximate) or ED (existence doubtful) beside reported hazards of questionable reliability.

Data currency is dealt with by updating existing charts with Notices to Mariners and by completely superseding older data in chart compilation when newer data becomes available for an area. No attempt has been made to represent absolute accuracy on charts (mostly because of the limitations of the paper medium) other than the commonly held belief that a sounding's true position lies within the area covered by that sounding on the chart. All of this will change with the capabilities afforded by ECDIS.

Mariners still rely on the definition of chart datums (as defined by CHS) and on predicted tides and currents for their knowledge of the real depth under keel. For electronic charts, knowledge of the absolute position and depth accuracy of charted bathymetric features is very important but perhaps more important is the level of assurance that no undetected hazards are present—the reliability. Computing the accuracy of predicted tides and currents is complex and will not be dealt with in this paper. The reliability of depth representation (excepting 100% bottom-coverage as in swath surveys) is an issue that has been dealt with elsewhere. [5]

Project Approach

The factors which contribute to the inaccuracy of bathymetric data are many. Inaccuracies may be considered in any of four components: latitude, longitude, depth (or height) and time. For simplicity, accuracy of position is usually considered as a single value which represents a spatial error. The depth precision component is usually considered separately and is estimated based on *a priori* estimates of all those factors which effect depth measurement and reductions. [9] The correlation between position and depth inaccuracies must be considered if the repeatability of depth measurements is desired, which is especially important if the sea-floor is very rugged.

The last thing anyone wants to do is to evaluate the accuracy of every piece of digital data on a case-by-case basis. It is also impractical to ground-truth every historic data set to the extent necessary for complete reliability, as it may as well be re-surveyed. So how do we go about classifying such a large volume of historic data? The approach taken in this project has been to evaluate errors in regions with common error parameters (see Figure 1).

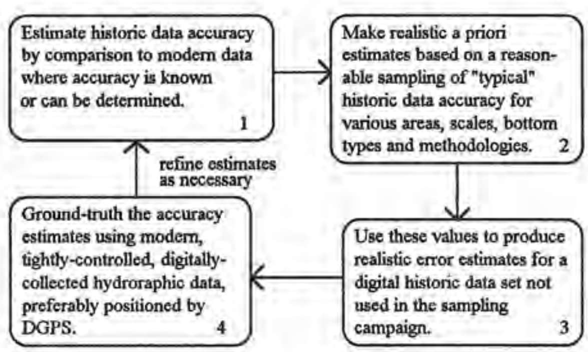

Figure 1: Project Approach Flow Diagram

This project has concentrated so far on the first two aspects of this approach. Since the true location of features, especially those which are always covered by water, can never be perfectly known, we cannot determine the absolute accuracy of our digital hydrographic data. We can however perform a model II Analysis of Variance on any hydrographic data set. Model II Analysis of Variance methodology identifies all known contributing error sources and statistically aggregates them into single values which are representative of all, as given by Equation 1 for position variance and Equation 2 for depth variance as follows:

$$\sigma^2_{position} = \sigma^2_{control} + \sigma^2_{positioning} + \sigma^2_{plotting} + \sigma^2_{digitizing}$$

Equation 1

The factors which contribute to position error come from errors in the control network, the positioning system, manual plotting methods and the digitizing operation.

$$\sigma^2_{depth} = \sigma^2_{datum} + \sigma^2_{sounder} + \sigma^2_{environment} + \sigma^2_{reductions}$$

Equation 2

Those which contribute to depth error come from an improper knowledge of chart datum, the imprecision of the sounder, errors due to heave, roll, pitch and loading of the launch, and errors in tide and velocity reductions and their application.

Two interesting things are worth noting about this approach to error propagation. First, although spatial error is usually treated as a bivariate normal distribution in x and y, this simplistic approach is quite commonly used in estimating spatial error [3]. Such an approach assumes that the radial error (circular error of probability or CEP) is propagated always in the same direction, which should always give a pessimistic (too large) estimate of the actual spatial error. Another approach is to use a discrete transformation of the Gaussian probability model such as regularly spaced points on a circle with radius equal to 1.25 times the spatial error (e.g. 8 points at directions with 45° spacing with the same 12.5% probability). The rigorous approach, propagation of the full spatial variance-covariance matrix, is possible but not practical since the evaluation of the precision of each sounding is what we wish to avoid by estimating historic data accuracy on a regional basis.

Second, the digitization of depths should not alter the accuracy of the original reduced depth, except when datum adjustments or velocity corrections are applied or a metric conversion is required. For the accuracy of rock heights an estimate of the precision of the height measurement method can be made in place of the sounder precision. Positioning errors and errors due to correlation of position and depth will be discussed in detail in the next section.

For simplicity, in this paper the errors are assumed to be normally distributed. In practice this is seldom the case because of the way our position and depth measurement systems work (e.g. sounders typically give erroneous measurements with a shallow bias; fish, weeds, bubbles, etc. are above the sea-floor).

With the variances of two overlapping data sets estimated, an estimate of the expected difference variance can be determined (Equation 3), where the position or depth error estimates for each data set are calculated from equations 1 and 2 respectively.

$$\sigma_\Delta{}^2 = \sigma^2_{digitized\_historic} + \sigma^2_{digitally\_collected}$$

Equation 3

As a check on this estimate, differences between the historic, digitized data set and a modern, digitally-collected data set can be taken and the variance can be determined (Equation 4).

$$\sigma_\Delta{}^2 = \frac{\sum_{i=1}^{n}\left(digitized\_historic - digitally\_collected\right)^2}{n}$$

Equation 4

As a check on the validity of the *a priori* error estimates, the two variances can be compared. This simple way of comparing data, by taking differences on a point-by-point basis, is called the point data paradigm. Comparison of linear features is more complicated as will be discussed later.

Data Analysis

An area on the west coast of British Columbia (Figure 2) was selected for analysis for several reasons:

1. Both modern, digitally collected data and historic, digitized data were available for the area.
2. The area has several diverse types of coastline and bathymetry, namely the west coast of Calvert Island, and Kwakshua Channel. The west coast of Calvert Island has an offshore smoothly-sloping sand bottom with 1 to 2 metre swells, a near shore exposed coast with swells, jagged rock outcrops above and below water, and rugged-rocky and smooth-sandy foreshore areas. Kwakshua Channel has sheltered passages with shallow waters and no swell, and a 'U-shaped', deep, sheltered fjord, with sinuous rocky foreshore.
3. Documentation was available for not only the modern data but also most of the historic data set.

Only bathymetry, including profile sounding and exams by both ship and launch, and coastline and foreshore features have been assessed. Both horizontal and vertical accuracy have been estimated for all soundings, exams and drying and high-water rocks while only the horizontal errors associated with the coastline and the low-water line have been assessed, since the elevation of these lines is assumed to be constant. These items are prioritized, in the sections that follow, from the most to least important data types from a safety-of-navigation perspective.

Contours have not been examined for two reasons. First, contours digitized from historic field sheets are not usually comparable to modern digital contours because they are not metric (hence the contour interval is different) and may be on a different vertical datum. Second, contours are derived data and hence the comparison contains errors from interpolation, generalization and interpretation (in the case of manually drawn contours) on both historic and modern sources. The low-water line is not wholly derived data because it is at least initially delineated on aerial photographs and only modified to fit the drying and deep soundings which conflict with the photographic information. It will be shown later that the comparison of derived data can cause problems.

As part of the digital collection methodology for historical documents, all data are converted to metric from imperial units (in this case fathoms with fathoms and fractions under 8 fathoms) and to North American Datum 1983 (NAD 83), which is for all intents and purposes the same as WGS 84. The datum conversion is accomplished by performing an adjustment of all horizontal control covering the field sheet in both datums (NAD 27 is what most historic documents are based on) and computing the mean coordinate difference between the two datums. This coordinate difference is applied as a horizontal shift in x and y, and the maximum and minimum differences from this mean value are calculated as a quality control check on this simplistic method. If these maxima are small (less than 1 mm at scale of the survey) the shift is applied. This process should put both data sets into the same absolute reference frame as the DGPS that the mariner

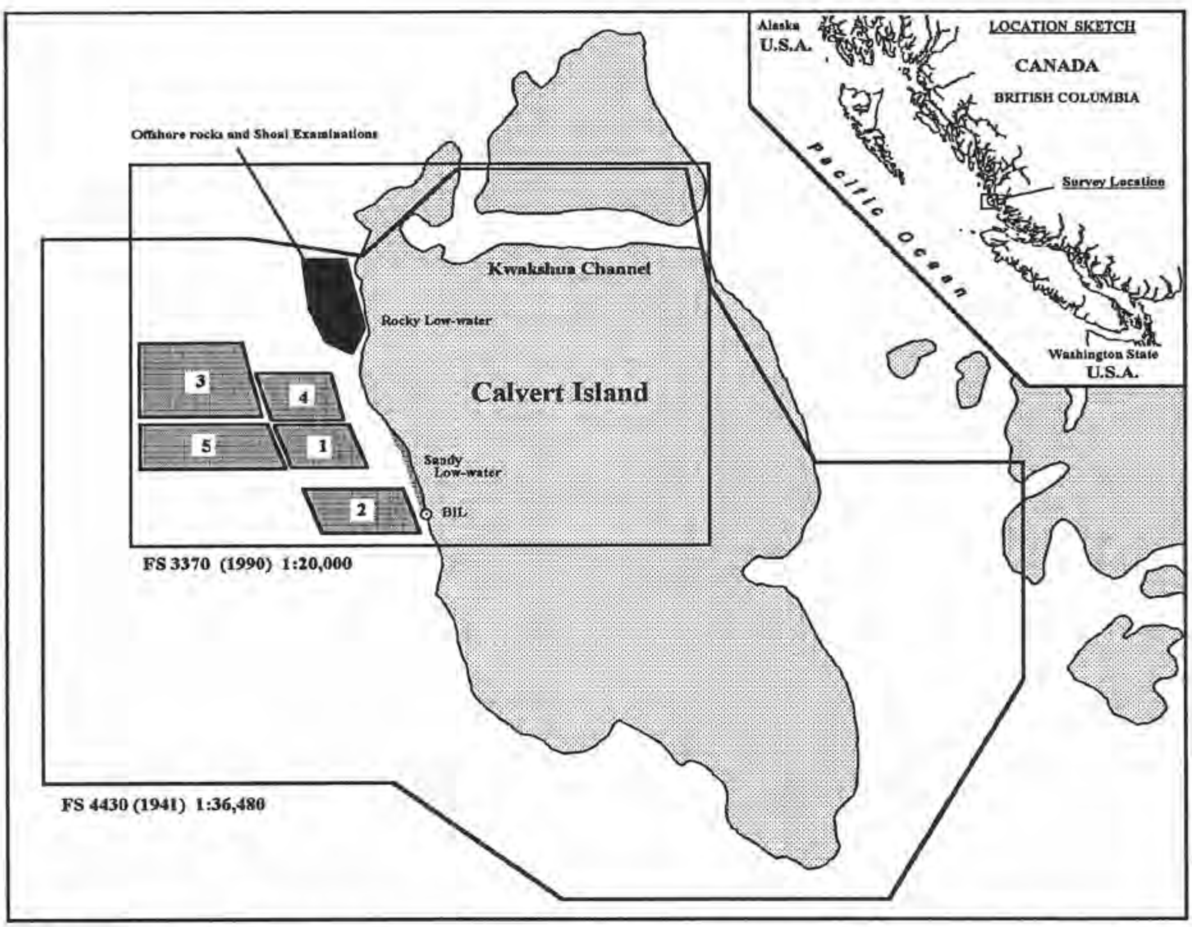

Figure 2: Area Chosen for Analysis, Showing Overlapping Field Sheets and Five Sounding Test Areas (labelled)

may interface with his ECDIS, but without real ground-truth data, all the comparisons that follow give only an impression of relative accuracy.

The 1941 (digitized) field sheet overlaps the 1990 (digitally-collected) field sheet (Figure 2). Seventeen horizontal control points are common to both surveys. The adjusted NAD 83 coordinates are based on horizontal control surveys carried out from 1984 through to 1991 which encompass the entire area. The adjustment was based on five fixed first-order horizontal control points, using their latest adjusted NAD 83 values. The largest 99% semi-major axis for any control point in the adjustment, within the overlap area is 0.17 metres at station BIL. The number of degrees of freedom was 702, computed variance factor was 1.15 and the solution converged in 2 iterations. No outliers were found at the 1% significance level using the Tau test statistic.

The 1941 field sheet control was based on four separate control schemes. Differences between the original field-computed coordinates and the adjusted NAD 83 coordinates revealed variations on the order of 3 metres at 95% confidence over the span of the field sheet. The differences between the adjusted NAD 83 values and the field values used on the 1990 survey revealed variations of about 0.4 metres at 95% confidence. Therefore, it is not unreasonable to expect that these discrepancies in horizontal control could introduce an additional error into any calculation of differences that is made on the digital data. These values are reflected in the estimation of all errors that follow.

Soundings—Position Errors

The knowledge of accuracy in the position of soundings is undoubtedly the most important aspect of digital hydrographic data, largely because soundings are used to define the location of a vessel's hazard (limiting depth plus safety margin) contour. The errors that affect the accuracy of a digitized sounding's position can be broken down into errors in collection, errors in presentation and errors in digitization.

Errors in collection include the errors in the system(s) used to obtain the position of the transducer, the errors in interpolation of soundings between positions and the errors in the horizontal control fabric. Errors in presentation include errors in reading depths from the sounding roll and positioning the reduced depth on the field sheet or document that is to be digitized. Errors in digitization involve the actual digitization process including the hardware and software used to convert the analogue information into digital form and the human limitations of the person digitizing.

For manually produced field sheets, an additional error is introduced because soundings are plotted using the horizontal control stations, which have been positioned from a manually plotted graticule. The scale of the 1941 survey was 1:36,480 which has an impact on the resulting sounding accuracy because of the manual methods employed. Because of the digital collection methodology employed in 1990, the scale (1:20,000) of the field sheet is irrelevant. The only error sources after digital collection of data are from interpolation and round-off. The interpolation error is negligible because of greatly increased positioning rates (one position per second as compared to one position about every minute for the sextant survey in 1941). The round-off error in position computations and data storage, is several orders of magnitude less than the precision of the positioning system.

For the purposes of comparison, only the range-range (R/R) soundings were used and not the range-bearing (R/B) soundings; this is because the precision attributes for each digital sounding give a realistic estimate of the accuracy. For sextant sounding, as was used for the 1941 survey, the precision of a fix is the sum of errors from the precision of the sextant angles (estimated at ± 4 minutes [4]): dilution of precision due to geometry of the shore stations with respect to the observers; errors due to lack of synchronization of the two angles at the fix; and errors introduced because the two observers cannot both occupy the position of the sounder transducer.

Errors created during presentation and digitization can be estimated and summed with the positioning errors to give an estimate of total error in position of the digitized sounding (Table 1). As can be seen, the positional accuracy of a digitized sounding is highly dependent on the scale of the original survey for manually collected bathymetry. For digitally collected bathymetry, only the errors of the control points and the positioning system need be considered. For the 1990 survey, the errors in the control fabric are an order of magnitude smaller than the errors in the positioning system, so the positional accuracy of the soundings are as described by the precision attributes.

Soundings—depth errors

Because the location of the mariner's hazard contour is determined by the water depth, any errors in the knowledge of the true depth will change its location. The final depth accuracy is a function not only of the depth measurement precision, but also of the precision of all the reductions applied to the measured value. Any errors in the vertical control (the knowledge of the true vertical datum) and inaccuracies in the measurement of tides will degrade the accuracy of the digital

Error Source	Estimated Magnitude (95%)	
	1941 manual survey	1990 digital survey
control points	+/- 3.0 metres	+/- 0.4 metres
plotting control points (including graticule errors)	+/- 0.2 mm at scale	N/A
positioning: sextant (1941), microwave R/R or R/B (1990)	+/- 10 metres	+/- 10 metres
tweenering (scaling soundings 'tween' fixes on sounding roll)	+/- 0.1 mm at scale	N/A
plotting fixes/tweeners (three arm protractor/picket fence)	+/- 1.0 mm at scale	N/A
inking (transferring sounding to field sheet)	+/- 0.3 mm at scale	N/A
recognizing/digitizing optical center (quality control allows)	+/- 0.4 mm at scale	N/A
Total:	43 metres	10 metres

Table 1: Estimate of Digital Sounding Position Error for Both Surveys (m)

Description	1941 Precision	1990 Precision
a) Transmission mark setting	0.57	0.14
b) Variation with time	0	0
c) Sound Velocity (SV) measurement	1.36	0.04
d) Spatial variation	0.02	0.02
e) Temporal variation	0.02	0.02
f) Application of SV	0	0
g) Sounder precision	0.4	0.1
h) Sounder resolution	0.4	0.1
i) Heave removal	0.15	0.12
j) Squat and draft error	0.02	0.02
k) Roll, Pitch, sea-bed slope	1.04	0.10
l) Tidal Measurement	0.06	0.06
m) Cotidal correction	0	0
n) Application of tide	0.15	0.15
o) Trace reading	0.23	0.23
p) Time Synchronization	0.04	0.04
q) Other reductions	0.15	0
Estimated Depth precision:	1.92	0.39
r) Due to positioning errors	0.4	0.16
Estimated Repeatable error:	1.96	0.42

Table 2: Sounding Error Budget Example (as used for test area 4 - see Figure 3)

sounding. Also, the ability of the mariner to predict tidal corrections will be directly affected by the knowledge of tides and vertical datums in the area. The accuracy of predicted tides and currents for use in risk assessment is outside the scope of this paper but is an area which requires further research.

In order to predict what errors might be expected in reduced soundings on a field sheet, or indeed on a chart, a sounding error budget containing all of the possible sources of depth error can be prepared (Table 2). Estimates of errors can be made by consulting manufacturer's specifications and by examining sounding rolls and other documentation on procedures employed for measurement and reduction of depth. Error sources 'a - o' in the table are from"Assessment of the Precision of Soundings" [9]. Category 'p' contains an estimated error due to watch synchronization between sounder and tide gauge. Item 'q' is to account for rounding errors in application of a bar check (or other datum) correction. Item 'r' accounts for the error in depth due to uncertain position, and is a function of bottom slope. Item 'r' is used for calculation of repeatable depth error, which is necessary when estimating the variance of differences between the two data sets since comparison to the 'truth' is not usually possible. An attempt at comparing acoustic measurements to 'truth' is being made in the Hydrographic Ground Truthing Project in the Bay of Fundy. [8]

In order to determine if the noise of the 1990 soundings is as predicted by the prepared sounding error budget, a comparison of the depths at the cross-over points of the 1990 check-lines with the main-line soundings can be made. Since the position of the selected soundings is never exactly the same on both these lines, some interpolation is required to get the main-line sounding value at the precise location of the cross-over point sounding from the check-line. Digital Terrain Model (DTM) software (the CARIS DTM package was used for this analysis [10]) can perform this difference operation by forming a dense Triangular Irregular Network (TIN) from the main-line selected soundings and computing the value at the check-line sounding position within any one triangular facet. The check-lines used were all in deeper offshore waters where the bottom is smooth and gradually sloping. Although there are swells of about 1 metre, peak to peak (p-p), an attempt was made in post-processing to remove these swells by fitting a smooth curve (polynomial) through the data. This method is estimated to leave about 15% of the p-p swell height as residual error. [9]

The sounding error budget, including the noise of the swell removal method, predicts repeatable errors at the 0.6 metre level, but the differences suggest errors more on the order of 1.0 metre (Table 3). The geostatistical interpolation software (HYDROSTAT [5]) was run on a set of the mainline data and suggests that errors on the order of 0.7 metres may exist between the mainlines (100 metre line spacing) at the 95% confidence level. This may be the reason why the actual difference values are larger than those predicted under the assumption that there is no interpolation error. The reason for the 0.4 metre shoal-bias on check line 1 has not been established. The 0.15 metre deep-bias on check lines 3 and 4 can probably be explained by the change in loading of the launch or the rounding of the draft corrections to the nearest decimetre. With the level of 1990 sounding noise verified, comparisons of the 1941 data to the 1990 DTM surface can be made.

Check line	Repeatable error	Expected Error	Deviation	Interpolation?	Points	Comments
1	0.450	0.636	0.970	0.732	118	bias -.40
2	0.440	0.622	1.040	0.833	127	bias -.06
3	0.430	0.608	0.910	0.677	105	bias +.15
4	0.420	0.594	0.940	0.729	65	bias +.15

Table 3: Estimated 1990 Errors, Calculated Depth Deviation (m) Between Main Lines and Check Lines (95%)

Shoal Examinations

Shoal examinations are arguably the most important type of data gathered, from a safety-of-navigation point of view. They also hold one clear advantage over soundings obtained by profiling. Given that the bottom is stable, it is reasonable to assume that the depth has not changed appreciably in the 49 years between the two surveys. This removes the temporal change aspect which could make studies in estuaries or areas of sand waves [11] very difficult. Also, if the depths are similar on both the historic document and in the modern digital file, and if the positions are within the repeatable accuracies of the old and new positioning methodologies, we can make the assumption that the shoals are in fact the same feature. Any differences must therefore be due to the inaccuracies in both old and new methodologies for position and depth. If we know or can closely approximate the accuracy of the modern data then we can infer from the differences the accuracy of the digitized historic data. Separate depth and position error budgets were prepared for shoal examinations for the 1990 and the 1941 surveys. Results of the comparisons are given later in this paper.

High-water and Drying Rocks

Comparing high-water or drying rocks between surveys holds the additional advantage over shoal examinations, in that no echo sounder was involved in the measurement. Because the peak is visible, there should be no mistake in positioning the feature, which may happen when obtaining a shoal sounding while in the trough of a swell. The resulting differences in positions should therefore not be biased by the roughness of the sea-surface or the rock itself. A drawback may be that the sounding positioning system was not employed in the positioning of high-water rocks, especially with electronic positioning systems since the antenna may not be easy to remove from the launch.

An error budget was prepared for rock positions for both surveys (Table 4). Some rocks may have been positioned by sextant fix (static fixes can be better than ± 2 metres [4]) however, control, plotting and digitizing errors still apply. The scale of the photographs on the 1941 survey was about 1:14,500. The photographs used for the 1990 survey were 1:60,000 scale, photographically enlarged to 1:20,000. For transferring photo-interpreted information to the field sheet, the 'squaring-down' process was used in 1941; a direct-reflecting projector (epidiascope) was used in 1990. The information was manually digitized in both cases.

For rock heights, the measurement of elevation depends on how well the water level can be determined and how well the height can be measured above that water level. The estimation of water level is probably good to ± 25% of the p-p swell height. The overall precision also depends on the precision of the tidal measurements and their application. Two areas were selected for examination; one exposed and the other one sheltered. The heights of rocks on the west coast of Calvert are typically higher than those in the sheltered waters of Kwakshua Channel, so at least one turning point would be required when leveling to the summit. Measurements of height were made to the nearest foot for older surveys and to the nearest 0.1 metres on modern surveys. An estimate of the expected errors is given in Table 5.

Description	Precision, 1941 (95%)	Description	Precision, 1990 (95%)
Control	3.0	Control	0.4
Graticules	3.7	Graticules	0
Control Point Plotting	3.7	Control Point Plotting	2.0
Station ID's	7.3	Station ID's	10
Squaring Down errors	11	Epidiascope errors	6.0
Interpretation errors	18	Interpretation errors	10
Digitizer	3.7	Digitizer	2.0
Digitizer Registration	3.7	Digitizer Registration	2.0
Point digitizing	7.3	2 pointing operations	5.7
Total point position error	25	**Total point position error**	17
Line following	15	2 line following operations	11
Total line position error	28	**Total line position error**	19

Table 4: Error Budget for Drying Rocks, Coastline, and Low-Water Line Positions by Photographic Methods

Description	Precision	Precision	Precision	Precision
Area/Year	Calvert/1941	Calvert/1990	Kwakshua/1941	Kwakshua/1941
Average number of turning points	1	1	0	0
p-p swell (estimate)	1.0	1.0	0.1	0.1
Measurement Resolution	0.3	0.1	0.3	0.1
Tidal reduction	0.3	0.3	0.3	0.3
Water Level Estimation	0.25	0.25	0.03	0.03
Leveling	0.42	0.14	0.3	0.1
Precision Total (95%)	1.13	0.81	0.83	0.62

Table 5: Error Budget for Drying Rock Heights (m)

High-Water Line Delineation

Because the line-work presented on hydrographic field sheets typically represents isobaths or other forms of contour, the accuracy of the height component can be ignored. What is most important for contours (only high and low-water lines will be considered as discussed above) is the accuracy of the horizontal representation. That is; how far is the high-water line on the ground from its digital representation? In this exercise, only the difference between two representations of these contours is calculated.

An error budget has been prepared in a similar way to the one for rock positions (point features). An error, larger than that for point digitizing, is introduced because of the dynamic nature of line-following with a digitizing cursor or pen, as shown with its resultant total error at the bottom of Table 4. A problem remains in that there is no guarantee that the corresponding point on the coastlines from the two data sets represents the same geographic feature.

Results

A priori estimates were made for both data sets and repeatability values for the sounding differences were calculated for 5 test areas (Figure 2). Areas 1 and 4 have smooth sea-floors while area 2 is slightly rougher. Area 3 was sounded by ship in 1941, as was area 5. Less is known about the errors associated with the ship sounding reduction because of the lack of documentation. The comparison of 1941 soundings to the 1990 DTM for Area 4 is shown in Figure 3. Other depth comparisons are similar.

The slope of the differences and the resultant deep bias are probably due to incorrect velocity setting (about 3% error) of the sounder during the 1941 survey. Although the shallowest comparisons are in 30 metres of water, it seems apparent that shallower soundings would be shoal-biased (common practice on older surveys). A trend seems apparent but the noise of the data makes for poor correlation between depth and error. *'Bright'* and *'Stbd#2'* are the launch names.

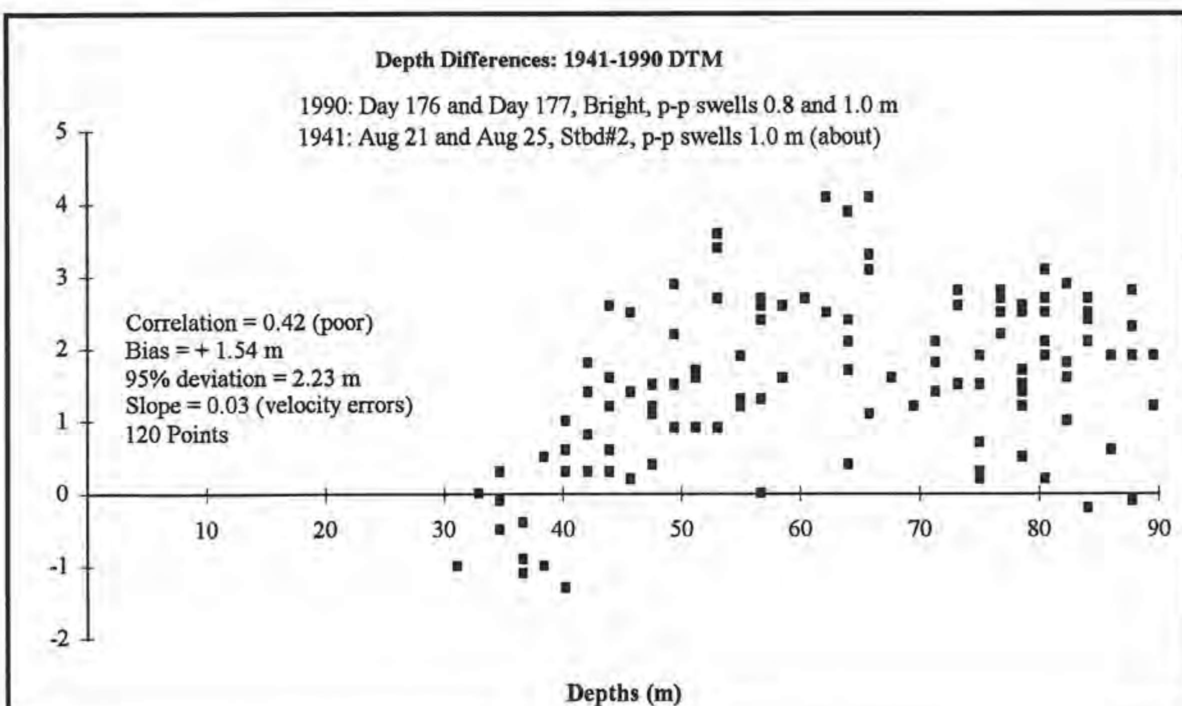

Figure 3: Depth Comparison Example (test area 4)

Table 6 shows the results of the comparisons made using the DTM formed from all the 1990 soundings with the 1941 ship or launch sounding days. 1990 sounding days were selected for high quality positioning (multi-range Trisponder with at least three ranges and 95% semi-major error ellipse axes less than 10 metres) and calm sea state (p-p swells smaller than 1 metre). Areas were also chosen for near-constant slope and roughness. Interpolation errors in the smooth areas can account for 0.7 metres as pointed out previously. The magnitude of the deviations suggests that some incorrect assumptions have been made.

The largest sources of error in the 1941 soundings are velocity and the effects of sounder beam width on a sloping sea-bed (Table 2). Since there was no documentation on the type of transducer used in 1941, an assumption of a 20 degree beam width may have been incorrect. The estimated velocity error was less than 2% even though from Figure 3 it appears to have been greater than 3%. For area 5, using a 2 metre p-p swell size (the ship's sounding rolls could not be found) may be the reason that the estimated error is larger than that calculated from the differences. The larger discrepancy in area 2 may be due to increased interpolation errors since the bottom was more rugged than in the other areas.

For shoal examinations, once it is established that the feature is identical for both surveys, interpolation error can be removed. By measuring the distance between examined depths and comparing this distance to the repeatable position error it is possible to establish if the feature is the same. The depths can then be compared directly, providing there are no differences in vertical datum. Error budgets were prepared for position and depth of exams for both surveys and the repeatable errors were calculated (Table 7). A bias component was also computed because both surveys examinations were shoal-biased (standard practice even today).

Two areas on the west coast of Calvert Island (one with steep-sided shoals and the other with gradually-sloping shoals) and one area in Kwakshua Channel were chosen for the analysis of examinations. Heave is the largest error source for the exams on the west coast of Calvert Island (areas 1 and 2) while velocity errors contribute a significant amount to the 1941 exams regardless of area. The predicted and actual errors and biases compare favorably, although the sample on which this evaluation is based is rather small.

The positions of shoals in area 1 are more variable because of the influence of swell and rolling terrain, as opposed to the steep-sided and well-defined peaks in the other two areas. The 50 metre mean positional error is outside the expected position difference, showing the high correlation between depth (heave-induced error and bias are larger on shoals) and position errors.

Peaks of drying and high-water rocks are visible, so the certainty of position should be better than on shoals, where the peak is submerged. Position comparisons were made (Table 8) in areas of exposed coast and sheltered waters. Position differences on the west coast of Calvert may be biased by the presence of a shifted area. The squaring-down process is very dependent on accurate photo-identification and positioning for the two stations used as the baseline on each photograph. On the west coast of Calvert, three ship-stations were used to establish the main control points, from which other stations were positioned by sextant fixes or stadia. By removing this shifted area, the differences fall to the 30 metre level; this is easily justified by the error estimation.

The possibility of shifted areas in surveys of this era, and in areas where ship stations were used to carry control along exposed coastline always exists and cannot be ignored. Assumptions about how well stations can be photo-identified or positioned using ship-stations and sextant angles could probably use some refinement. A global 3.0 metre value for control errors over the entire field sheet may need to be broken down into regional control errors for better accuracy assessment.

The errors in the heights of these rocks can be computed in a similar manner and compared to the estimated values (Table 9). The comparison is quite favorable and there is little or no bias in the results (i.e. the bias is at the noise level of the 1941 measurements: ± 1 foot or 0.3 metres). The sample is, however, quite small. There is a need for statistical tools to reject or identify blunders in such a comparison so that it can be automated.

Area	'41 errors	'90 errors	Expected	Deviation	Additional	Points	Comments
1	1.890	0.420	1.936	2.260	1.166	90	Launch: smooth area
2	1.410	0.410	1.468	2.470	1.986	176	Launch: rough area
3	2.160	0.440	2.204	2.550	1.282	121	Ship: smooth/deep
4	* 1.960	* 0.420	2.004	** 2.230	0.977	120	Launch: smooth area
5	2.210	0.450	2.255	1.670	N/A	91	Ship: calm seas?

Table 6: Comparison of Predicted and Calculated Depth Errors (95%—metres)
* see Table 2 ** see Figure 3

Area	1941 error	1990 error	Expected Error	Diff. Error	Expected Bias	Diff. Bias	Points	Pos'n. Error	Comments
1	1.65	1.06	1.96	2.14	-1.6	-0.8	7	50	Calvert smooth
2	1.34	1.06	1.71	1.41	-1.6	-1.4	22	31	Calvert rugged
3	1.00	0.35	1.06	0.99	-0.6	-0.4	6	22	Kwakshua

Table 7: Comparison of Exam Difference Errors (depth)

Area	Type	1941 errors	1990 errors	Repeatable Error	1990 - 1941 diffs.	Points
Calvert	Exposed	25	17	31	42	77
Kwakshua	Sheltered	25	17	31	31	22

Table 8: Drying Rock and High-Water Rock Position Comparisons

Area	1941 errors	1990 errors	Repeatable Error	1990 - 1941 diffs.	Bias (m)	Points
Calvert	1.13	0.81	1.4	1.6	-0.08	32
Kwakshua	0.83	0.62	1.0	1.1	0.05	21

Table 9: Drying Rock and High-Water Rock Height Comparisons

Finally, a comparison of coastline and low-water line (LWL) was made by measuring the displacement between the two lines at regular intervals for various regions with similar foreshore types and environmental conditions (Table 10). Since there is no way of knowing with linear features if the same feature is located perpendicularly adjacent on the two lines, there is a chance that the error estimates will be large, even if all biases have been accounted for. From the table we see that the differences do seem to be generally smaller than predicted, with the exception of the low-water line on an exposed sandy beach on the west coast of Calvert Island. Examination of the field sheet revealed that the drying line had been 'pulled' from its photo-interpreted location to fit with the drying soundings obtained at the end of the sounding lines that ran into shore. Shoal-biasing of shallow soundings accompanied by increased swell height close to shore may account for this problem.

Discussion

A large error source in estimating sounding accuracy is interpolation between sounding profiles. This error source can be removed with the use of swath data sets using an area data paradigm. Without proper compensation for heave, smaller errors will be buried in the noise level of the heave error, especially in rugged terrain where heave cannot be filtered out. Assumptions about these smaller error components are then difficult to verify. The errors introduced by an inability to set the sounder velocity properly on historic surveys, although systematic in nature, can be treated as a large regional random error. A better knowledge of the noise level of the controlling data set may help determine what contributes the most error to the differences. Such knowledge requires good documentation.

Regional systematic biases can influence the overall error estimates. It is important to assess errors in areas localized enough that their magnitudes are consistent. Determining what constitutes a consistent region is where a large part of future research lies. It appears that the magnitude of errors in most data types is heavily dependent on the ruggedness of the terrain. Since the variogram is a geostatistical measure of roughness, IHOstat [6] may be useful as a tool for ranking regions by ruggedness. To estimate coastline or low-water line ruggedness, a value such as the Boundary Index (BI), as employed by Bregt et al. [2] for estimating rasterization error may be used. These tools need to be integrated into one automated package which can be used to evaluate errors in historic digitized data sets by making comparisons to precise swath data and also to make error estimates for quality assessment of digitized historic data sets where no control is available.

Conclusions and Recommendations

Any comparison between data sets gives, by its very nature, only relative accuracy. In order to properly assign accuracy values to any hydrographic data we must know where it is in

Area	Type	'41 error	'90 error	Repeatable error	1990-1941 diffs.	Points
Calvert West	Coastline	28	19	34	43	56
Kwakshua (bay)	Coastline	28	19	34	38	47
" (north)	Coastline	28	19	34	28	28
" (south)	Coastline	28	19	34	22	28
Calvert West	LWL - rock	28	19	34	28	46
"	LWL - rock	28	19	34	17	69
"	LWL - sand	28	19	34	190	54
Kwakshua	LWL - sand	28	19	34	31	36
"	LWL - rock	28	19	34	24	67

Table 10: Coastline and low-water line comparisons (position displacement)

the real world (i.e. WGS-84) so that the ECDIS can make valid risk assessment. This must be done by collecting DGPS ground-truth, preferably swath data, for all types of historic digitized documents. With shipping company owners demanding knowledge of depths to the nearest decimetre so that vessels can take on another $100,000 worth of cargo, or leave port two hours sooner, the likelihood of a grounding due to an error in risk assessment seems imminent. To reduce the chances of such a disaster, all digital hydrographic data must have reliable accuracy attributes.

This paper has shown only one approach to quantifying the accuracy of digital data from historic sources using a point data paradigm. The authors hope that it has given a better feel for the large number of influencing parameters that affect the accuracy of digitized data. The approach taken has not been wholly rigorous but is similar to that used by others in hydrography and other fields. The results leave many questions unanswered and demonstrate the need for future research.

The next step in researching the quality of digitized hydrographic data is to evaluate the accuracy of digitized charts and source data from other eras, agencies, scales, areas, methodologies, etc. The processing paths must be assessed along with the magnitudes of the acceptable errors introduced at each step (e.g. Compilation, Drafting, Quality Control, Printing), so that the accuracy of digital data acquired by these routes can be assessed. Once all the estimations have been made, an error evaluation package can be designed so that an estimate of all digital errors can be computed.

It is hoped that by cooperating with other hydrographic offices a standard methodology for assigning accuracy attributes to digitized historic hydrographic data can be established, and that the procedures can be coded into user-friendly, interactive software. The long-term goal is to integrate this software into IHOstat (internationally accepted quality assessment software).

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An Analysis of Captain Cook's Longitude Determinations at Nootka, April 1778

by
Nicholas A. Doe

"The sheets were all read until no error could be found; therefore I hope very few have escaped; but it is highly probable there will be some among such a multiplicity of figures."

(W. Bayly, Commissioners of Longitude's astronomer on Cook's third voyage)

"...that gentleman's [Bayly's] book is full of errors..."

(Lieutenant King, chief astronomer and later Captain on Cook's third voyage)

"...W.W. has seen many bad reckonings, but few so bad as it [King's log] contains."

(W. Wales, astronomer on Cook's second voyage)

The aboriginal people of the west coast of Vancouver Island have known for at least 4000 years where their village of Yuquot is. But for Captain James Cook and his crew, who arrived there in April 1778, the location of King George's Sound, or Nootka as it came to be known, had to be determined by its latitude and longitude. For the 18th-century British explorers, Nootka was thousands of kilometres from anywhere.

We live now in an age when the art of haven-finding demands little more of us than the ability to push buttons and read displays; it is, perhaps, difficult for us to look back to a time when the development of techniques for measuring geographic location was cause for excitement. But when Cook embarked on the first of his famous voyages to the Pacific in 1768, European explorers and the interested public alike were exuberant that it was at last possible to sail across thousands of kilometres of open ocean to never-before-visited lands and islands, guided only by two simple numbers.

The latitude of any place is its angular distance north or south of the Earth's equator. Its measurement is relatively easy, for the further north you are the proportionately lower will the Sun and stars in the sky to your south appear. Longitude, however, is far more difficult to determine accurately. Longitude is the angular distance east or west of a given line (meridian), running from the north to the south pole. Nowadays the universally adopted prime meridian is the one through the observatory at Greenwich in England, but before this was agreed upon in 1884, navigators selected their own prime meridians. Eighteenth-century Spanish charts of the B.C. coast, for example, have longitudes marked relative to Cadiz, Tenerife, San Blas, and occasionally Paris.

The measurement of longitude boils down to measuring the difference between local time and Greenwich time. The later that local noon occurs after noon at Greenwich, the further west you are. Hence to measure longitude, one could set one's clock to be twelve at the moment the Sun is due south, and then phone a friend at Greenwich who had done the same, and compare times. Alternatively, you could fly to England, set your watch by the Sun, bring it back home, and check it at noon. In the city of Vancouver, if we neglect small variations in the timing of noon due to the Earth's slightly elliptical orbit, your watch would be $8^h\ 12^m\ 24^s$ fast, which corresponds to a longitude of 123° 06' W. [Note: 1° (degree) = 60' (minutes of arc) = 4 minutes of time].

Captain Cook had neither telephones nor airlines, nor quartz digital watches that could keep good time for the many months it took to reach the B.C. coast. He did have good time-keepers, chronometers as they are called, and these he used extensively for measuring the relative longitudes of places not too far apart, but eventually cumulative errors made it necessary to re-calibrate them. For the time signals he needed to do this, he had to look to the sky.

The method that the British Navy used to tell the time at Greenwich is known as the method of lunar distances. Basically this involves measuring the position of the Moon in its monthly orbit around the Earth, and then using pre-calculated tables to determine the predicted time for the Moon to be at that position. The Moon was most often located by measuring the angular distance between it and the Sun, but its distance from selected stars was also used.

Other methods for finding Greenwich time, such as observing the timing of eclipses of the moons of Jupiter, or the timing of the occultation of stars by the Moon, were more accurate, and were used successfully on the west coast by the Spanish. However, these methods could not be used at sea because of the difficulty of aiming a high-powered telescope from a swaying deck. The instrument used for measuring angular distance, the sextant, overcomes this problem by using a system of mirrors that brings the images of the two bodies being observed together, irrespective of the unsteadiness of the hands that are holding it.

The Moon completes its orbit around the Earth, on average, once every 27.5 days relative to the (fixed) stars, and once every 29.5 days relative to the Sun. These times are different because as the Earth moves around the Sun in its annual orbit, the direction of the Sun, relative to the background of stars, slowly changes. The movement of the Moon is most familiar to us as the gradual progression from new moon (when the Sun and Moon appear in the same direction and set together in the evening), to full moon (when they are in opposite directions and the Moon is high in the sky throughout the night). The transition from full moon back to new moon is less conspicuous because during this part of its orbit the Moon is only visible to the casual observer in the early morning hours.

Compared to the Sun's 24 hours, it takes the Moon, on average, 24 hours and 50 minutes to reappear in the same position in the sky each day. Consequently, although the Moon rises in the east and sets in the west, just like the Sun, it does so more slowly, and it always appears further to the left of where it was 24 hours earlier. It is this constantly changing position, relative to the Sun and stars, that the 18th-century navigators sought to measure, and thereby determine Greenwich time and hence their longitude.

Captain Cook spent four weeks at Ships' Cove (now Resolution Cove) on Bligh Island in Nootka Sound (49° 36.4' N, 126° 31.7' W). There he repaired and re-provisioned his ships, met and traded with the native people and did all the things that famous explorers do. During this time, he and his chief astronomer, Second Lieutenant James King, made 91 sets of measurements of their longitude. William Bayly, the astronomer aboard HMS *Discovery*, the ship accompanying HMS *Resolution*, made a further 31 sets of measurements. Since each set usually involved the averaged value of six observations of the position of the Moon, the sum total of observations made could well have been in excess of 600.

The translation of a measurement of the Moon's position to a determination of longitude was no simple matter. This is because the Moon's apparent location is modified by both refraction and parallax.

Although the distorting effects of refraction in the Earth's atmosphere are much less than those of, say, water or glass, we nevertheless see the Sun, Moon, and stars as though through a giant lens. The navigator must correct for this in the course of making his calculations.

Parallax was an especially difficult complication to the method of lunar distances. Because the Moon is so close to us relative to the other heavenly bodies, the apparent direction of the Moon changes as we move about on the Earth's surface. In order to be able to use a universally applicable set of tables describing the lunar orbit, the navigator was obliged to calculate from his observations the direction in which the Moon would appear if it were to be observed from a position corresponding to the centre of the Earth.

The step-by-step instructions for computing corrections for refraction and parallax occupied 17 pages in one early navigators' manual, and resembled, in their complexity and obscurity, a modern income tax form. If we remember that this work had to be done for each of the 122 sets of measurements made at Nootka, in cramped and poorly lit quarters and without the aid of calculators or computers, we can get some idea of the great investment Cook made in fixing his position accurately.

Yet for all that, Cook's determination was not perfect. His Journal records the longitude of Ships' Cove as 126° 42.5' W (233° 17' 30.5" E in the old notation), which is 10.8' (12.9 km) west of its true position. Moreover, when Cook's midshipman, George Vancouver, returned to the coast 14 years later and re-determined Nootka's longitude over a hundred times (636 observations) using the same techniques, his result was 8.6' (10.3 km) too far east [see Lighthouse Edition No. 47]; this compares poorly with the Spanish determinations which were correct to one or two minutes of arc.

The slowness of the Moon's motion is the source of difficulty in the method of lunar distances. It takes the Earth only four seconds to rotate through one minute of arc, but the Moon takes 30 times longer (2 minutes) to move the same amount relative to the stars and Sun. Hence, a longitude accuracy of one minute of arc (one sixtieth of a degree) requires the Moon's position to be pin-pointed with an accuracy 30 times better than this, or about one thousandth of the diameter of its own disc. Even modern sextants are about five times less precise than this, and the uncertainties in the refraction corrections preclude any further improvement.

By taking hundreds of observations and averaging the results, the 18th-century navigators were attempting to reduce the effect of the random errors of their instruments. In principle, this strategy is a good one. The random error of the average of 625 results will, on average, be less than the error of the individual results by a factor of $\sqrt{625} = 25$. So, given a basic sextant accuracy of about one minute of arc, it should have been possible by averaging over 600 results to have improved the accuracy sufficiently to make a longitude reckoning of the same order of accuracy.

So where's the snag? Hydrographers, of course, hardly need to be told. The snag is that the errors must be truly random for this technique to work. If every result contains exactly the same error then so will the average, and this will be so no matter how many results are averaged. Captain Cook's determinations show every sign of containing such a non-random (systematic) component, which averaging could and did not eliminate. The author's task in analysing Cook's results was to identify precisely this systematic error.

The source material for this work is contained in Bayly's book, "The Original Astronomical Observations...", published in 1782 by the Commissioners of Longitude. It contains 350 pages of details of astronomical, horological, meteorological, oceanographic, geomagnetic and geodetic observations made during the course of the third voyage. Each of the 122 sets of lunar distance observations made at Nootka is summarized in a 14 column entry; these are: the date, time according to the deck watch, apparent time (i.e. true local solar time), the lunar distance from Sun or star, the altitude of the Sun or star, the altitude of the Moon, the sextant used, the sextant index error, the barometric pressure, the temperature, the identity of the observer (Cook, King or Bayly), the latitude of Nootka (which was accurate to 0.3'), the deduced longitude and the identity of the star, if not the Sun, from which the lunar distance was measured. Although the original editors of Cook's Journal make no mention of Bayly's observations, I have included them in my analysis, as they are, so far as I can tell, equal in quality to those of Cook and King.

Two developments in late 20th-century technology have made a re-examination of Cook's longitude determinations possible. The first is the ready availability of personal computers. My own machine is not by any means state-of-the-art, yet it is easily possible for me to repeat all 122 calculations of longitude, including looking up refraction tables, correcting for parallax and performing inverse interpolation on the Nautical

Almanac positions of the Moon to determine Greenwich time, in less than two minutes. Originally this work must have taken at the very minimum ten days to complete, working diligently throughout the day, hour-after-hour, day-after-day.

The second development is a means of accurately calculating the positions of objects in the solar system. It is based not on theoretical analysis of telescopic observations but on direct measurements of their mass and movements using space probes, radar, and, in the case of the Moon, laser signals bounced from quartz reflectors left behind by the Apollo astronauts. A good indication of the accuracy of the ephemerides used for this analysis is that, in calculating the positions of objects in the sky over Nootka two centuries ago, I have had to take into account the cumulative effect of fluctuations in the Earth's axial rotation due to tidal friction, even though these daily fluctuations are typically measured in fractions of a millisecond.

The way I tackled the analysis was to re-do Cook's calculations four ways. The first way (analysis mode as I call it) was to take Bayly's figures as literally as possible, and re-compute the longitude using 18th-century tables and techniques. The second analysis mode, mode 2, was to take those mode 1 results where there was a discrepancy between Bayly's and the calculated longitudes and look at the possibility that there was a simple arithmetic or typographical error that could plausibly explain the difference. The objective of the mode 2 analysis was to reproduce Cook's results exactly. For mode 3, I corrected any errors that Cook made and re-computed the longitudes, still however using 18th-century tables and techniques. And for mode 4, I re-worked all the calculations using modern tables and modern techniques.

For mode 1, only obvious errors were corrected; for example, calculation shows that observations dated April 19 could only have been made the previous day. In 7 cases for the Sun and 6 for the Moon the nature of the altitude was also incontrovertibly wrong. In fact the first surprise, and a foretaste of what was to come, came with the first look at the first result, which is an observation credited to King made on April 2, 1778 [Bayley, p.46]. Actually, this observation was made shortly before 4 o'clock in the afternoon on April 1, as Cook reckoned local time to be 16 hours ahead of Greenwich, not 8 hours behind as we do today. The Sun's altitude is recorded as 62° 35', a value which is only reached at noon on a mid-summer's day at Nootka. In fact, what had been recorded was the angle between the Sun's lower limb and the point immediately above the observer's head (the zenith); the actual altitude of the Sun corrected for refraction was only 27° 39'.

Some of the results of these mode 1 computations agreed with Cook's results and some did not. On the whole, the comparison was not good. In only 63 of the 122 cases was the computed distance, cleared for parallax and refraction, within 10" of arc of the value that was used to compute the longitude given in Bayly's book (mean difference 8", stnd. dev. 15"). [Note: 1" (second of arc) = 1/3600 of 1° (degree)].

For the mode 2 analysis I looked for simple explanations for the mode 1 discrepancies. This was fairly successful. A typical example of what was found was the first observation using the star Regulus made by Cook on April 3. The given zenith distance of the Moon's upper limb (39° 07') gives an altitude for the Moon which is too low by almost exactly its own diameter. Taking the table entry to be the zenith distance of the lower limb not only corrects the altitude by modern reckoning, but reduces the distance discrepancy from 13" to zero, i.e., there is a 'typo' in the table; ZD UL should be ZD LL. There are at least 18, and perhaps as many as 28 examples of this kind of error in Bayly's tables.

Four amusing calculation errors were discovered among the 31 observations credited to Bayly. In each case, whoever made the calculations failed to clear the lunar distances for refraction. This is a fairly major oversight, yet interestingly the uncleared distances give longitudes closer to Cook's mean longitude than they would have, had they been processed correctly.

The most difficult kind of error to deal with in the mode 2 analysis was the sextant index error. I spent a lot of time looking into these and am left with the distinct impression that the figures given by Bayly are not very reliable. The index error is the sextant reading when the two images of the same body are brought together. The reading ought to be zero, but in practice there is often a small variable off-set.

The difficulty with the hypothesis that some of the index errors are incorrectly tabulated is that by postulating a different index error one can always remove the distance discrepancy, and yet have no substantiating evidence that the proposed alternative error value is correct. However, in some cases it was possible to accept that the errors had been carelessly recorded. For example, the two observations made by King on April 21 and 22 using the Dolland instrument appear to have been corrected by -15", even though Bayly's figures indicate he used -15" on the 21st and -30" on the 22nd. King used -13" for his observation with the third Ramsden instrument (R3) dated April 4, but Cook's result with R3 on the same day has been processed using +13". There are many other similar examples.

The end result of the mode 2 analysis was 103 cases out of 122 where the computed lunar distance agreed with Cook's to better than 10" of arc (mean difference 4", stnd. dev. 12").

Certainly more interesting than typographical errors which could have crept into Bayly's figures at any time after the original calculations were made, are those errors that were incorporated into the longitude calculations. There seem to be just as many of these errors as there were typographical errors. A typical example would be Bayly's second observation dated April 22. The given altitude for the Moon is exactly right by my reckoning , yet the 77° 29' for the zenith distance of the Sun's upper limb puts the Sun 29', i.e. about one diameter, too low. Almost certainly what was measured was the lower limb, but the calculations show that the upper limb was nevertheless used in the longitude calculation.

To see the consequences of this type of error I re-calculated the mode 2 results, correcting any mistakes that had been found. This constituted the mode 3 analysis. As indicated above, I then re-calculated the mode 3 results using my own version of the Nautical Almanac. This was based on positions of the Sun and Moon in 1778 generated by one of the Numerically Integrated Ephemerides developed at the California Institute of Technology's Jet Propulsion Laboratory in Pasadena.

The results of this work are shown in the Figures.

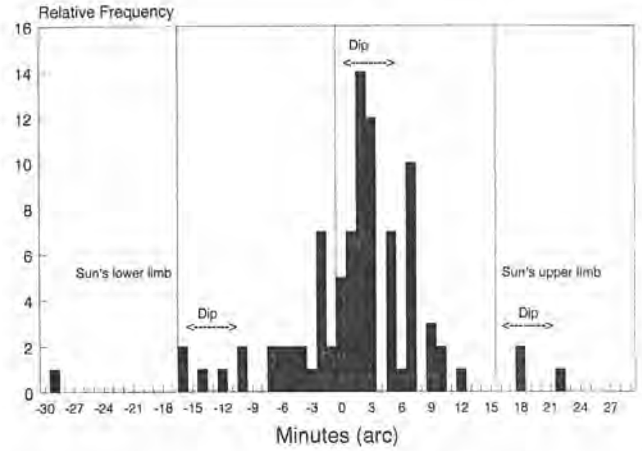

Figure 1: Sun Altitude Errors
Cook's - Modern values (excluding unknown dip)

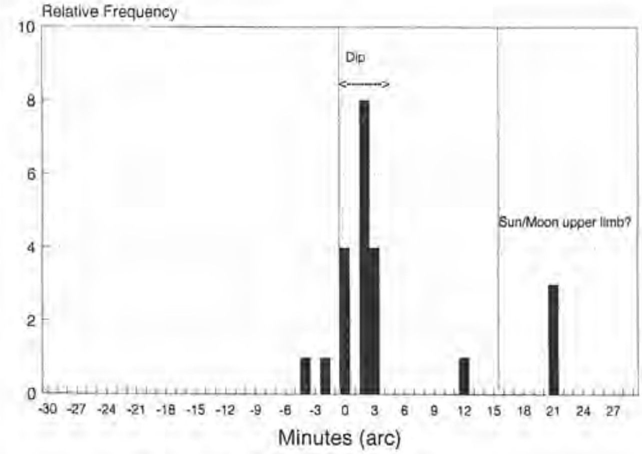

Figure 3: Regulus Altitude Errors
Cook's - Modern values (excluding unknown dip)

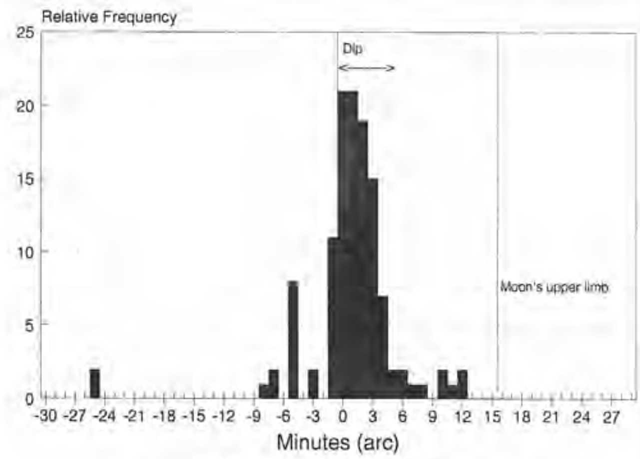

Figure 2: Moon Altitude Errors
Cook's - Modern values (excluding unknown dip)

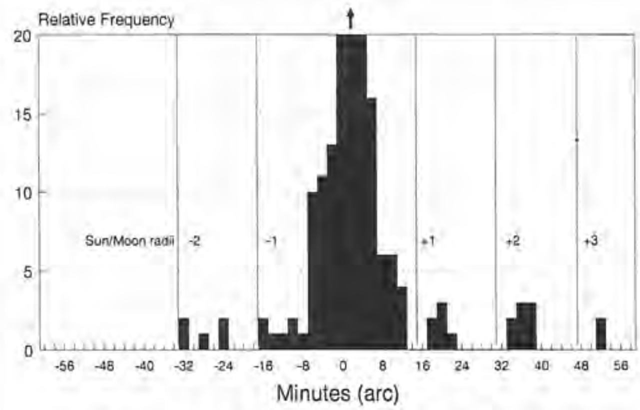

Figure 4: Anomalous Altitude Errors
Cook's - Modern values
Sun, Moon and Regulus

Figures 1 to 3 show histograms of the error in the altitude measurements used for the longitude calculations (mode 2). Altitudes of the Sun, Moon or star (Regulus) were only required for the parallax and refraction corrections of the lunar distance; very precise measurements were not necessary. Nevertheless, the 18th-century navigators usually made good observations as evidenced by their latitude determinations which were usually less than a minute of arc in error. Similarly precise measurements would have been used by Cook to establish the relationship between apparent (local solar) time and the time by his chronometers.

The standard deviation of the altitude errors in Cook's observations is about 5', which is a bit high. One possible contributing factor, as indicated in the Figures, is that some unrecorded allowance was made for dip, i.e. the height of the observer's eye above sea-level. If the altitudes in Bayly's tables need to be corrected for dip, a correction I did not make, then there would be a positive error in the range 3' to 6'. It seems unlikely however that such a routine correction would not be made, and it might not even have been necessary if, due to the very restricted view of the open ocean at Ships' Cove, an artificial horizon (a basin of quicksilver [mercury]) was used.

The possibility that the altitude errors are due to time-of-day errors was ruled out by analysis.

All the calculations that navigators make involving the position of the Sun and Moon are based on the position of the centre of the disc, but in practice observations of position are made relative to one or other of the edges (limbs) of the disc. To find the centre, the radius (semi-diameter) is then added or subtracted as required. Figure 4, which shows a composite histogram of the altitude errors, provides evidence that this routine operation was not always made with care. If, for example, the upper limb is observed for an altitude measurement but the radius is added instead of subtracted, the altitude will be out by two radii. If the correction is neglected, it will be out by one radius. If, as Figure 4 suggests, the figures are reworked without good records being kept, it is possible to make more than one such mistake and be out by three radii or more.

Two of Bayly's observations of the altitude of the star Regulus, which of course has no limbs, are out by the radius of the Sun, and in one case the incorrect altitude is not just a 'typo', it was actually used! In one observation by Cook and one by King, the altitude of the star Regulus is out by the diameter of the Sun, though these incorrect values were not used.

So what was the effect of these and other errors on Cook's longitude determinations? The answer is not much. Figure 5 shows a histogram of longitude determinations as listed by Bayly compared to the true longitude of Ships' Cove. The mean error is 8.3' W, slightly less than Cook's Journal figure because I have included Bayly's observations. For observations using the Sun the error is 12.1' W, and using Regulus 5.7' E, a difference I shall come back to later. After correction (mode 3) the error becomes 5.3' W. For the Sun observations alone it becomes 10.3' W, and for the Regulus observations 13.3' E.

The non-Nautical Almanac errors evidently did contribute somewhat to Cook's westerly error, but as Figure 6 shows, on the whole these types of error tended to average out.

Figures 7 and 8 show the results after being re-worked using my modern version of the Nautical Almanac. Figure 7 shows the Sun observations; Figure 8 the Regulus observations. Figure 7 is a pleasing histogram. Not only has the mean longitude error been virtually eliminated (0.8' W or 1000 metres), but the curve has a symmetry which suggests that individual observations were subject to a truly random error, as indeed they would be if the only remaining error were to be in the sextant readings of the lunar distance. Unfortunately, Figure 8 shows that this is not true for the Regulus observations; the error here has actually increased to a surprising 25.0' E.

In order to check that the good results shown in Figure 7 were not just a chance occurrence, I applied the same analysis technique to Vancouver's and Whidbey's observations at Nootka in 1792. The result was equally as good; their longitude can be corrected to within 0.5' (600 metres) of the correct value.

Figures 9 to 12 show the nature of the errors made in Cook's 1778 Nautical Almanac. Figure 9 shows the error in the lunar distance from the Sun for the month of April. In the first part of the month the Nautical Almanac underestimated the lunar distance (a negative error) . Since the Moon was moving away from the Sun, this led to estimates of Greenwich time which were too fast, and consequently the difference between local and Greenwich time was taken to be too large, and the longitude was determined to be west of its true value. This was the main cause of Cook's error. In fact, his error would have been considerably worse but for the fact that the Nautical Almanac was virtually correct for the observations made around the twenty-first.

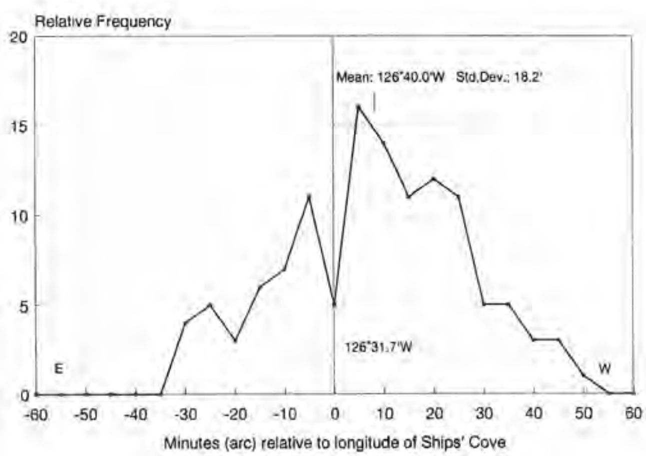

Figure 5: Cook, King and Bayly's Longitudes
As given in Bayly's Tables of Results

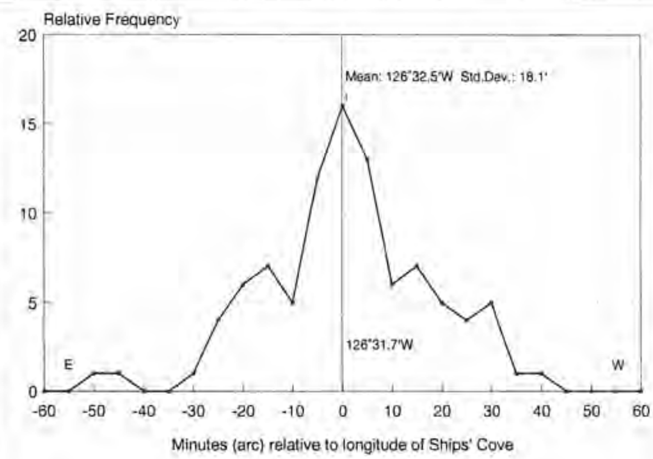

Figure 7: Cook, King and Bayly's Longitudes
Sun - Moon Results
1778 Nautical Almanac and other errors corrected

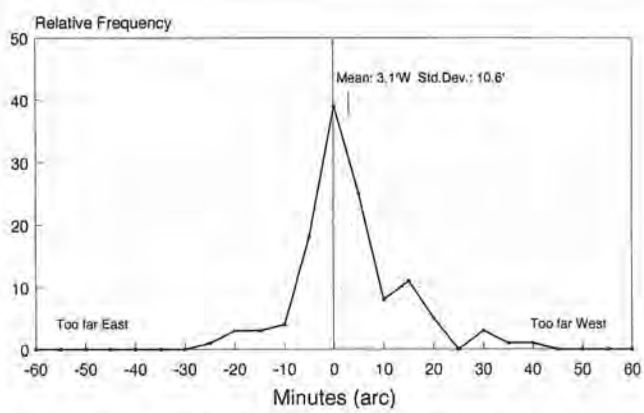

Figure 6: Corrections to Longitudes
Excluding Nautical Almanac corrections
Cook's result - computed result
(The main source of errors is improperly cleared altitudes)

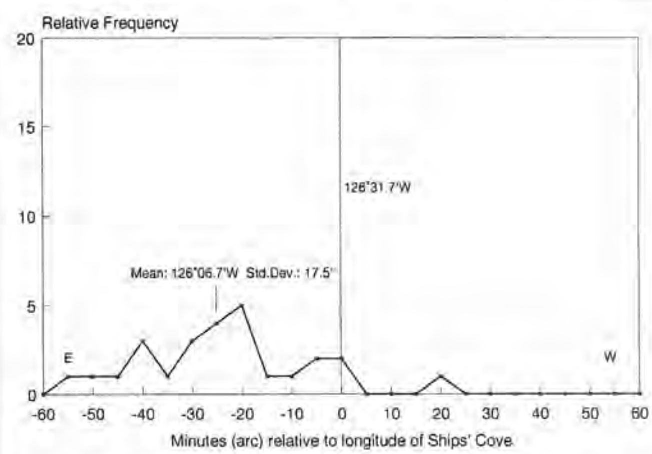

Figure 8: Cook, King and Bayly's Longitudes
Regulus - Moon Results
1778 Nautical Almanac and other errors corrected

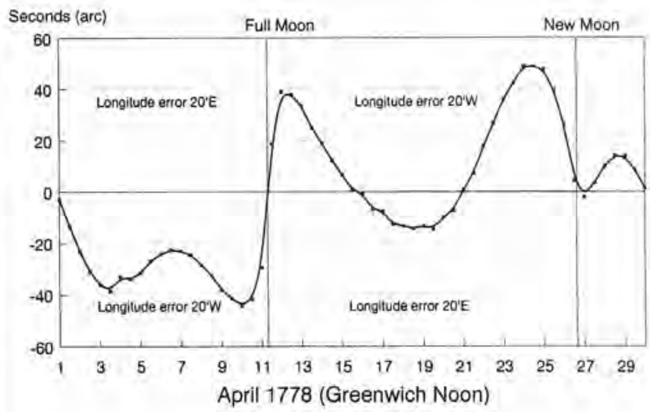

Figure 9: Sun - Moon Distance Error
1778 Nautical Almanac - Modern values

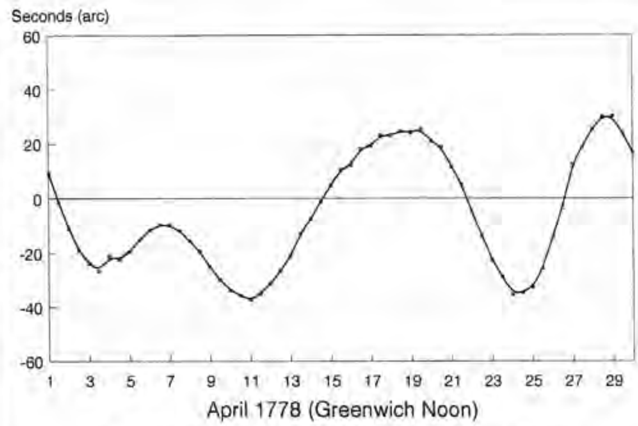

Figure 11: Moon Ecliptic Longitude Error
1778 Nautical Almanac - Modern values

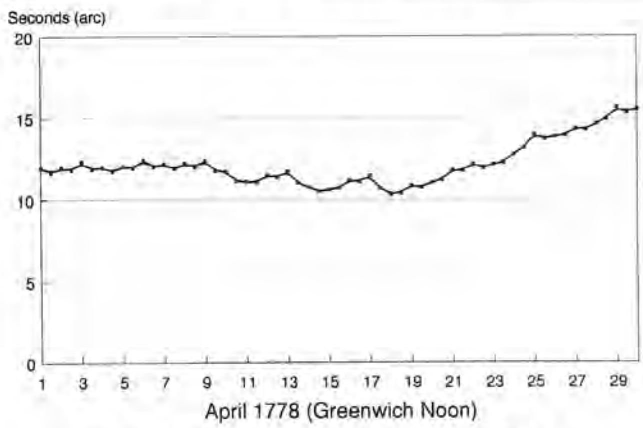

Figure 10: Sun Ecliptic Longitude Error
1778 Nautical Almanac - Modern values

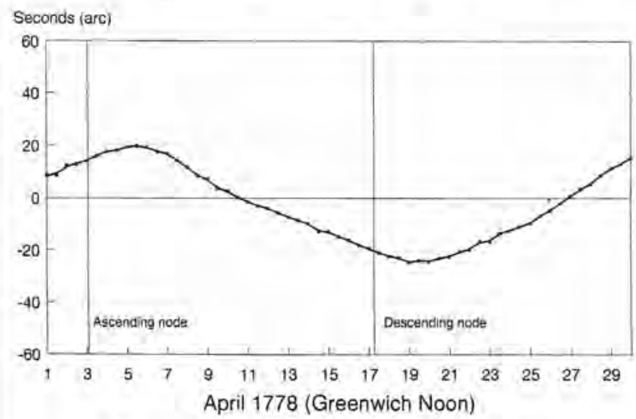

Figure 12: Moon Ecliptic Latitude Error
1778 Nautical Almanac - Modern values

Lest any reader looking at Figure 9 be tempted to be critical of the 1778 Nautical Almanac, and thereby of Johann-Tobias Mayer's equations for the motion of the Moon, it should be noted that for the most part the error in lunar distance is decidedly less than 1 minute of arc. This was the accepted goal of his time; even today, non-professional astronomers would be hard-pressed to do better.

Figures 10, 11, and 12 trace the source of the errors in the tabulations of lunar distance from the Sun. Lunar distance was computed from determinations of the ecliptic latitude and longitude of the Sun and Moon. Figure 10 shows the error in solar longitude, Figure 11 the error in lunar longitude, and Figure 12 the error in lunar latitude. Clearly the errors shown in Figure 9 are mostly attributable to the error in lunar longitude, Figure 11. [Note: Ecliptic (or celestial) latitude and longitude are measured for a sphere whose equatorial plane is the Earth's orbit around the Sun, i.e. by definition the solar latitude is zero. The zero longitude point, the celestial equivalent of Greenwich, is defined by the Spring Equinox. Ecliptic and terrestrial latitudes and longitudes would be equivalent if the Earth were not tilted by 23.5° and it did not rotate every 24 hours].

Some idea of the complexity of the Earth's and Moon's orbit in April 1778 can be seen in Figures 13 to 16.

Figure 13 shows the distance (actual, not angular) of the Earth from the Sun. In April, the Earth, which has a slightly elliptical orbit, is moving away from the Sun. However, this movement is not as smooth as Figure 13 would suggest.

Figure 14 clearly shows the variation in the Earth's velocity away from the Sun as it orbits the centre of gravity of the Earth and the Moon. This variation, which was neglected by the compilers of the Almanac in order to simplify the calculations, is probably the origin of the increase in the solar longitude error visible in Figure 10 towards the end of the month.

Figures 15 and 16 similarly show the complexity of the Moon's orbit. These odd shaped curves take equations containing a hundred or more terms to accurately describe, and result from the complex interaction of the gravitational fields of the Earth, Sun, and planets.

Figures 17 shows the Moon's ecliptic longitude and the difference between the true and mean motion for the month. The variation in longitude can easily be ascribed to the eccentricity of the Moon's orbit as evidenced by Figures 15 and 16. Not so clear is the link between the longitude error shown in Figure 11 and the actual longitude shown in Figure 17. Although I have not examined Mayer's equations for the Moon's motion in longitude, I suspect from the fact that the error appears to go through three complete cycles in the month, and that the positive and negative peaks of the error are roughly equal, that it is an inevitable consequence of the limited number of terms he was forced to use in order to make his calculations tractable.

Figure 18 shows the latitude (and declination) of the Moon. Comparison with Figure 12 shows the error to be in almost perfect phase quadrature with the latitude, suggesting a small timing error in the equations. Latitude errors are of small import as they mostly represent displacement perpendicular to the line joining the Sun and Moon. Displacements in this direction change the angle of the line relative to the stars, but not its length.

Although this analysis has cleared up many problems associated with Cook's observations, there remains one mystery. As shown in Figure 8, those determinations that rely on measurements of the distance between the Moon and the star Regulus give a corrected longitude which is 25.0' too far east. Yet as shown in Figure 19, the Nautical Almanac errors in the position of the Moon that generated a westerly bias for the solar measurements should also have done the same for observations made with the star.

The first thought that came to mind in looking at this is that the compilers of the Almanac had got the position of Regulus wrong. However, calculations showed this not to be the case. Figure 20 shows the computed latitude and longitude of Regulus throughout 1778. [Note: Almost none of the motion in longitude of a star is due to any actual change in the position in the star; it is due mainly to changes in the position of the zero longitude point. This point (the equinox) is defined by the intersection of the Earth's equatorial plane with the ecliptic, and because the Moon causes the Earth's axis to wobble, so also does this reference point. It's as if Greenwich moved about a bit. The phenomenon is known to astronomers as nutation.]

It was easy to show that modern values for the latitude and longitude of Regulus in April 1778 were within a few seconds of arc of that used by the 18th-century mathematicians for their lunar distance calculations. Moreover, the position recorded in the catalogue of stars in the Nautical Almanac of 1773 is also perfectly correct.

The only other explanation I have for the discrepancy is that for some reason the distance measurements for Regulus have been over-estimated by about 40" (much too large to be a statistical aberration). Assuming an additional sextant index error of this amount corrects the longitude determinations made with the star and also has relatively little effect on those made with the Sun. Because all of the Regulus observations, without exception, were made when the Moon was approaching the star, an over-estimate of distance pushes the apparent

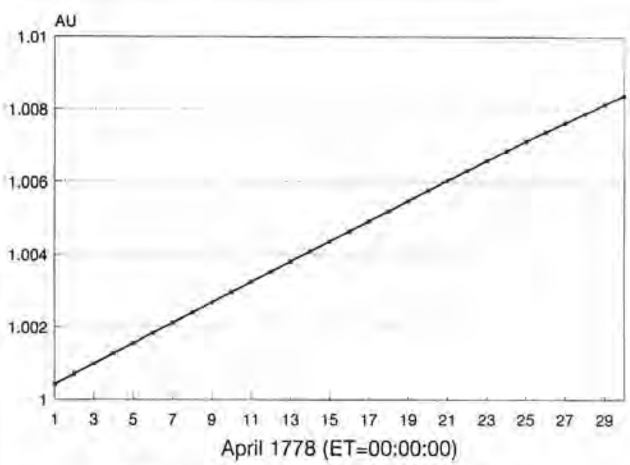

Figure 13: Sun Distance from Earth

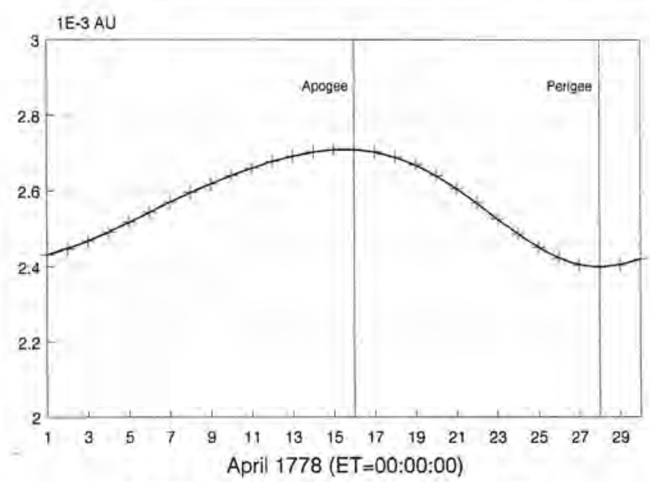

Figure 15: Moon Distance from Earth

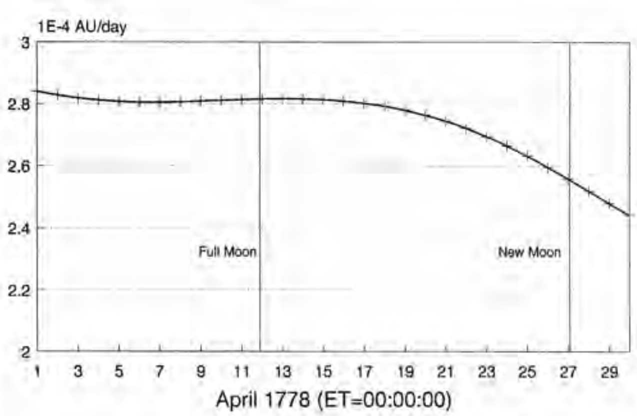

Figure 14: Sun Radial Velocity
+ = away from Earth

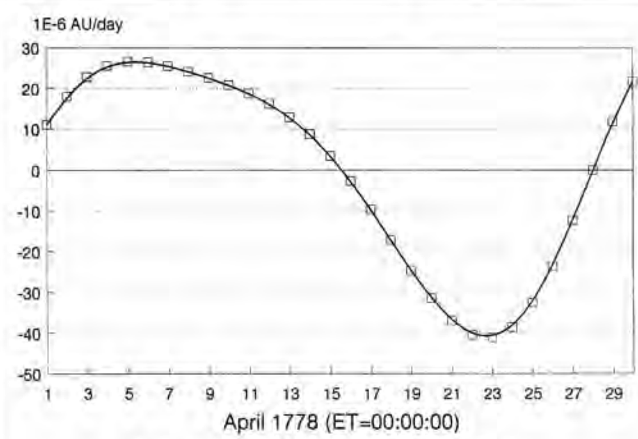

Figure 16: Moon Radial Velocity
+ = away from Earth − = towards Earth

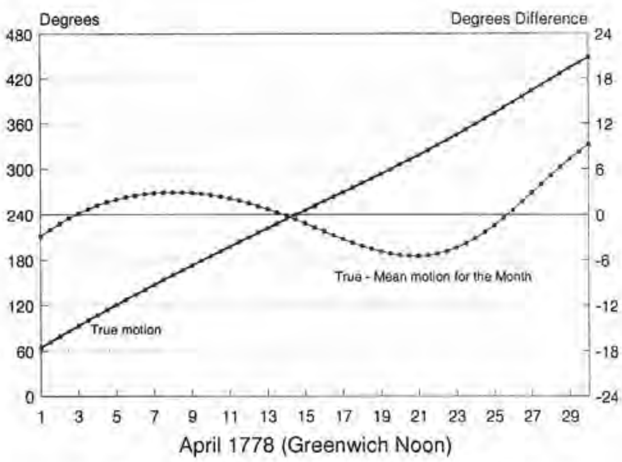

Figure 17: Moon Ecliptic Longitude

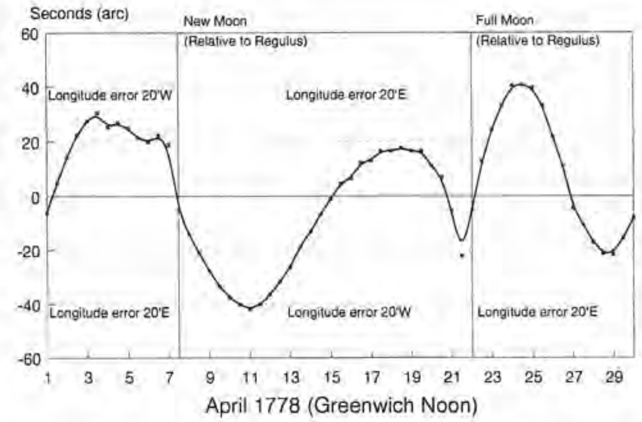

Figure 19: Regulus - Moon Distance Error
1778 Nautical Almanac - Modern values

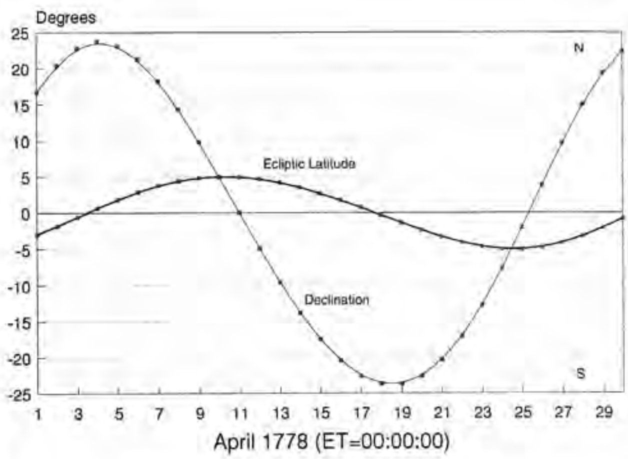

Figure 18: Moon Ecliptic Latitude

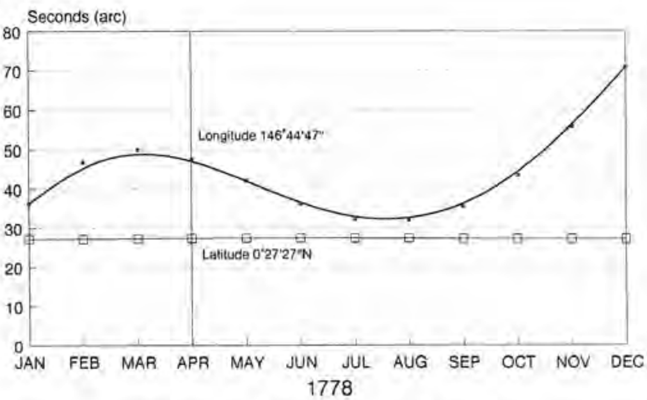

Figure 20: Position of Regulus
Corrected for precession, aberration, nutation and proper motion

longitude east. However, observations using the Sun were made both before and after full moon, so an over-estimate of distance would produce a mix of errors which tend to cancel out.

But why the over-estimate? Was one of their sextants particularly bad? Because relatively few Regulus observations were made with any one sextant it is difficult to make any absolute judgements on this, but the results of analysis point very strongly to the notion that the error was not attributable to one particular instrument. For some reason, all lunar-star angular distance measurements made at Nootka in 1778 appear to have been over-estimates, no matter who made the observation, or with what instrument. And there, for the moment, unless any reader can offer an explanation, the matter rests.

Each of the three observers whose names appear in Bayly's book took around 30 observations of the lunar distance from the Sun at Nootka. The mean error of their longitude determinations after correction for Nautical Almanac errors is 10' E ± 21' for Bayly, 7' W ± 18' for Cook, and 3' W ± 12' for King. This may be slim evidence that King was the best observer of the three, but as a reward I will at least let him have the last word. The following quotation shows that he would hardly have been surprised by the results of this analysis.

"...[it] seems necessary to be known that young folks may not lay aside this certainly most excellent method, by perceiving the results of their observations are not so regular as might be expected...considerable differences will often happen, but it will almost allways be found that the mean of many results with different sextants will be very near the truth..."

(Notes in King's Log, Nootka Sound)

Acknowledgements

The author gratefully acknowledges the help of Dr. Myles Standish of the Jet Propulsion Laboratory, Pasadena, California, who supplied a very accurate Ephemeris for the Sun and Moon 1778 (DE-118 + LE-062). Without his help this work would not have been possible. I would also like to thank Mr. Adam J. Perkins, Archivist of the Royal Greenwich Observatory at the Cambridge University Library in England, for his interest and encouragement.

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Nicholas A. Doe is an engineer living in White Rock, British Columbia. His interests include sea-kayaking, 18th-century navigational techniques and archaeoastronomy in the Alexander Thom tradition. This article represents his third in a series of historical articles based on the original surveys of Canada's West Coast by Captains James Cook and George Vancouver (see Lighthouse editions 46 and 47).

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(Advertisement, Toronto Globe, Sept. 9, 1882)

"...Low pressure area situated over the Lakes region and western states."
"Lakes – fresh to strong southerly to westerly winds; fair warm weather with a few local showers..."

(Meteorological forecast for September 13, 1882, Toronto Globe)

The synoptical weather chart for the evening of September 13, 1882 showed, among other things, a small depression situated over Manitoba. As this depression was considered comparatively unimportant it was virtually ignored. However, the next morning as the next chart was prepared it was seen that the depression had now moved to the north shore of Lake Huron. Its gradients had steepened, the curves closed up in the centre and its rapidity of translation and intensity of development heralded the birth of a hurricane. The centre had travelled over 500 miles in less than eight hours. [1]

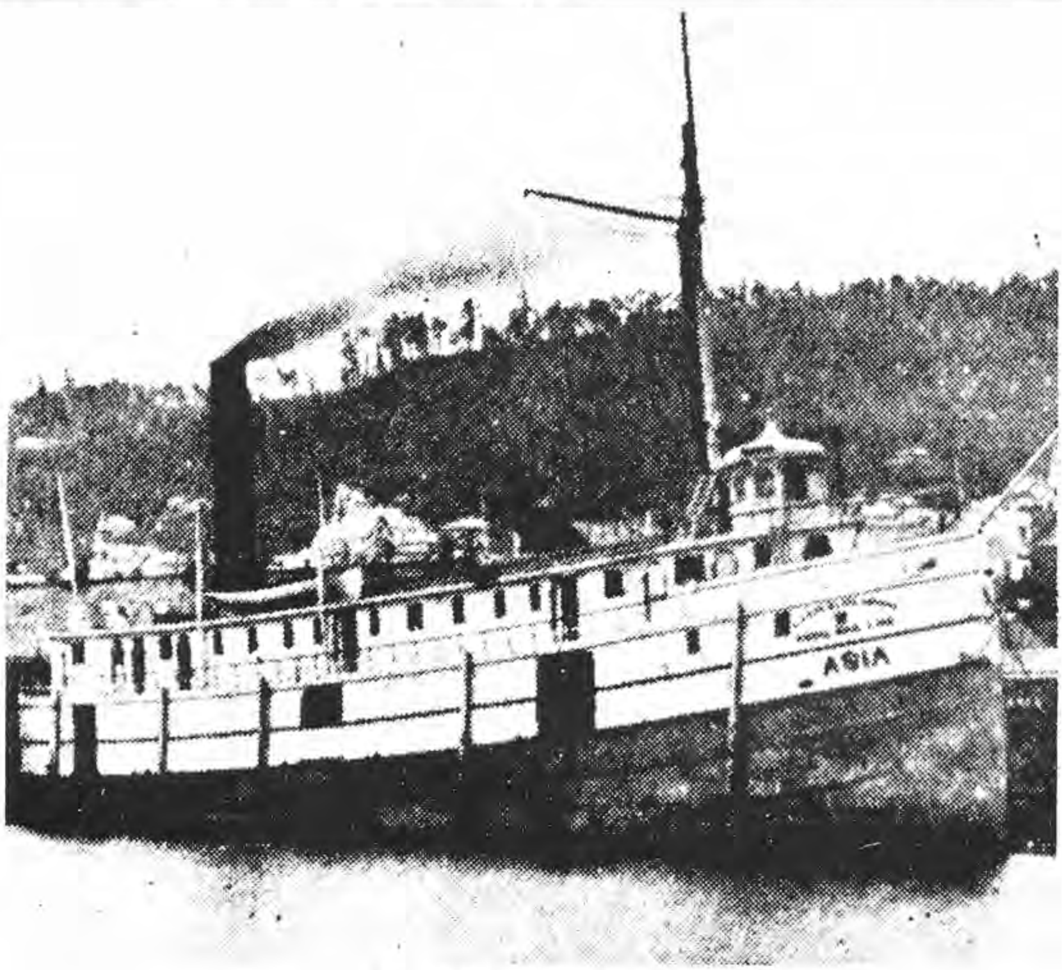

Figure 1: The Unfortunate 'ASIA'

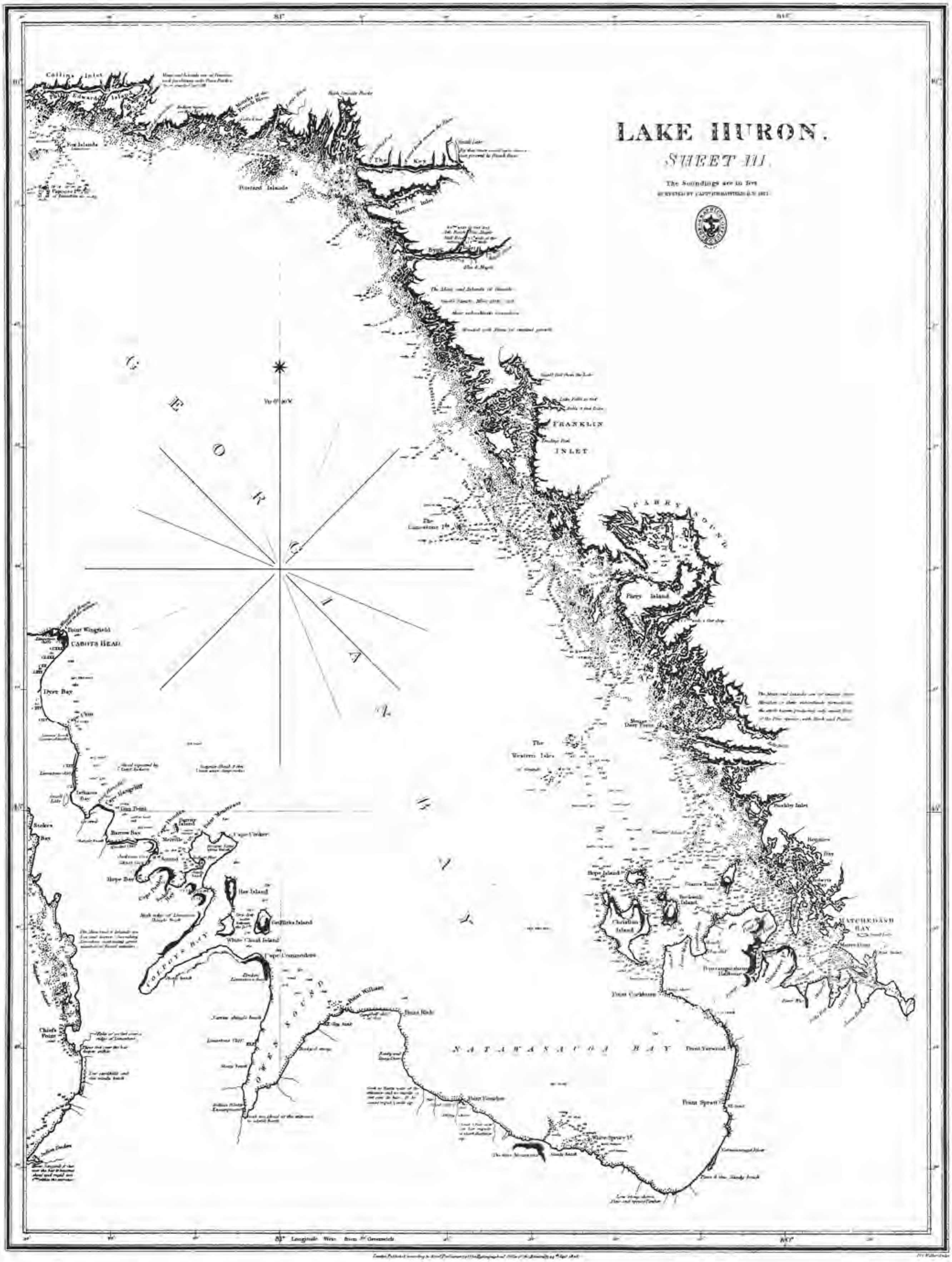

Figure 2: Georgian Bay (Lake Huron) Chart, as published by Hydrographic Office of the Admiralty, Sept. 29, 1828
(Surveyed by Capt. H.W. Bayfield R.N. 1822)

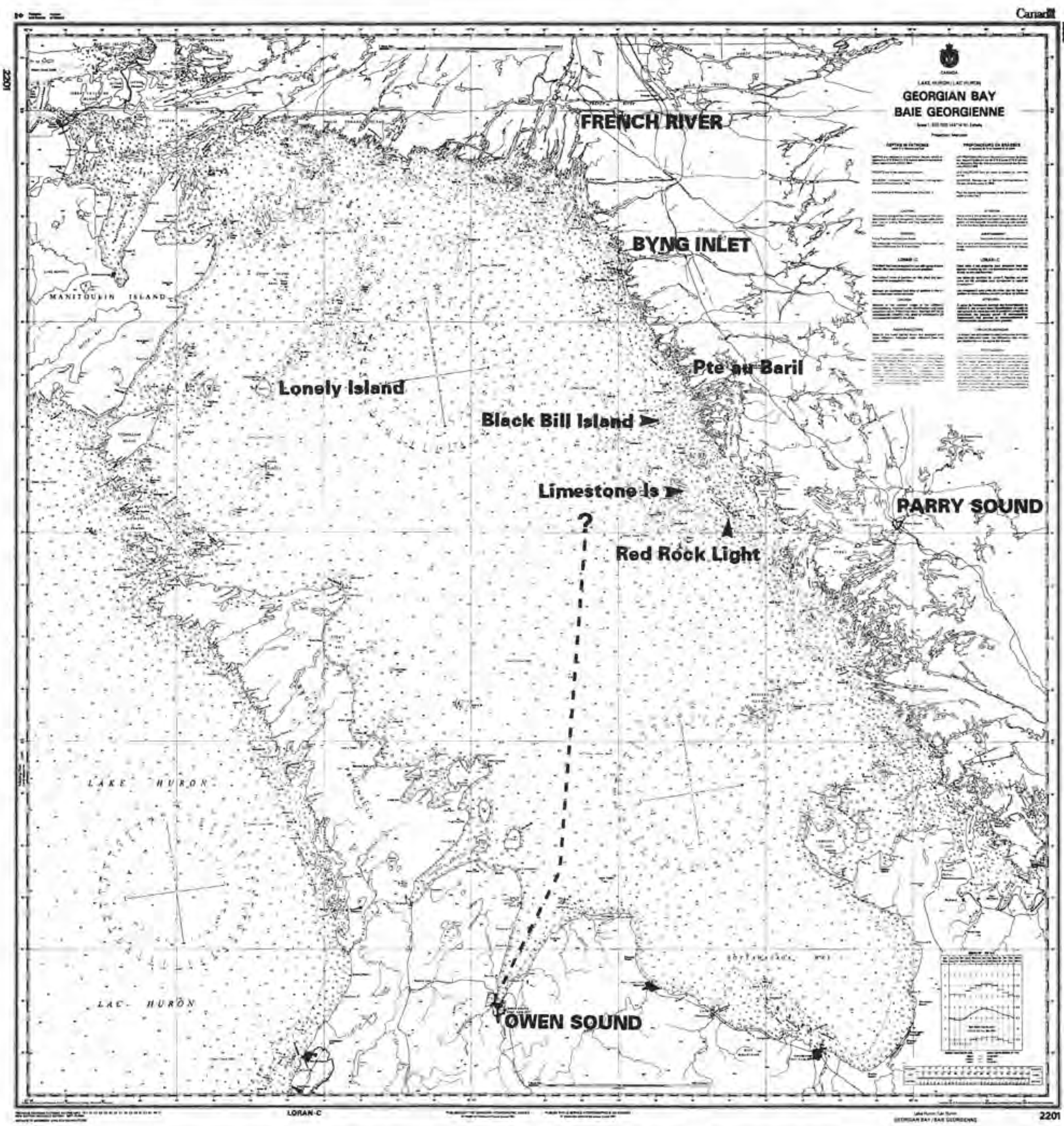

Figure 3: Existing CHS Chart 2201 (edition: Sept. 21, 1984)

About the same time as the meteorologists were examining this latest chart, the steamer 'ASIA' was being prepared to leave the port of Owen Sound bound for Sault Ste. Marie via the settlement of French River.

The 'ASIA', a steamer of 347 tons, was of a class of ships known as "Old Canal Propellors" and although not designed to run on the Great Lakes was pressed into service and had served there for a number of years. She carried a general cargo and up to 120 passengers. As seen in Figure 1, she was short, stubby and very top heavy. She wouldn't appear to inspire anyone with great confidence by today's standards. Nevertheless she was classified A–2 by Inland Lloyds and must have appeared fit enough to the 100 odd people who were on board that morning.

By nine o'clock that morning the storm was reported from Manitoulin Island to have reached the velocity of a hurricane causing much damage there before continuing on its journey.

The'ASIA', blissfully unaware of the situation, was well on her way, her course set for French River, an intermediate port where some of the passengers were to have disembarked.

It would appear that the course of the steamer 'ASIA' would have intercepted the course of the storm at about 11 o'clock that morning.

> "...Collingwood, September 17, the following report has just reached here...Captain A.M. McGregor...reported passing the wreckage of a

> steamer off the Limestone Islands. He picked up and brought with him a trunk, a door and a pillow slip marked Steamer 'ASIA'."
> (The Globe, Toronto, Sept. 18, 1882)

The loss of the 'ASIA' and all but two of her passengers was the worst shipping disaster to have happened in Canada at that time. The news was greeted with shock as it trickled down to Toronto and the nation. The two survivors, a Miss Morrison and a Mr. Tinkias, gave an account of the events preceding their rescue:

> "...the steamer was crowded and all the staterooms were full and many passengers were lying on the sofas and the cabin floor. All went well until eleven o'clock Thursday morning when the storm struck us...dishes and chairs were flying in every direction. We left the cabin and found difficulty in getting on deck, the boat was rolling so heavily..."

According to an article in the Toronto Globe:

> "She rolled heavily for about twenty minutes when she was struck by a heavy sea and foundered going down with the engines working a half–past eleven." [2]

A number of people got into one of the lifeboats but it turned over several times, each time losing some of the people who were in it so that after the storm had subsided, only seven were left. Of these seven, five died of exposure, including the Master, Captain Savage and his mate Mr. McDonald. The lifeboat stranded about Pointe au Barrie* about daylight on Friday, the two survivors being spotted by an Indian who brought them to Parry Sound.

*[Author's note: The Globe, in its many articles about the disaster, continually made references to Pointe au Barrie. I suspect, however, that this refers to a point now recognized as Pointe au Baril.]

The exact location of the foundering is unknown. It was reported in the Globe to be "about thirty-five miles northwest of Parry Sound and probably ten miles from the French River." This seems unlikely though, considering Captain McGregor's statement about the wreckage he saw off the Limestone Islands. The lifeboat which carried the two survivors stranded ashore about ten miles northeast of these islands and a boat which had been in tow of the 'ASIA' up until two hours before foundering was recovered at Red Rock Light—about five miles east of the islands. All of this would seem to indicate that 'ASIA' foundered off the Limestone Islands and not farther north off Byng Inlet as previously suspected. The first search vessels were instructed to search the area from Pointe au Barrie to Mink Islands. As there are many small islands in this area there was hope that some survivors had reached shore and were still alive.

The search continued for many days, the perimeter of the search location gradually enlarging as the floating wreckage spread. On September 23 a body was recovered southwest of Byng Inlet.

Due to the delay in search vessels reaching the scene of the tragedy the floating wreckage had spread a good distance from the location of the actual foundering. Thus the search was operated over a relatively large area of virtually uncharted waters.

Eventually, as was inevitable in those shoal-infested waters, a shoal was discovered in the search location. The Tug 'MARY ANN' reported "...a dangerous shoal...covering five hundred acres...about twelve miles off Blackbill Islands." Thus speculation arose that the 'ASIA' had not foundered as a result of being unable to withstand the storm because of poor design, but that she had run aground on an unmarked reef. This was the explanation followed by the ship's owners and in a letter to the Globe they claimed:

> "The shoal with numerous others not marked on our charts were reported to the Dominion Government years ago by one of our Lake captains whose knowledge of the inland seas from Montreal to Duluth is excelled by none. This shoal will carry fourteen feet of water on it. A more dangerous shoal, and quite unknown, is one of vast extent and composed of gravel and large honeycombed rocks lying east of Lonely Island at a distance of eight miles, and directly in the course of vessels from Lake Huron to French River or Byng Inlet. Upon this reef it is the writer's opinion that the late Georgian Bay disaster occurred and is explained this way.
>
> The 'ASIA' left Owen Sound Bay shortly before daylight with a strong southeast wind, for French River, and her drift would carry her in close proximity to this dangerous reef at about the time she foundered, say 11 a.m. The government has been asked to indicate and mark these shoals but little notice was taken of the informant's views in regard to them. The Canadian Government has been very dilatory in regard to lighting the coasts upon the Georgian Bay and shores of Lake Superior that the private individuals have had to place beacons and buoys among the different channels used by the vessels approaching and leaving the harbours upon the rock bound coast. The chief cause for disaster upon the Georgian Bay and north shores may be attributed to the want of lights, fog whistles, buoys and beacons. The harbours are nature's own and numerous, better than can be artificially made and only require the guide marks to indicate the proper channel to the storm tossed mariner and his human freight..."

The ship's owners, fearing government intervention and possible legal action may have had obvious reasons for pursuing such an explanation. An examination of the chart (Figure 3) however would seem to refute this theory, especially in light of the fact that the first wreckage was spotted near the Limestone Islands. Nevertheless, the point was well made that the aids to navigation in that area and indeed all over the Great Lakes were woefully inadequate.

An inquiry conducted by Captain P.A. Scott, R.N., Chairman of the Board of Examiners of Masters and Mates, came to a different conclusion. According to Captain Scott:

> "...the vessel was not in good ballast trim, and that she was of a class of vessels which were not intended to run on the Great Lakes being of that

> class of vessels known as Old Canal Propellers. The vessel appears to have been too light forward, and therefore unable to luff when the gale struck her, but had to bear its whole force on her broadside. It also appears that she had not sufficient cargo in her hold to enable a vessel of her description, with lofty upper works, to stand up against the gale."[1]

Later in the summation, Captain Scott says:

> "The question is frequently asked, was this gale such a one that even a well found and well handled ship must necessarily have foundered? To this I can only reply that I have no reports of instrumental measures, of the velocity of the wind at Manitoulin Island, as we have no anemometer there; but from the general damage done and some of the particular cases I have quoted, I believe that the force of the wind must have been almost that of a hurricane for a short time and over a limited area—and as such gales, although fortunately rare, do occasionally pass over the Great Lakes, all vessels navigating these waters should be so constructed and equipped as to be prepared to meet them."[1]

Although it was proven through the inquiry that the presence of shoals in the area had nothing to do with the actual foundering it was obvious to Ottawa that something must be done to improve the navigational aids in the lakes. High on the list of priorities was a full-scale charting program.

Charting on the Great Lakes had last been carried out in the nine years preceding 1825 under H.W. Bayfield (later Admiral) of the British Admiralty (see Figure 2).

Accordingly the Federal Government, fifteen years after Confederation, decided to assume responsibility for charting its own waters. Up until this time all charting had been undertaken by the Admiralty. However, as British funds and personnel were required elsewhere on the globe, the Canadian Government was encouraged to exercise its new-found independence and develop its own hydrographic service. As there were no Canadians suitably trained to undertake this project the British Admiralty was approached to appoint a competent hydrographer—the understanding being that the Canadian government would supply all equipment, vessels, and assistance required. It was also assumed that suitable Canadians would be trained to be hydrographers and so eventually complete the takeover.[3]

The officer was Captain J.G. Boulton and for ten years he headed all hydrographic surveys undertaken by the Canadian government. Upon his return to England, W.J. Stewart, a Canadian, was named to the post of Chief Hydrographer (later Dominion Hydrographer).

By 1910 the last Admiralty ship had left Canadian waters and the Hydrographic Service's realm of responsibility was really *"A Mari usque ad Mare".*

[editor' note: As Mike has indicated the wreck of the 'ASIA' was very instrumental in the establishment of the Canadian Hydrographic Service (initially called the Georgian Bay Survey). This article was reprinted with permission from Lighthouse Edition No. 12, November, 1975. The reproduction of the 1828 chart (Figure 2) was an editorial addition (by J. H. 'Sam' Weller) to this reprint.]

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3. Thomson, Don W., "Men and Meridians", Vol. 1 and Vol. II.

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At the time of the original writing of this paper Mike Casey was a hydrographer with Central Region of the Canadian Hydrographic Service. Mike is still with the CHS, as Chief of System Development in Ottawa.

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Book Review / Critique d'un livre

by
R. M. Hare

"HYDROGRAPHY for the Surveyor and Engineer" Third Edition.
A.E. Ingham. Revised by V.J. Abbott. Oxford: Blackwell Scientific Publications Ltd., 1992. 132 pp. Paperback.

The Third Edition of this book builds on the previous edition (1984), and includes some of the more modern practices and technologies available to today's hydrographer. Two wholly new chapters have been added and a minor restructuring of some of the topics has taken place. The remaining text is largely unchanged with the exception of the chapter on positioning, which now has less emphasis on sextant and medium-frequency positioning methods. A list of related journals, addresses of professional organizations and sources of hydrographic information has been added to the list of references.

The Introduction to this edition is expanded and now contains the chapter on the Elements of Hydrography from the Second Edition as well as some fundamentals of geodesy and map projections. Chapter Two, The Physical Environment, is mostly new and discusses tide-raising forces, acoustical properties of sea-water and the propagation properties of different radio-frequencies in the atmosphere. The sections on tide gauges and vertical datums have been included in this chapter. The following chapter, on planning a survey, has been restructured but contains the same pertinent information as in the last edition.

The chapter on positioning has undergone the most significant change, which is understandable considering the changes in positioning technology since 1984. The chapter has been reduced by about one-third, mostly in the sections on sextant and medium-frequency positioning. This change is not surprising considering that GPS is now the offshore positioning tool of choice. What is surprising is that the section on GPS, and especially differential GPS (DGPS), is not much larger. Barely more than one additional page is dedicated to GPS than in the previous edition and no consideration is given to multipath, a significant source of error in the marine environment. The section on acoustic (underwater) position fixing (UPF) systems is largely the same as in the Second Edition. The section on integrated positioning systems has been dropped, which is unfortunate since the integration of Loran-C and GPS has gained recent prominence in literature. Also, additional information from attitude sensors such as heading, roll, pitch and heave is required to compute accurate coordinates for soundings even when using GPS, which requires an integrated approach.

The chapter on Acoustic Measurement and Investigation, called Underwater Sensors in this edition, has been reorganized to some extent and now contains the section on seismics (formerly in the Miscellaneous Aspects of Hydrography chapter). New figures have been added to the sections on acoustic sweep and swath technologies. The chapter titled Environmental Operations contains much of the same information that was in the Miscellaneous Aspects chapter of the previous edition. The chapter on Miscellaneous Applications in this edition is mostly new material and covers charting, dredging, construction and environmental surveys, site and hazard surveys, rig moves, pipeline surveys, wire sweeps (in Miscellaneous Aspects of Hydrography in the Second Edition) and reinstatement of seabed sites.

The chapter on Data Handling is much the same as the Processing of Hydrographic Data chapter in the previous edition. Both manual and automated processing are discussed. New to this edition is a discussion of computer modeling and display of dense data sets, Geographic Information Systems (GIS) and ECDIS, which should correctly be called Electronic Chart Display and Information Systems. Finally, a wholly new chapter on Professional Aspects of Surveying has been added. Sections discussing professional standards, Law of the Sea (which appears to be incorrectly labeled as "The Law of the Surveyor"), liability, safety, quality control and quality assurance systems (with reference to ISO 9000) are included in this chapter.

As stated in the book's Preface, this text is for the surveyor or civil engineer encountering marine works for the first time or for students in related subjects. As a consequence, the approach is necessarily general and broad-brush. A more appropriate title for this book might be "HYDROGRAPHY for the Land-Surveyor, Civil Engineer and Student," but that is rather long-winded. Overall, I found the book to be quite readable and without errors, except as noted above. The quality of some of the figures is poorer than in the previous edition, possibly due to photo-reproduction of the originals with new text (consistent font).

A list of references is provided for those who wish more detail on a particular subject. However, the list of references could be greatly expanded and embellished with abstracts as was done in the previous edition. Conspicuously absent in the list of references is the FIG Commission IV Report on the Detection of Depth Anomalies which gives an excellent detail of acoustic, magnetic, optical and mechanical methods of mapping the ocean floor. Also, since the audience of this text is likely to be unfamiliar with hydrographic terminology, a glossary of terms should be included as an appendix and the index should be more detailed. Similarly, the table of contents could be expanded to give the section titles, so that reference may be made more quickly to the appropriate section.

About the Author

Robert Hare has been a field hydrographer with the Pacific Region of CHS since 1982. He holds a Diploma in Survey Technology and a BSc. in Surveying Engineering. He is also currently the Vice-President of the CHA Pacific Branch.

Canadian Hydrographic Association / Association canadienne d'hydrographie

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 the 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.

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.

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.

Membership

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

Branch & Regional Activities

The Canadian Hydrographic Association has eight (8) branches located across Canada. National headquarters is located in Ottawa.

For further information write to:

National President
Canadian Hydrographic Association
P.O. Box 5378, Station F
Ottawa, Ontario
Canada
K2C 3J1

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 les pays 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 Societée de l'hydrographie.

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

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'industries ou du gouvernement autant national qu'international, apparaissent dans cette revue. Le tirage actuel de la revue est d'environ 900 copies.

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.

Sections et activités régionales

L'Association canadienne d'hydrographie possède huit (8) sections à travers le Canada. L'administration central se trouve à Ottawa.

Pour plus d'informations, s'adresser au:

Président national
Association canadienne d'hydrographie
C.P. 5378, station F
Ottawa, Ontario
Canada
K2C 3J1

Sustaining Members / Membres de soutien

In 1987 the CHA defined a new form of membership to allow companies, closely linked with the hydrographic field, to become more involved with the activities of the CHA and to maintain closer contact with users of their products. Through LIGHTHOUSE these Sustaining Members are also able to reach a world-wide audience of people involved with hydrographic work. The benefits of Sustaining Membership include:

- a certificate suitable for framing;
- three copies of each issue of Lighthouse;
- copies of the local Branch newsletters, where available;
- an invitation to participate in CHA seminars;
- an annual listing in Lighthouse;
- an annual 250 word description in Lighthouse; and
- discounted advertising rates in Lighthouse.

The annual dues for Sustaining Membership in the CHA are $150.00 (Canadian).

Current Sustaining Members are listed below.

Aanderaa Instruments Ltd.
100 - 4243 Glanford Avenue,
Victoria, British Columbia,
Canada V8Z 4B9
Fax: (604) 479-6588
contact: Gail Gabel *(affiliation - CHA Pacific Branch)*

Atlas Elektronik
Atlas Elektronik of America,
90 Myrtle Street, Cranford, NJ
USA 07016
Fax : 908-276 3822
contact: Karl Kieninger (affiliation - CHA Central Branch)

C-MAP / USA
P.O. Box 1609,
Sandwich, Massachusetts,
USA 02563
Fax: (508) 833-2480
contact: Kenneth J. Cirillo *(affiliation - CHA Central Branch)*

Datasonics Inc.
P.O. Box 8,
1400 Route 28A,
Cataumet, Massachusetts,
USA 02534
Fax: (508) 563-9312
contact: Paul Igo *(affiliation - CHA Central Branch)*

EG&G Marine Instruments
P.O. Box 498,
1140 Route 28A,
Cataumet, MA,
USA 02534 *(affiliation - CHA Central Branch)*

Garde Côtière canadienne
104 rue Dalhousie, Suite 311,
Québec, Québec,
Canada G1K 4B8
Fax: (418) 648-4236
contact: Claude Duval *(affiliation - ACH Section du Québec)*

l'Institut maritime du Québec
53 St-Germain Ouest,
Rimouski, Québec,
Canada G5L 4B4
Téléc: (418) 724-0606
contact: Claude Jean *(affiliation - ACH Section du Québec)*

Quester Tangent Corporation
9865 West Saanich Road,
Sidney, British Columbia,
Canada V8L 3S3
Fax: (604) 655-4696
contact: John Watt *(affiliation - CHA Pacific Branch)*

Racal Positioning Systems Ltd.
118 Burlington Rd.,
New Malden, Surrey,
United Kingdom KT3 4NR
Fax: 44 81 942-6630
contact: Paul Deslandes *(affiliation - CHA Central Branch)*

Sea Beam Instruments Inc.
141 Washington Street,
East Walpole, Massachusetts,
USA 02032-1155
Fax: (508) 660-6061
contact: Steve Withrow *(affiliation CHA Central Branch)*

Simrad Mesotech Systems Ltd.
202 Brownlow Avenue
Dartmouth, Nova Scotia,
Canada B3B 1T5
Fax: (902) 468-2217
contact John Gillis *(affiliation - CHA Central Branch)*

terra surveys ltd.
1962 Mills Road,
Sidney, British Columbia,
Canada V8L 3S1
Fax: (604) 656-4604
contact: Rick Quinn *(affiliation - CHA Pacific Branch)*

Sustaining Members / Membres de soutien

Sustaining Members of the CHA are offered space in Lighthouse each year for a 250-word description of their services.

Atlas Elektronik

Atlas Elektronik of America, which specializes in nationwide marketing of hydrographic survey, navigation, fishing and satellite telephone systems, has moved to new enlarged premises in New Jersey.

New address details are:

Atlas Elektronik of America,
90 Myrtle Street, Cranford, NJ
07016 USA
Tel : 908-276 9400,
Fax : 908-276 3822

Quester Tangent Corporation

Quester Tangent is celebrating their first decade in business. The technology associated with Hydrographic data logging and processing licensed from the CHS in 1983, has led to the on-going development and sales of the ISAH line, primarily in the international market place. At present, the company is the largest vendor of automated hydrographic data logging equipment. They are closing the decade on a strong note. The 100th ISAH has been ordered by a client in SE Asia, and will be delivered early this year.

Quester Tangent offers their sincere thanks to their partners in Canada, including the CHS, DPW and DND. In spite of very limited budgets, each has supported research projects which have led to international sales. In the last year, DND has funded trials of ISAH-T which have documented the performance of RGPS system and DPW has supported trials of the bottom classification technology developed in the ISAH-S program.

Institut Maritime Du Québec

Le centre de formation en plongée professionnelle de l'Institut maritime du Québec bientôt une réalité!

Grâce à la participation financière du gouvernement fédéral et du ministère de l'Enseignement supérieur et de la Science du Québec, totalisant près de 2,6 millions de dollars, l'Institut maritime du Québec a pu aller de l'avant dans son projet de construction d'un centre de formation en plongée professionnelle à Rimouski. Le financement de ce projet, évalué à un peu plus de trois millions de dollars, sera complété par l'Institut maritime du Québec et le Collège de Rimouski, dont l'Institut est l'une des composantes.

Il s'agira d'un édifice de trois étages, d'une superficie totale de 1611,5 mètres carrés qui sera érigé entre les ailes C et B du siège social de l'Institut et principal centre de formation au Québec. La partie centrale de la nouvelle aile sera occupée par un bassin de 50 pieds de longueur, de 18 pieds de largeur et de 12 pieds de profondeur avec, à l'une de ses extrémités, une fosse cylyndrique de 50 pieds de profondeur. On retrouvera aussi des ateliers de travail, des laboratoires spécialisés et des salles de cours. Le nouveau centre abritera également un simulateur de salle de machines ultra-moderne qui permettra une formation encore plus poussée des mécaniciens de marine à l'Institut maritime du Québec.

Seul établissement d'enseignement collégial au Québec autorisé par le M.E.S.S. à offrir une formation de scaphandrier et de scaphandrier inspecteur, mission qu'il accomplit depuis 1988 au Centre de formation aux mesures d'urgence en mer à Saint-Romuald, l'Institut maritime souhaitait disposer d'installations de qualité, conçues expressément pour l'enseignement de la plongée professionnelle. L'établissement d'un tel centre à Rimouski ajoutera à l'expertise maritime déjà très importante que l'on retrouve dans cette région et permettra au Centre de Saint-Romuald de se consacrer entièrement à sa vocation première, soit la formation aux mesures d'urgence en mer et le combat des incendies.

L'inauguration du Centre, à l'automne 1994, sera l'un des événements durant lesquels sera souligné le cinquantenaire de l'Insitut.

Traditionnellement, et de manière exclusive au Québec, l'Institut maritime du Québec forme une main-d'oeuvre compétente en architecture navale, navigation, génie mécanique de marine et radiocommunication et électronique maritime. Pour assurer son développement, au cours des dernières années l'Institut a étendu ses activités à d'autres domaines: l'hydrographie, la plaisance, la plongée avec scaphandre et la logistique du transport intermodal. Outre à Rimouski et à Saint-Romuald, l'Institut administre des centres de perfectionnement pour le personnel de l'industrie maritime canadienne à Montréal et à Québec. La qualité de la formation qu'il dispense est reconnue mondialement.

Lighthouse Puzzler / Casse-tête du Lighthouse

by
Beth Weller

Lighthouse Puzzler # 9

Four hydrographers, Les, Paola, Louise and Heimo, and their spouses, are all in the Caribbean for a winter holiday. Each couple went to a different island and had a different highlight to remember.

From the conversation at the next CHA meeting, can you figure out who is married to whom, which island they visited, and what their highlights were?

The clues:

1. Les does not like deepsea fishing; Jennifer did not like the limbo dancers.
2. Paola loved St. Barts but did not go to see the steel band or go fishing.
3. Louise, who is not married to Brad, did not care for anything to do with a boat.
4. Les and Terese, who were not on the same island, the couple who went to St. Maarten, and the woman who loved the rum cruise, all had a bit too much sun.
5. The couple who went to St. Kitts did not like steel band music.

Hydrographer	Spouse	Island	Highlights

	Terese	Jennifer	Jon	Brad	St. Kitts	St. Barts	St. Maarten	St. Lucia	Limbo dancers	Rum cruise	Steel band	Deepsea fishing
Les												
Paola												
Louise												
Heimo												
Limbo dancers												
Rum cruise												
Steel band												
Deepsea fishing												
St. Kitts												
St. Barts												
St. Maarten												
St. Lucia												

Solution to Spring Puzzler (#8)

The black hat is not Paola [Clue 5], Jim [Clue 4], or Jack [Clues 1 & 2] so must be Gabriella swinging the lead [Clue 2], and Paola is wearing the white hat and Jack a red hat. Paola, with CHA [Clue 5], is not at the helm [Clue 1] or lead line or sails [Clue 3] so must be on the sextant.

By elimination, the person from THSOA is at the helm and must be Jack [Clue 1], and the person from CIG–TB is on the lead line and must be Gabriella. Jim in his blue hat is with AOLS and is trimming the sails.

Coming Events / Événements à venir

U.S. Hydrographic Conference '94

The 6th Biennial International Hydrographic Conference will be held at the Omni International Hotel, Norfolk, Virginia, April 19-23, 1994. This conference is sponsored by NOAA (Coast and Geodetic Surveys), USCG, The Oceanographer of the Navy, DMA, The Hydrographic Society of America, and FIG. The conference theme is "Marine Information Partnerships".

For more information please contact:
U.S. Hydrographic Conference '94
P.O. Box 732, Rockville, MD
U.S.A. 20848-0732

Or contact Commander George Leigh, NOAA:
Telephone: (301) 713-2783 Fax: (301) 713-4019

(see advertisement on page 10)

1994 CIG Conference

This conference, jointly sponsored by the Canadian Institute of Geomatics and the Association of Canada Lands Surveyors, is scheduled for April 20 to 22, 1994, in the Victoria Conference Centre in Victoria, B.C. The theme of the conference is "New Boundaries - New Horizons".

For more information please contact:
C.I.G. '94
P.O. Box 2460, Sidney, B.C.,
Canada V8L 3Y3

GIS / ISPRS 1994

The 6th Canadian Conference on Geographic Information Systems (GIS) and the Symposium of the International Society for Photogrammetry and Remote Sensing (ISPRS) Commission II is scheduled for June 6-10, 1994 in Ottawa, Ontario. The GIS Conference will include papers on GIS research and technology, uses and applications, and management and education. The ISPRS Symposium will focus on systems for data processing, analysis and representation.

For more information please contact:
Dr. Mosaad Allam, Chairman
GIS 1994 Conference and ISPRS II Symposium
615 Booth Street, 7th Floor
Ottawa, Ontario, Canada K1A 0E9
Telephone: (613) 996-2812 Fax: (613) 952-0916

(see advertisement on inside back cover)

KIS94

The International Symposium on Kinematic Systems in Geodesy, Geomatics and Navigation will be held in Banff, Alberta, Canada, from August 30 to September 2, 1994. This event will be organized by the Dept. of Geomatics Engineering at The University of Calgary, and will be sponsored by international agencies such as the International Association of Geodesy, FIG, and the (U.S.) Institute of Navigation.

For further information please contact:
KIS94
Dept. of Geomatics Engineering,
The University of Calgary,
2500 University Drive N.W.,
Calgary, Alberta,
Canada T2N 1N4
Telephone: (403) 220-5834 Fax: (403) 284-1980

International Geographic Information and Resource Technology Seminar "Decision Support - 2001"

This conference, in Toronto, Canada, September 12-16, 1994, will be hosted by Natural Resources Canada, the Ontario Ministry of Natural Resources, and Resource Technology '94. Decision Support - 2001 will give you an opportunity to help shape the future development and use of Decision Support Systems (DSS) for the management of natural resources and environment.

For further information, please contact:
Gabriella Zillmer, Co-Chairperson
Ministry of Natural Resources
Natural Resources Information Branch
90 Sheppard Ave. East, 4th floor
North York, Ontario,
Canada M2N 3A1
Telephone: (416) 314-1219 Fax: (416) 314-1336

Hydro 94

The Ninth Biennial International Symposium of The Hydrographic Society is to be held in Aberdeen, Scotland, September 13 to 15, 1994.

For further information please contact:
George Ritchie, Chairman
Hydro '94 Organising Committee
Positioning Resources Ltd.,
64 Commerce Street, Aberdeen,
AB2 1BP Scotland
Fax: +44 224 574354

Coastal Zone Canada '94

Coastal Zone Canada '94 is a major international coastal zone management conference. It will be held at the World Trade and Convention Centre in Halifax, Nova Scotia, September 20 to 23, 1994. The theme of this conference is "Cooperation in the Coastal Zone".

For further information please contact:
Coastal Zone Canada '94, Conference Secretariat
Bedford Institute of Oceanography
P.O. Box 1006
Dartmouth, Nova Scotia
Canada B2Y 4A2
Telephone: (902) 429-9497 Fax: (902) 429-9491

Section du Québec

Dans le cadre du congrès annuel de l'Ordre des arpenteurs-géomètres du Québec tenu au début de juin au Château Frontenac à Québec, Bernard Labrecque a représenté l'Association canadienne d'hydrographie au souper du Président du 4 juin 1993. Dave Pugh ne pouvait être présent car il préparait la conférence hydrographique du Canada qui avait lieu la semaine suivante à Toronto. Cela a été une bonne occasion d'échanger et de mieux faire connaître l'Association.

Le 18 juin 1993, sous le thème de "Six ans en mer", Carl Mailhot et Dominique Manny nous donnaient l'occasion de partager les moments excitants qu'ils ont vécus avec leurs trois enfants pendant leur tour du monde en voilier. Des diapositives magnifiques supportaient leur propos, cela donnait l'envie de tout lâcher et de faire comme eux...

La Section du Québec a organisé une journée au parc du Bic le 20 juin 1993. Les dix-huit places disponibles pour les excursions en bateau dans les îles du Bic ont vite été comblées. Notre guide et navigateur ne se tarissait pas en histoires et légendes de toutes sortes sur la région. Pour clôturer le tout, les amis se sont joints aux membres pour un souper en plein air.

Au mois de juillet, deux de nos membres ont uni leur destinée en l'église de Charlesbourg. Il s'agit de Roger Côté et de Geneviève Robichaud. Nous leur souhaitons tous nos voeux de bonheur dans leur "nouvelle" vie de couple.

Bernard Labrecque a représenté l'Association canadienne d'hydrographie le 18 octobre 1993 au Forum sur le DGPS organisé par la Garde côtière canadienne (GCC) à Québec. Plusieurs organismes et associations ,tant au niveau gouvernamental que privé, ont été invités. Ce forum a commencé par une revue du GPS et la présentation du concept d'utilisation du DGPS par la GCC. Par la suite, on a présenté les phases d'implantation du réseau DGPS sur le fleuve Saint-Laurent, le banc d'essai entre Montréal et Les Escoumins, le niveau de service relié à son utilisation et l'aspect légal. Finalement, on a traité de la navigation électronique et de la mise à jour des cartes marines.

Pour une deuxième année consécutive, la Section du Québec exposait au 27e Salon du livre de Rimouski du 28 au 31 octobre 1993. Cette année, un Hall maritime regroupait les organismes et les auteurs ayant la mer comme point d'intérêt. Cela a permis à la Section de faire des échanges intéressants avec le public et les exposants dont, entre autres, les représentants du Salon du livre maritime de Concarneau (France).

La Section du Québec a organisé à Québec le 6 novembre 1993 une présentation du vidéorestituteur numérique (VRN), connu aussi sous son nom anglais "Digital VideoPlotter", développé par le centre géomatique de l'université Laval. À partir de photos aériennes numérisées et amenées à l'écran d'un micro-ordinateur, la cartographie est facilitée et plus précise. On peut mettre à jour les fichiers numériques de cartes tout aussi facilement que rapidement. Une vision tridimensionnelle est en cours de développement, son potentiel s'annonce des plus prometteurs.

La troisième édition de notre Carnet de bord est en cours de préparation. Robert McKay, en remplacement de Julie Bellavance, a réalisé notre campagne publicitaire. Le tout a été rendu possible grâce à une subvention du Programme du développement d'emploi du ministère Emploi et Immigration.

La Section du Québec a bénéficié de subventions du Programme d'aide à l'insertion de l'employé du ministère de la Main-d'oeuvre du Québec. La permanence au magasin a ainsi été assurée par Chantale Fiola jusqu'à la fin juillet et par Denis St-Laurent jusqu'à la fin octobre.

La Section du Québec s'est dotée récemment d'un télécopieur. Ainsi, les membres et le public en général ont un moyen supplémentaire pour communiquer avec l'Association. Vous n'avez qu'à composer le 418-723-1831 pour nous rejoindre.

Ottawa Branch

Seminars
The CHA has had a successful seminar program:

- Electronic Charts: "The Revolution is Happening".
  The Branch provided pizza and pop to the over fifty attendees who came to hear Mike Casey and Paul Holroyd review the CHS electronic chart demonstration project.
- "Object-Oriented Data Bases for Electronic Charting", presented by Steve Glavin.
- "Electronic Chart Display Design". Mike Eaton gave a two-part talk on ECDIS presentation standards. We were pleased to welcome the participants at the Germany-Canada Electronic Chart Workshop to this seminar.
- "Oracle MD and CHS Data Management", presented by Herman Varma.

The Branch also held two lunch time video seminars:

- "Scandal at Sea: Ships of Shame", a BBC documentary exposing the alarming state of the world's shipping fleet.
- "The 1992 Pelly Bay Survey", a video by Denis Pigeon.

Social Events
The Branch held two traditional social events again this year.

- On June 29, 70 members and their families, rendez-voused at Mooney's Bay to enjoy sun, fun, burgers and hot dogs at our annual picnic. Special thanks to Dee Mehlman and Jaclyn Pugh for their help with the children's games.
- The Christmas luncheon was again a great success. Seventy-five "friends of hydrography", new and old, met at the Sala San Marco on December 16 to join in the holiday

spirit. Once again the Branch is very grateful to the companies that helped to sponsor the event:

Associated Information Managers
AZON
Bytown Marine Ltd.
GE Hamilton Technology Services Inc.
Kars Graphic Equipment Limited
Offshore Systems Ltd.
Oracle Corporation Canada Inc.
Quester Tangent Corporation
Rochester Pub
Sirius Solutions
SPS Computing and Engineering Consultants
Terra Surveys Ltd.
Universal Systems Ltd.

Personal Notes
Congratulations to Paul and Shelley Holroyd on the birth of their daughter. Amanda Michelle was born on June 14, 1993, just in time to make her social debut at the CHA picnic.

Our Best wishes to Joel Box and Michelle Lafleur who were married in Hamilton on October 23, 1993. Joel is a member of the CHS Electronic Navigation Chart team and Michelle was formerly a coop student in the CHS Ocean Mapping Unit.

Some more long-time CHA members became grandparents for the first time, in the past few months. Terry Tremblay is now the proud grandfather of Marisa and since the fall Carole Prest is the busy grandmother of two, Zachary and Zoe.

Rolly Gervais
The Branch lost a good friend this past year. Rolly Gervais passed away in September 1992 at the age of 62.

Rolly joined the CHS in Ottawa as a chart compiler in 1950 and retired in 1987, but remained a member of the CHA. While with the CHS, Rolly rose through the ranks, in Ottawa, to the position of Chief of Chart Production, Atlantic Region. When the CHS decentralized its chart production activities, Rolly transferred to the Bedford Institute of Oceanography in 1977. After a number of years he returned to CHS Headquarters to serve as the Head of Cartographic Standards.

While at Headquarters Rolly was an active CHA member, he was well known for organizing speakers luncheons and office Christmas parties. After thirty-seven years with the CHS Rolly did not believe in settling into a quiet retirement - he took up a new career with Revenue Canada and still found time to build his dream home in Dunrobin.

We extend our condolences to his wife Shirley, their children Catherine, Christopher, Philip and Heather and their families.

Central Branch

Members of Central Branch have had an extremely busy but very rewarding year. We all survived the 1993 Surveying and Mapping Conference last June. The three projects, Conference Registration, GIAC/CHA Workshop and the Heritage Launch Re-enactment were all successful and to those who helped make these things happen—Thank You.

Meetings
We have had three meetings since the field season ended. At these meetings we opened and closed nominations for Central Branch 1994 executive, opened and closed elections and discussed fundraising for the Heritage Launch. We also enjoyed watching some video footage of the Heritage Launch from various events over the summer.

Once again the Central Branch's Annual General Meeting was held under the wooden rafters of the Mimico Cruising Club, Etobicoke. Unlike last year's AGM, our members and guests didn't have to contend with the white winter-type stuff. Sean promptly and tactfully disposed of the business side of the meeting and our 45 attendees were treated to a delectable gourmet chicken dinner prepared by Louise Durham, Terese Herron and Paola Travaglini.

Louise Durham Preparing the AGM Dinner

The highlight of the evening was Sean's presentation, a brilliantly prepared slide show(with musical accompaniment) depicting two years in the life of our Launch. Great show Sean! In the presentations that followed: a framed print of Bouchette's 1792 chart of Toronto Harbour was presented to Mr. Earl Brown, Regional Director of the CHS Central and Arctic for their support in the Heritage Launch Project.

Keith Weaver was presented with our first Member-of-the-Year Award for his hard work and dedication to CHA's contribution to the CHS/CIG Conference and for keeping the Launch Project alive while most of us were in the field. Thanks Keith!

Sean Hinds' excellent contribution as Chairman of the Heritage Launch Project was recognized with an engraved plaque.

Many thanks to our dinner sponsors:

Ron Dreyer and Associates Inc.
McQuest Marine Sciences Ltd.
John Halsall Hydrographic Surveys
CHS, Central and Arctic Region.

The 1994 Central Branch Executive was announced:

Vice President	Terese Herron
Secretary Treasurer	Andrew Leyzack
Past VP	Sean Hinds
Executive Members	Jon Biggar
	Jennifer Campbell
	Chris Gorski
	Ken McMillan
	Brad Tinney
	Sam Weller

Heritage Launch *(Surveyor)*

Our Heritage Launch, now dubbed *'Surveyor'*, had a very successful debut year. The christening took place at CCIW on May 28 after almost a year of effort in terms of work and fund-raising. From that day on there was no holding back as the launch crew went from one event to another. The Official Launching and highlight was on a beautiful day at the end of the Surveying and Mapping Conference in Toronto. Events continued throughout the summer, with seven water and five land appearances. These were at events such as:

- Landing at the Forty (Grimsby, Ontario);
- Tall Ships (Erie, Pennsylvania);
- Old Fort York (Toronto);
- Old Mill Restaurant (Toronto);
- Simcoe Day Celebration and Battle of Hanlan's Point (Toronto);
- Picton (Ontario) Boat Show;
- Port Credit (Ontario) Boat Show;
- Wooden Boat Festival - "1st prize in heritage class" (Penetanguishene, Ontario);
- Battle of Lake Erie (Put-In-Bay, Ohio); and
- Canada Centre for Inland Waters (CCIW) benefit BBQ (Burlington, Ontario).

Surveyor is well received wherever she goes. A great deal of credit should go to those who crew the launch and act as ambassadors for the CHA.

Surveyor will reside at CCIW for the winter. A program for 1994 is now being planned, starting with the Toronto International Boat Show in January. Central Branch will retain ownership of *Surveyor* until such time as a suitable organization is able to assume ownership.

Annual Central Branch Barbecue

This year's Barbecue, held on Saturday August 21, was a great success. About 40 CHA members, Heritage Launch volunteers and their families spent the afternoon in brilliant Beamsville sunshine. We all enjoyed classic BBQ fare and great company, while the kids amused themselves with a super-soaker water gun. Sincere thanks go to Andrew and Cindy Leyzack for welcoming the crowd to their back yard.

Captain Vancouver Branch

Captain Vancouver Branch held their AGM on December 1st at Annacis Marine Base and now have a new executive.

Vice President: Mr. Paul Sawyer, Chief Surveyor at Sandwell, a consulting engineering firm in Vancouver. Paul has been working in Colombia on a port development study.

Secretary-Treasurer: Mr. George Pugach, past VP, is an independent consultant in hydrographic and engineering surveying. George has just returned from Russia where he spent a month surveying for a gold mine development.

Technical Committee: Mr. Michael Tarbotton, a coastal engineering consultant in Vancouver.

Social Committee: Mr. Reg Labinski, a project management consultant in Delta, B.C.

One of the items on the agenda was, in view of our decreasing membership, whether we should continue to function as a branch. The alternative would be to join the Pacific Branch. The vote was to try for one more year. The feeling was that going out to Sidney for meetings would be more difficult than putting out the effort to make our branch bigger and better.

Our first meeting in 1994 is scheduled for March 3rd. We look forward to it with greatly renewed optimism.

CHA Pacific Branch

A very special welcome back to Sev Crowther! Congratulations also to a number of our members who have had additions to their families in the last few months. Pacific Branch members in this category include George Schlagintweit, Mike Ward, Kal Czotter, and Ernie Sargent. Changing diapers has just been reinserted into the job descriptions of these four dads!

While many members of this branch spent part or all of the summer enjoying the sunny weather of the B.C. coast, the Western Arctic, or the Fraser River, other members have been traveling farther afield.

Murray Farmer spent a month traveling in Europe. Ken Halcro and Carol Nowak cruised (being a non DFO vessel, a cruise was still permitted) from Vancouver to New Orleans via the Panama Canal. Fred Stephenson spent three weeks in Japan. Tony O'Connor just returned from England. Tony Mortimer just returned from Indonesia.

The branch executive had "the world's largest sextant" repaired for the IOS Open House in September. The newly repaired sextant unfortunately was broken again in the first few hours of the Open House when a student(s) decided to use it as an arm rest. Hopefully the re-repaired sextant will be even stronger!

The second annual CHA (Pacific Branch) Photo Contest received a total of 33 entries. Contest rules stated that the photographs had to have been taken in 1993, but didn't have to be work related. The judging was held in conjunction with a wine and cheese social on December 1. The winners were: Dave Thornhill (people); Dave Thornhill (wildlife), Carol Nowak (scenery), James Wilcox (things), and Mike Ward (B&W).

Pacific Branch jointly hosted the 22nd Annual Beer, Bun and Bellowing Bash (BBBB) with the Victoria Branch of the Canadian Institute of Geomatics on November 24. The first two Bs need no explanation. The bellowing came from the simultaneous darts, shuffleboard, and cribbage tournaments (two to a team). This year's overall winners were Patti Dew and Trish Kimber, who narrowly beat out Willie Rapatz and Stan Huggett for top honours by a cut of the cards.

During October and November, Rob Hare and Mary-Beth Bérube organized a series of four ECDIS demonstrations on the B.C. Ferry *'Queen of Vancouver'*. Thanks to their efforts 36 Branch members (59 people in total) had an opportunity to observe the Offshore Systems Ltd. 'ECPINS' in operation.

The branch held it's Christmas luncheon at the Glen Meadows Golf and Country Club on December 7. Sixty members attended. Our luncheon speaker was Rob Hare (a Vice-President's job is never done), who gave a presentation titled "Calibration of LIDAR Bathymetry in Dolphin and Union Strait using Dense Acoustic Ground-Truth", comparing LIDAR data collected in 1990 with detailed acoustic measurements collected in five test areas in 1993.

CHA / C. B. Heritage Launch At The Battle of Lake Erie

by
Andrew Leyzack

During the September 10 - 12 weekend, the Heritage Launch Project participated in a commemorative re-enactment, celebrating 180 years of international peace between Canada and the United States. The event took place on and off the shores of Put-In-Bay, South Bass Island, Ohio, in the western end of Lake Erie. One hundred and eighty years ago, in 1813, the waters northwest of the islands were the scene of the Battle of Lake Erie, one of the few American naval victories.

***Surveyor*, A Reproduction of 1788 Bounty launch, modified rig.**

The launch, which we've come to call *Surveyor*, sailed in the company of two circa 1812 ship's boats. One was from the *Lord Nelson* (aka. schooner *Scourge*), under the command of builder Gill Bibby, and the other from HMS Brig *Detroit* commanded by marine artist Peter Rindlesbacher. Our duty was to escort the British Squadron arriving from Amherstburg, Ontario. Our crew will agree that one of the high points of the day was the sight of the Squadron running down on us with Brigantine *St. Lawrence II* in the van.

"Full-and-bye"

At 14:00 we crossed through the British line astern of the flagship while gunner John Dixon fired a salute to Squadron Commodore Victor Suthren (Director of the Canadian War Museum in Ottawa). Taking station to windward of the Brig *Fair Jeanne*, her decks crowded with the scarlet uniforms of Royal Marines, we made our way to Put-In-Bay's inner harbour amid a sea of pleasure craft and blaring horns.

Under the guns of the U.S. Brig *Niagara*, the Frigate *Rose* and a crowd of spectators numbering in the thousands, each of our ships let loose as much signal protocol as our eardrums could handle.

One unfortunate mishap occurred during the finale of the Toledo Symphony's rendition of Tchaikovsky's 1812 Overture. While the ships were firing their guns in time with the orchestra, a cartridge box accidentally exploded aboard the *Fair Jeanne* sending a gunner to hospital with flash burns. After the many generations of peace since our countries fought that senseless war, one couldn't help but reflect on the suffering our sailors and soldiers endured so many years ago.

The Launch Crew

The launch crew was as follows: Andrew Leyzack was Officer-In-Charge, Brian Power and Bill Warrender were the stroke oarsmen, Louise Durham, Ken Hipkin, Heimo Duller and Pete Wills provided the additional muscle, John Dixon provided the bang. Rick Huntley, a seaman pressed aboard from the *HMS Detroit* crew, willingly took to the duties of a Provincial Marine. This photo also shows auxiliary crew members Craig Power, Julia Duller, Jason Power, and Sean Power.

1993 CHA Directors' Meeting

Royal York Hotel, Toronto, June 8, 1993

Present: Dave Pugh, National President
Bernard Labreque, VP, Québec Branch
Sheila Acheson, VP, Ottawa Branch
Sean Hinds, VP, Central Branch
Frank Colton, Prairie Schooner Branch
Rob Hare, VP, Pacific Branch

Regrets: George Pugach, VP, Captain Vancouver Branch
Absent: Frank Hall, VP, Newfoundland Branch

1. Acceptance of Agenda

Motion to accept the agenda as proposed.
Hare/Hinds - Carried

2. Minutes from 1992 Annual Directors Meeting

Motion to accept the minutes of the 1992 Directors Meeting as presented. Acheson/Colton - Carried.

3. Report on Action Items from 1992 Directors Meeting

3): Action Items from the 1991 Annual Directors' Meeting
Distribution of CISM (CIG) Journal: In response to interest from all Branches present, Dave Pugh will have one copy of each new edition sent to each Branch.
Action: D. Pugh

Translation and Distribution of the Association Bylaws: The bylaws have been translated and will be printed in an inexpensive booklet format that will be ready for distribution in the fall. **Action: D. Pugh**

Membership Lists: All branches are to send membership address lists to Pacific Branch so they can be incorporated into a complete, up to date national membership list. **Action: All Directors**

11): Carnet de bord: Bernard Labreque presented copies to each director and was congratulated on a job well done.

14): Liability of the members of the Board of Directors: The directors agreed that liability insurance should be regarded as a standard business expense and that the CHA should purchase a policy. **Action: D. Pugh**

Liability insurance would consist of a base policy with riders for different events. Each Branch will submit a list of all of their activities that need to be covered and note if these events are free or if there is a charge for them.
Action: All Directors

15): CIDA activities: See Agenda Item 15.

16): 1992 AGM: The 1992 was conducted via a teleconference call on Dec. 16, 1992. Although this is not the preferred method of holding the AGM, it was an acceptable option, given the cost savings.

17): CHA Support for Members Consortia: Because there was no response to a request from Mr. Pugh to interested sustaining CHA members that they submit an outline of potential activities, the Board felt that no further action is necessary.

18): Memberships: The total number of "life members" is five.

Atlantic	1
Central	2
Pacific	2

4. Auditor's Report on 1992 National Account

The National President added a few remarks on items in the auditor's report:

- The annual grant from DFO is no longer available
- To help stabilizing funding for Lighthouse, the journal now receives $3000 per annum from the National Account, rather than the $5 per member it had received in the past.
- The report does not include any 1992 membership dues received in 1993.
- The additional expenses for the President's participation at Hydro '92 were due the fact that he had to pay registration fees.

Motion to accept the financial report as presented.
Hinds/Hare Carried.

Copies of the President's expense claims will be sent to all Branches. **Action: D. Pugh**

5. CHA National Dues for 1994

Each Branch present reported their 1993 annual dues rates:

Québec	$30
Ottawa	$18
Central	$30
Prairie Schooner	$30
Pacific	$25
International	$30

Motion to maintain the National dues at $15/member for 1994. Hare/Colton Carried.

6. Lighthouse Report for 1992

Bruce Richards, Editor of Lighthouse, presented the 1992 Lighthouse Report. He noted that advertising revenues for the 1993 Spring Edition exceeded last Spring's revenues. The work of producing each edition has been re-organized and different tasks have been grouped together and re-assigned. Bruce will give a copy of this new organization structure to Dave Pugh.
Action: B. Richards

7. Lighthouse Financial Statement for 1992

Bruce Richards presented the 1992 Lighthouse Financial Statement. Motion to accept the financial statement as presented. Hinds/Hare - Carried.

8. Lighthouse Proposed Budget for 1993

Bruce Richards presented the Lighthouse Proposed Budget for 1993. It includes a lump sum funding from

CHA National. The budget includes $3000 per annum from the National Account, rather than the $5 per member it had received in the past.

Motion to accept the proposed budget as presented.
Hinds/Hare Carried.

9. CHA Academic Award Program

T.D.W. McCulloch presented a report on behalf of Barry Lusk. The $2000 scholarship is available for a selected student in hydrography. Material advertising this program has been sent to 18 universities and colleges across Canada. The list of these institutions and a copy of the promotional material will be provided to the Branches. **Action: D. Pugh**

The Directors expressed their gratitude to Barry Lusk for all the support he has provided to this program.

10. Carnet de bord

Bernard Labreque presented a brief report on the success of the second edition of this publication. Of the copies printed, 2,000 were distributed to sailing schools, some were distributed to chart dealers and 1000 were distributed free to advertisers. With the help of substantial advertising receipts, a profit was realized. The 1994 edition of Carnet de bord is already in progress.

Dave Pugh expressed the admiration of all present for Québec Branch's hard work and successful results on this project.

11. Geomatics Workshop - 1993

The CHA and the Canadian Geomatics Industry Association are cosponsoring a day-long Geomatics Workshop, with presentations by government, industry and academia. Registration is expected to exceed the original estimate of fifty participants.

There was discussion about the possibility of holding future workshops on a progression of different topics.

12. Historical Hydrographic Survey Launch Project

Sean Hinds gave a brief slide presentation on the building of the launch and the goal of the project - to develop an appreciation of hydrography and boat building. There will be several exhibits of the launch during the summer of 1993; many of these are related to the 200th anniversary of the founding of Toronto. [The 'Official Launching' took place on the last day of the Conference, with a recreation of the first survey of Toronto Harbour in 1792.]

To assist paying for the launch expenses there was a motion to change the $2,500 loan from CHA National to Central Branch for the Heritage Launch Project to a $2,500 grant. Pugh/Acheson Carried.

One of the rowing stations on the launch will carry a plaque acknowledging the CHA contribution.

13. International Members

International Membership rates are $25 and are paid to Central Branch, which services them. However, in addition to the $15 per international member which Central forwards to the National, it costs them $15 per international member to send them Lighthouse and newsletters. Accordingly, CHA National will provide Central Branch a subsidy of $5 per International Member.

14. CIDA Projects

Tom McCulloch presented his reports on the status of CHA projects in Jamaica and Malaysia.

Mr. Willie Rapatz is the now the CHA coordinator for the Jamaican Hydrographic Training Program. To date 36-40 Jamaicans have participated. Mr. McCulloch remains the coordinator for the Malaysian Project.

Dave Pugh thanked Tom for all his efforts in coordinating CHA's cooperation with CIDA.

15. Memberships

a) Atlantic Branch: If Atlantic Branch is reactivated, it will have access to the $1500 in the Branch account before became inactive, if it does not reactivate these funds will be transferred to National to be held in trust until the Branch is active once more.

b) To increase memberships, it is suggested to increase the advertising of the CHA in colleges and universities through the CHA Student Awards Program. Student membership fees remain at $15; any student members will be serviced through the closest Branch.

16. Revenue Canada and Non-profit Organizations

Dave Pugh will investigate Revenue Canada's regulations and ensure that the Association complies with them. He will also investigate if CHA needs a GST number. **Action : D. Pugh**

17. Proposed National Budget

Dave Pugh presented the proposed National Budget. Motion to approve the proposed budget.
Hinds/Hare Carried.

The CHA National will suggest to Lighthouse that the subscription rate be raised to $30 to make the journal more self-sufficient. **Action: D. Pugh**

18. Timing of Directors Meetings

In response to concern about the time lag between the and of the Association's fiscal year and the Annual Directors' Meeting, it was agreed that all Branch reports and financial statements, and the Lighthouse report and financial statement should be submitted to the National by Feb. 15. **Action: All Branches**

In an attempt to complete the Association's business by April, the 1994 AGM is tentatively scheduled for Victoria, April 1994, during the CIG Conference.

19. Five Year Plan for CHA

The Directors discussed whether the CHA needs to adopt a five year plan to assist in shaping its' future. After some discussion it was felt that in part because of the fluctuating level of both membership and active participation in the association, we are not ready for such long-term planning. It was agreed that the CHA is on track in advancing its cumulative work and should retain the existing flexibility to select and pursue its priorities.

The meeting adjourned.

1993 CHA Annual General Meeting

Minutes
Canadian Hydrographic Association
1993 Annual General Meeting
Royal York Hotel
Toronto, Ontario
June 10, 1993

Attendance: as per register

1. **Welcome**
Dave Pugh called the meeting to order and thanked everyone present for their participation.

2. **Agenda**
Motion to accept the agenda as issued.
Acheson/Hare - Carried.

3. **Receiving Reports of the Directors**
The following Branch reports were presented as follows:

Pacific - Rob Hare;
Captain Vancouver - Dave Pugh (for George Pugach);
Prairie Schooner - Frank Colton;
Central - Sean Hinds;
Ottawa - Sheila Acheson;
Québec - Jean Proteau (for Bernard Labreque); and
Newfoundland - Dave Pugh (for Frank Hall).

Although Atlantic Branch is inactive at present Dave Pugh reported that he continues to provide services, including Lighthouse, to eighteen former members of Atlantic Branch. There are a few individuals who are currently trying to rebuild the Branch. If it is not formally re-established in 1994 the Branch's funds will be transferred and held in trust by the National Executive until such time as the Branch is re-activated.

4. **Financial Statement and Auditor's Reports**
a) Motion to accept the Financial Statement and Auditor's Reports as presented.
Nowak/Colton - Carried.

The balance $19K at the end if 1992 is approximately equal to expenses incurred over a typical 18 month period. This cushion is in agreement with Revenue Canada guidelines.

b) Appointing Auditors:
Motion to accept the appointment of Jake Kean and Sheila Acheson as auditors of the 1993 Financial Statement.
Hinds/Hare - Carried.

5. **Other Business**
a) Willie Rapatz invited CHA to hold its 1994 Annual Directors and Annual GeneralMeeting in Victoria, in conjunction with the Canadian Institute of Geomatics Conference to be held there in April. Any requests for facilities during theconference should be made to Alex Raymond.

b) In response to an action item from the 1992 Annual General Meeting, Dave Pugh reported that CHA has a total of five Life Members; two in Pacific Branch, two in Central Branch and one in Atlantic Branch.

Motion that CHA review the role of Life Members within CHA, particularly as it compares to the role of Life Members within the Canadian Institute of Geomatics.
Raymond/Nowak - Carried.
Action: Alex Raymond

c) The 1993 Proposed Budget was presented to the meeting. Some significant changes from the 1992 Budget were noted: the declining number of members; the additional expense of liability insurance; and the granting of a $5 subsidy for each International Member to Central Branch to help defray postage and related expenses.

d) Geoffrey Haskins, President of the Hydrographic Society, tabled a message from the Society to the CHA in which he stressed the importance of continued cooperation between our two sister organizations.

[editor's note: See page 4 of this edition of Lighthouse]

e) Dave Pugh thanked the 1993 Surveying and Mapping Conference Organizing Committee for providing assistance and facilities to CHA for our meetings and the Geomatics Workshop during their 1993 Conference.

6) **Lighthouse Awards**
For the 1992 editions of Lighthouse the following papers were selected for the Lighthouse awards:

Best Non-Technical Paper:
Dr. Fosco Bianchetti
"The ECDIS Paradox"
(Fall Edition).

Best Technical Paper:
Peter R. Milner and James L. Galloway
"A Field Evaluation of the KAE Fansweep - A Portable, Shallow-Water, Multi-Beam Sonar System"
(Spring Edition).

[editor's note: Congratulations to all and keep those papers coming in!]

7) **Other Business and Closing**
As there was no other business the 1993 CHA Annual General Meeting was closed and all looked forward to the CHA Heritage Launch re-enactment scheduled for June 11th.

News From Industry / Nouvelles de l'industrie

Andrews Hydrographics Ltd., United Kingdom

Rapid mobilisations, the repetitive making and breaking of connections, the effects of vibration on the electronics and general wear and tear in transit; all place great stresses on office-PC systems used under offshore/marine conditions.

Andrews' first generation of VIGA integrated navigation/ positioning systems for survey vessel chartrooms used off-the-shelf PC's in an office-type arrangement. The company now houses the whole VIGA package in a specially developed Field Survey Unit (FSU). It is constructed from 'ruggedised' components and housed in an enclosure based upon Andrews' tried-and-tested NAVBOX coastal survey system - a unit often used in 'open' situations. The FSU contains the whole system, including a powerful processor, VDU, printer, power supply and environmentally-sealed keyboard, all in a protective shock resistant case.

The FSU supports the full range of VIGA survey software which can be applied to surveys close to rigs including borehole seismics (VSP's), bathymetric and environmental projects, including baseline studies to assess water and seabed pollution levels around oil rigs. Post-processing includes facilities for editing and plotting track charts, bathymetric plots and contour charts, plus terrain modelling and volume calculations.

Atlas Elektronik, Germany

DESO 11, a new compact black box-type echo sounder for external PC-control featuring simple installation and operation, is announced by Atlas Elektronik. Developed for precise measurement of depths and sedimentation analyses as well as determination of water levels and wave heights, it has a depth range down to 650m depending on chosen frequency and transducer; resolution is 1 cm.

Weighing only 6.3 kg and with adjustable operating frequencies within low 28-35 kHz or high 150-225 kHz bands, the system incorporates a range of facilities normally only associated with larger sounders. It can be used as an independent sounder on small survey boats and ROV's or as part of fully-integrated survey configurations aboard special-purpose vessels.

For integration purposes, it permits complete remote control and setting of all internal parameters via either a portable PC or virtually any other type of processing equipment. Integral software allows for printout, logging and replay of data via RS-232C interfaces, while connection to heave compensation units is also possible. A built-in digital depth display and a programmable mode switch additionally allow the system to be operated in a stand-alone mode.

Introduction of DESO 11 complements existing DESO 15 and 25 sounders with which it is fully compatible. Meanwhile, the first units have been supplied to the Rijkswaterstaat in the Netherlands by Bennex Holland; they form part of purpose-designed portable integrated survey systems for shallow water operations.

C-MAP/USA

In response to user demand, C-MAP, the leading designer and manufacturer of cartridge-based electronic charts, has expanded its coverage of the St. Lawrence Seaway from Sorel east to Newfoundland with the release of three new cartridges.

The area from Sorel to Quebec is covered on cartridge H144.00 and the area from Quebec to Ile de Bic is covered on cartridge H143.00. Both of these cartridges provide a high level of detail, and may be used by recreational boaters and commercial fishermen. The third cartridge in the series, H142.00, covers the area from Ile de Bic to Newfoundland to Prince Edward Island (Gulf of St. Lawrence) and was designed primarily but not exclusively, for commercial fishermen, containing mostly small scale charts for offshore coverage. Additional coverage west from Sorel will be released later this year.

C-MAP/USA is a wholly owned subsidiary of C-MAP s.r.l. of Marina di Carrara, Italy, designer and manufacturer of electronic charting systems. C-MAP/USA is the exclusive licensee of C-MAP technology in North and South America, and the Pacific Rim.

Geomatics Positioning Systems Ltd., Canada

Geomatics Positioning Systems Ltd. was established earlier this year as the exclusive Ontario Agent for Gemini Positioning Systems Ltd. of Calgary, the Canadian Distributor of Ashtech GPS Technology.

Although Geomatics Positioning Systems Ltd. is a new company, we are by no means new to the GPS industry. Through Gemini's long standing relationship with Ashtech of California, we can offer our clients access to state of the art GPS Technology.

Geomatics Positioning Systems Ltd. has been formed in order to provide the Survey, Mapping, Resource and Engineering communities with the latest in Ashtech GPS Technology, including sales and rentals of receivers and software, training on all aspects of GPS Surveying and Navigation, and to provide users of GPS Technology with a source for integration and customization of GPS with other products and or services.

Through our alliance with Gemini we can offer our clientele a wide range of services including 24 hour Bulletin Board Service, GPS Support line, training (in-house or on-site) and complete service facilities.

We would welcome your call to discuss how Geomatics Positioning Systems Ltd. might assist you in evaluating and filling your GPS requirements. We look forward to hearing from you and assuring you of our best attention at all times.

Klein Associates Inc., USA

Klein Associates, Inc., is pleased to announce that the firm will provide a Multi-Beam, dynamically focused side scan sonar to the Royal Australian Navy Minesweeping Project Office for use in associated tasks. The new sonar, designated the Klein 'MULTI-SCAN' Side Scan Sonar, has the capability to operate at speeds up to 10 knots with 100 % bottom coverage.

The MULTI-SCAN Side Scan Sonar prototype has been extensively tested by various groups and has demonstrated a capability to produce high resolution images of small, mine-like targets in both the towed (VDS) and hull-mounted modes of operation. Trials conducted in the hull-mounted mode on an 8.8 meter launch proved the capability of the MULTI-SCAN Side Scan Sonar prototype to image mine-like targets in shallow water beach zones to depths as shallow as 2 meters.

The MULTI-SCAN sonar utilizes five dynamically focused sonar beams per side, a total of 10 beams, to produce the full sea floor coverage. These beams are collimated and produce a 20 cm along-track resolution out to approximately 80 meters with an ultimate beam angle of 0.15 degrees.

The new sonar eliminates image resolution degradation normally associated with operations in the acoustic near-field of the sonar through the use of dynamic focusing of the sonar beams, permitting high resolution imaging down to as close as several meters from the transducer face.

The MULTI-SCAN sonar is available as a commercial off-the-shelf item, providing high performance at nominal prices for cost-effective solutions to small object detection tasks.

Copies of the shallow water trials and additional information on the performance of the MULTI-SCAN Sonar are available from:

Klein Associates, Inc.,
Klein Drive,
Salem, New Hampshire
03079, USA.

Hydroquip, United Kingdom

Hydroquip Limited of Aberdeen, a rental supplier of positioning systems, has had their quality assurance system certified and accredited by Det Norske Veritas Quality Assurance to IS09002, EN29002, BS5750 Part 2. DnVQA conducted the audit on Hydroquip on 30 June 1993, the Certificate of Conformity was issued on 28 July 1993. The assessment scope of the audit covers "Hire and Repair of Hydrographic and Subsea Positioning Equipment for marine and land based activities".

Hydroquip welcome this formal endorsement of their quality assurance system which had been in place at various levels of development for several years. Users can be further assured that the entire company is committed to the provision of reliable equipment, as the majority shareholder and Managing Director, Barney Barron, is also the Quality Assurance Manager. This enables the ethos of a standard to be built into a company and its supplied product.

Knudsen Engineering Ltd., Canada

Donald Knudsen, President of Knudsen Engineering Limited, has announced that his company has been awarded a contract by Thomson-CSF Systems Canada Ltd. to supply 12 navigation echosounder and remote display systems for the Canadian Maritime Coastal Defence Vessel Program.

"We are pleased to make this sale in our home market", commented Mr Knudsen, "and believe it will provide a real boost to export market opportunities for our 320M Marine Echosounder."

Knudsen Engineering Limited incorporated in 1981, specializes in rugged digital acoustic systems for use in Arctic, underwater, and shipboard environments.

NORCONTROL Seacraft, Norway

The Norwegian company NORCONTROL Seacraft in cooperation with Simrad Subsea awarded a major contract for the delivery of hydrographic equipment for a new Taiwanese oceanographic research vessel to be constructed at the Fincantieri Shipyard in Italy.

NORCONTROL will deliver a complete integrated system for seabed mapping. The system consists of the following parts:

- KonMap hydrographic data acqusition- and processing system;
- KonMap sailing control system;
- KonMap chart production system; and
- KonMap survey planning and chart-generation system working together with the Simrad MDM-system and neptune-system.

Racal Positioning Systems Ltd., United Kingdom

The Danish Material Command has ordered over £300,000 worth of DeltaFix SR differential GPS equipment from Racal Positioning Systems Ltd. The equipment will be used for hydrographic survey operations by the Danish Navy in Danish and Greenland waters and is the first purchase of the new DeltaFix system in Scandinavia.

The contract is for the supply of seven DGPS reference stations and 10 mobile units. The mobile units will be installed aboard hydrographic survey vessels and the Danish Navy's new Standard Flex 300 multi-role warships. First deliveries of the equipment will begin in October.

The DeltaFix SR short range DGPS system has been developed specifically for hydrographic surveyors, harbour authorities, dredging contractors and other users needing low cost, high accuracy DGPS positioning over relatively small areas. The system's positioning accuracy is better than three metres and its operating range is up to 60 kms, depending on local propagation conditions. DeltaFix SR, which incorporates a special VHF or UHF radio data link, complements the LR version which provides reliable long range DGPS positioning using frequency diversity techniques at ranges greater than 600 kms.

DeltaFix systems function through the use of a shore-based GPS reference receiver located at a precisely known position which transmits corrections to observed GPS pseudo ranges over appropriate VHF, UHF or HF channels. The vessel's DeltaFix receiver decodes the corrections and these are applied to the onboard GPS receiver.

Racal Positioning Systems Ltd is the Racal Electronics Group's specialist company in the design, development and manufacture of high accuracy positioning systems. It is a part of the Racal Energy Group, which includes Racal Survey, and is based in New Malden, Surrey.

Seatex, Norway

Seatex AS, Trondheim has taken over the industrial activities of Kongsberg Navigation AS.

Kongsberg Navigation AS, a wholly owned subsidiary of the NFT group, has sold its industrial activities (product development and marketing of satellite based GPS navigation systems, positioning systems and products) to Seatex AS.

The agreement, active from 16 June 1993, means a concentration of Norwegian activity in Global Positioning System (GPS) and differential GPS (DGPS) into one company, which will give increased strength in the international market. Seatex will thus become one of Europe's leading companies in the development and marketing of DGPS-based products and systems.

As part of the take-over of the industlial activities, Seatex AS will establish a wholly-owned subsidiary at Kongsberg which will concentrate on navigation and positioning products, based on GPS/DGPS technology for the professional maritime market.

Carl-Erik Mo has been appointed Managing Director of Seatex in Kongsberg.

SubSea Survey, United Kingdom

A new self-contained version of the SonarGraphics remotely operated 3D seabed sonar profiling system has been developed by SubSea Survey of Aberdeen. Also featuring a modular electro-hydraulic launch and recovery capability, it provides a swath coverage of up to 100m. Operating depths are from 2m down to 1000m with an accuracy of +/-lOcm.

The new system is a derivative of the SonarGraphics unit originally developed by British Gas, which is currently being marketed worldwide under licence by SubSea Survey for an extensive range marine engineering applications.

Main system element is a transponder head for transmission and reception of ultrasonic signals as it rotates in pre-programmed increments along longitudinal and vertical axes for acquisition and production of sub-sea target profiles. Compensation is provided for errors induced by pitch, roll, yaw and any X, Y and Z excursions due to varying sea states.

The new system's integral data processing facilities enable merging of up to ten individual surveys. Full-colour presentation formats include those for contour, 3D and section while for quality control, edit, scatter and compensation graphs can be produced. Volumetric and dimensional anaylsis can also be carried out via special contour and section software.

Hard copy output facilities include A4-size colour printouts direct from the computer screen within 15 minutes of completion of a survey; chart-size plots are also available for final reports.

Typically suitable for monitoring erosion as well as bridge, pile and offshore foundations, the new system has recently been demonstrated at the ports of Aberdeen and Lerwick. Further demonstrations elsewhere in Europe are planned for later this year.

The Hydrographic Society

Commodore Folke Hallbjorner, recently retired Hydrographer of Sweden, has been elected President of The Hydrographic Society in succession to Geoffrey L. Haskins. [editor's Note: see letter on page 6]

One of the longest-serving national hydrographers of recent times, Commodore Hallbjorner headed the Swedish Hydrographic Department from 1973 until his retirement last August. He had previously served with the Royal Swedish Navy, having at one time commanded a destroyer in addition to holding a number of senior staff appointments.

President of the IHO's International Hydrographic Conference in 1992, he was also inaugural Chairman of the Baltic Sea Hydrographic Commission which he co-founded in 1983. He had also twice chaired the North Sea Hydrographic Commission as well as three Nordic Hydrographic Commission conferences.

A member of the Royal Institute of Navigation and the Nautical Institute, he is also Vice-President of the Royal Swedish Society of Naval History and President of the Board of the Swedish Maritime League's Eastern Region. Other domestic affiliations include membership of the Swedish Naval Sciences, Cartographic, Geographic and National Maritime Museum societies.

Trimble, USA

Convenience, confidence, cost effectiveness for the hydrographic surveyor. As a totally integrated field-to-finish hydrographic survey product, the HYDRO system offers top quality performance coupled with speed and efficiency.

The HYDRO system's high level of integration ensures a minimum turnaround time from field to finished plots. A special feature is the system's ability to accept data from a variety of sources, including both stand-alone and differential GPS, surface and sub-surface positioning systems (USBL), echosounders, compasses and other types of sensors. And because it can monitor two positioning systems simultaneously, quality control during survey is greatly enhanced.

Differential positioning accuracy is also considerably improved, as the HYDRO system has the capability to record raw Trimble GPS data. This can be reprocessed with raw GPS data from a PC-based reference station and Trimble software.

Editing of hydrographic survey data is easier too, with fully interactive graphical screens enabling you to carry out tide reduction, position re-calculation, and sounding selection rapidly and simply. The HYDRO system's ability to support user-defined grid types, plan formats and international measurement units makes the presentation of plots a straightforward matter, with visually impressive results.

Added features of the system include being able to form contours quickly and accurately, and easily produce profile and section plots of surveyed lines or any part of the ground model. It also offers you a choice of calculating volumes by end areas or between two surfaces.

This PC-based product bears the assurance of quality that has made Trimble a world leader in the survey market. This is backed up with a worldwide network so that support issues can be handled quickly.

Valeport Ltd., United Kingdom

A new version of the UK's best-selling CTD instrument has been launched by Valeport Ltd, UK.

The Series 600MkIII measures conductivity, temperature and depth as standard from which direct computations of salinity, speed of sound and density are made. Up to five additional parameters may be measured and there is also the facility to interface and monitor external instruments for parameters such as fluorescence, dissolved oxygen, pH and turbidity.

The 15-bit resolution instrument comes in selfrecording/direct reading or direct reading-only versions. The self-recording version has a 2Mbyte memory to enable over 300,000 records to be obtained. Real time or recorded data is cabled to a PC on the surface or to the optional Valeport Control Display Unit. Data sampling is continuous (time-based) or triggered by depth increments, both down and up, to enable the unit to be used for both spot and profile measurements.

Three data communication methods allow a wide range of cable types and lengths.

With the exception of the pressure sensor, the Series 600MkIII is entirely designed and manufactured at Valeport's Dartmouth, UK facility. All metal parts are in aluminium bronze to provide excellent corrosion resistance and the instrument can operate to depths of 1500 metres.

The instrument has a body diameter of 76mm, overall length of 600mm and weighs 10kg in air (8kg in water).

Valeport Ltd manufactures a range of oceanographic and hydrometric instruments, including current meters, electromagnetic flow meters, CTD probes, tide gauges, water samplers, winches, connectors and accessories.

Canadian Hydrographic Service News

CHS Headquarters, Ottawa

CHS/Nautical Data International Agreement

On Oct. 25, 1993, the Canadian Hydrographic Service signed an agreement with Nautical Data International (NDI), Inc. to distribute CHS digital products and to create products from CHS data. This agreement will allow CHS to take advantage of private sector expertise to quickly respond to the demands for digital products while CHS provides quality control. [editors note: For more information on NDI see page 7]

Electronic Chart Pilot Project

The CHS Pilot Project is well under way. Over one hundred Electronic Navigation Charts (ENCs) have been created for use in the project. To date, demonstrations of the Offshore Systems Ltd. ECPINS system have been completed or are currently underway at the following sites:

- the QUEEN OF COWICHAN ferry, running between Horseshoe Bay and Langford, British Columbia;
- a BC ferry operating in the Strait of Georgia, between Tsawwassen and Swartz Bay;
- the Atlantic Marine ferry running between Digby, Nova Scotia and Saint John, New Brunswick;
- an ARCO supertanker running beteen Valdez, Alaska and Cherry Point, Washington;
- a SOCONAV oil tanker running between Montreal and Quebec City;
- the Ontario Northlands ferry CHI CHEEMAUN on the Tobermory to Manitoulin Island run;
- the Canadian Coast Guard Ship GRIFFON, operating in Lake Ontario; and
- the Marine Training Institute in St. John's, Newfoundland.

The Canada Steamship Line's (CSL) purchase and use of eleven ECPINS systems on their fleet of Great Lakes bulk carriers has been a major addition to the CHS Electronic Chart Pilot Project. The CHS supplied all the ENCs used by CSL in their operations. The second edition of the CHS newsletter "Contour" includes an article on the CSL electronic chart experience, written by Captain John Pace, Director of Navigation and Ports and Safety for CSL.

A questionnaire has been prepared, and each master who uses the electronic chart is being interviewed so that their comments will be documented and evaluated.

Awards

Eight staff members received their 25-year service plaques this year: Jake Kean, Yves Bouchard, Peter Richards, David Gray, Lewis Boone, Bev Aubin, Jacques Dupras and Aurèle Rochon.

Jake Kean receiving his 25-year plaque from Dr. Bill Doubleday, Assistant Deputy Minister, Science, Department of Fisheries and Oceans

CHS excellence continues to be acknowledged:

- Congratulations to Marilyn Van Dusen, Tides, Currents and Water Levels, who received a plaque from Canada Communications Group for producing a "Canadian Best Seller", the Tide and Current Tables.
- Neil Anderson and Dave Pugh received awards under the Federal Awards Program honours contributions to "managing and shaping the government's information management arena." Dave received the bronze medal in the "Distributing Computer Power to Managers and Staff - Training and Education" category for his work in developing a Technology Assisted Learning and Coaching program for CHS. In recognition of his contribution to the NDI/CHS agreement Neil was awarded the gold medal in the "Building Partnerships - Team Effort, Industry/Government" category.
- Dave Gray was awarded the Terra Surveys Ltd. Prize for the best article on hydrography in the 1992 editions of the Journal of the Canadian Institute of Surveying and Mapping. Dave's article was entitled "Where has Sable Island Been for the Last 200 Years?"

GPS

Mike Casey, in addition to coordinating the EC Pilot Project, is the current Chairman of the Canadian Navigation Society. The Society will be holding a Canadian Navigation Symposium; "Navigation in Canada in the GPS Era", on May 3, 1994 in Winnipeg. Capt. Pace will be presenting a paper based on CSL's experience with ECDIS, "Emerging User Requirements for Cost-Effective ECDIS Implementation".

Marine Geomatics

David Monahan returned to his position as Director after a two-year special assignment, heading up the CHS Green Plan projects. Dick MacDougall, who acted as Director while Dave was on special assignment, took up new duties as Manager, Nautical Publications and Distribution in August when he returned from a 12,000 km drive to the Pacific.

Francoise Lajoie, was injured in a truck-pedestrian accident (August) and is recuperating.

Paul Holroyd, and the Ocean Mapping Section have been heavily involved in the Electronic Navigation Charting (ENC) process by performing quality control and customizing files for Offshore Systems Limited in support of the Electronic Chart Demonstration Project.

Peter Richards also has a new assignment; as Manager, Nautical Publications he is now responsible for Tides, Currents and Water Levels, as well as Sailing Directions.

Lise Lague had a very busy 1993, she participated in the Ironman competition in British Columbia. This competition included a 3.8 km swim, followed by a 180 km bicycle race and concluded with a 42.2 km marathon. Lise completed the competition in 11 hours 42 minutes and 11 seconds, finishing 375th among the 1013 athletes who finished the competition.

Jean Papineau

CHS Headquarters has lost a long time employee and friend. Jean Papineau, cartographer, farmer, captain, boat builder, Caisse Populaire Credit Committee member, and husband, departed our presence on July 22, 1993. Jean was an enthusiastic practitioner of cartography as he was of his other varied activities, with many great stories of the everyday happenings of a person that is so involved. He was a very diligent person and strove for perfection in everything in which he participated. The folks in the Notices to Mariners section, as well as others who knew and toiled with Jean over the many years of his dedicated service to the Canadian Hydrographic Service bid Jean a sorrowful but fond farewell in remembrance of the good times we had together. We extend our sympathy to his wife Diane, companion of many years. Farewell Captain Jean.

Retirements

George Yeaton retired in November after 33 years with CHS. His friends and colleagues gathered at a luncheon late in November to salute George and to send George and Joan off in style. George started out as a field hydrographer in Atlantic Region and soon became a senior hydrographer and then HIC; his surveys ranged from Seal Cove, Nova Scotia to the Beaufort Sea. George moved to Ottawa in 1976 to become Chief of the Nautical Geodesy Section. He was seconded to the Training Unit for a few years and then returned to his true home in the Geodesy Section, which later broadened its scope to include the Tidal Section as well. We wish George and Joan all the best in this new stage of their lives.

CHS Central and Arctic Region

Electronic Charting
The CHS has accelerated its Electronic Navigation Charts (ENC) production program in order to meet an immediate demand for digital products in the Great Lakes and St. Lawrence River. In collaboration with Offshore Systems Ltd. (OSL), a manufacturer of a Canadian Electronic Chart Display and Information System, CHS agreed to produce and quality control approximately 100 ENCs by September 1.

Initially, the ENCs consisted of shoreline, channel limits, a safety contour and navigational aids. Eighty of the charts are from Central and Arctic Region. The charts were delivered in two phases: 30 by June 1, 1993 and the remaining 50 by September 1, 1993. At the end of August, our Regional ENC team met its goal of producing the 50 ENCs required for phase 2. The program is now focusing on increasing the content of these files to International Standards and keeping them up to date to Notices to Mariners.

Arctic Survey/Charting Program
A reconnaissance survey of the western portion of Coronation Gulf was completed in April. The program collected preliminary data required to define a safe shipping corridor using an airborne Through-Ice-Bathymetry-System (TIBS) to measure over 13,000 kilometres of continuous depth profiles. TIBS data was supplemented with over 4000 spot soundings obtained by helicopter. TIBS was operated under contract by Aerodat, Limited of Mississauga, Ontario.

In May and June, a corridor survey between Cambridge Bay and Victoria Strait was completed. TIBS was used to collect continuous depth profiles and to detect navigation hazards.

A ship survey in Victoria Strait took place between August and October. Based on board the Canadian Coast Guard Icebreaker Sir John Franklin, the survey was an important step in making it possible for a number of mining companies to transport minerals from exploration sites in the Northwest Territories. Three hydrographic launches and the ship were used to examine shoals that were detected during the TIBS airborne electromagnetic survey. The survey vessels also collected data in the alternate shipping route south and east of Jenny Lind Island.

In addition to ship support provided by the Canadian Coast Guard, the Arctic Survey Program had financial support from the Department of Energy, Mines and Resources Polar Continental Shelf Program, the Department of Indian Affairs and Northern Development and the Government of the Northwest Territories.

New Charts were completed for Churchill Harbour (Hudson Bay) and the Approaches to Chisasibi (James Bay). These two, full-colour, charts are currently being printed by electrostatic plotter on a Print-On-Demand basis. This cost-saving process (as opposed to offset printing) is possible due to the limited demand of these products.

A New Chart of previously uncharted Pelly Bay (Central Arctic), produced from 1992 survey data is nearing completion. This chart will also be printed using Print-On-Demand technology.

Great Lakes Charting Programs
In Lake Huron, a program to obtain hydrography for a series of new charts from Cape Hurd to Point Clark completed a third season. The area was surveyed by LIDAR, an airborne laser sounding system, in 1991. Shore-based surveys have been examining shoals detected by LIDAR and sounding deep areas where the laser could not penetrate. The sounding program is scheduled to continue in 1994.

The area between Cobourg and Toronto, last surveyed in 1912, was the only portion of Lake Ontario that had not been surveyed to modern standards. The 1993 program was the culmination of a multi-year effort to update the coastal survey data of the Canadian portion of the lake, for use in a series of new charts from Kingston to Toronto.

The Revisory Survey completed an annual program to update existing navigation charts prior to issuing New Editions, and to supplement information for New Charts in production. It included field work in the St. Lawrence River, and in Lakes Ontario, Erie, Huron, Superior and Winnipeg. This year the survey also resolved some unknown datum chart problems in Georgian Bay, Lake Erie and the Welland Canal. New Editions of these charts will be produced on NAD83 in anticipation of increased use of GPS for navigating in the Great Lakes.

A New Edition of Chart 2021 (Trent-Severn Waterway - Murray Canal to Healey Falls Locks) was completed. This New Edition incorporated new survey data and combined strip chart 2031 (Murray Canal) into the 2021 strip chart package.

New Chart production continues in the St. Lawrence River, Georgian Bay, and the North Channel of Lake Huron.

Unknown-Datum Chart Conversion Program
Central and Arctic Region has intensified its program to convert all hydrographic charts previously constructed on unknown or inconsistent horizontal datums to North American Datum 1983 (NAD83). This will ensure compatibility with modern marine navigation systems and continued safe navigation. The need for this conversion has become increasingly more important with the introduction of the Global Positioning System (GPS) and the recent emergence of electronic charting.

There are currently 33 unknown datum charts in the Region. Many of these were originally constructed over 75 years ago. Data from 1993 surveys will be used to construct new or reconstruct existing charts.

A Notices to Mariners Chart Correction Patch was completed in December 1993 for the inset of "Erieau - Entrance to Rondeau Bay" on chart 2181 (Harbours in Lake Erie). This patch incorporated new survey data and provided geographic graticule (NAD 83) to a previously non-datum inset.

Unknown-datum charts currently in production include New Editions of: 2042 (Welland Canal); 2289 (Georgian Bay - Giants Tomb Island to Lone Rock - south of Parry Sound); 2282 (east side of the Bruce Peninsula); and 2297 (Lake Huron - north confluence), and New Charts 2213 (Owen Sound), and 2215 (Collingwood).

Surveying and Mapping Conference
From June 8 - 11, the Surveying and Mapping Conference, co-sponsored by the Canadian Hydrographic Service and the Canadian Institute of Geomatics, was held at the Royal York Hotel in Toronto. The conference theme, "Celebrating Our Heritage, Charting Our Future", acknowledged pride in our history and profession and provided a forum for shaping the future. The conference attracted 495 attendees from 19 countries. In addition to technical sessions, 48 exhibitors from Canada, the USA and the United Kingdom promoted and demonstrated new surveying and mapping technologies. Several related meetings and seminars were held during the conference.

Electronic chart technology was demonstrated on board the Canadian Coast Guard Ship GRIFFON. Also announced during the conference was a cooperative agreement between the Canadian Hydrographic Service and Nautical Data International (NDI), Inc. for NDI to market and distribute CHS electronic chart products [see page 7]. The closing highlight of the conference was the re-enactment of the original (1792) hydrographic survey of Toronto Harbour by the CHA-Central Branch 'Heritage Launch'. [see Lighthouse Edition No. 47, page 48]

Radio Repeater Network
In August, a radio repeater network was installed in the east arm of Great Slave Lake to provide emergency communications for Fisheries officers working in the area. The system consists of four solar-powered remote radio repeaters and two base stations. The system resulted from cooperation between the Department of Fisheries and Oceans, Canadian Coast Guard and the Royal Canadian Mounted Police.

New Chart Distribution Agreement
In October, an agreement in principle was reached with the Manitoba Land Information Centre, (formerly the Surveys and Mapping Branch) of the Province of Manitoba, for that office to assume chart marketing distribution responsibilities for the CHS. The area of responsibility will include the province of Manitoba and east to Thunder Bay and the United States from Minnesota to Chicago. The existing 91 provincial map dealers in the area will be given the opportunity of selling CHS charts. The existing CHS chart dealers will be given the opportunity of selling provincial maps. This new distribution system is viewed as a major step in marketing our products and servicing the needs of the marine community.

All Staff Meetings
Captain John Pace of Canada Steamship lines visited the Region to discuss his experiences to date with Electronic Charts. At an all staff meeting, Captain Pace outlined the process that led his company to invest one million dollars in this technology. He also related the experiences of the ships officers with the systems and painted a vision of the future for electronic charts. Later, he visited with the ENC production team in the Region to learn more about the processes that CHS are using to create ENCs.

All staff meetings are scheduled every two weeks between October and April, as part of a Regional program to maintain good communications with CHS staff.

CHS Pacific Region

Field Hydrography
During the 1993 field season there were four major surveys. The PENDER party (G. Eaton) continued last year's work from a base in the McNaughton Group, sounding and coastlining in the complex of islands and rocks east and north of Queen's Sound. The R.B. YOUNG party (K. Czotter) started the season in Blair Inlet on the central coast completing work started in 1989. The second half of the season was spent in Pearse Canal on the B.C./Alaska border continuing work carried out last year in Tongass Passage. A NOAA exchange officer joined the R.B. YOUNG for this survey to assist with work on the Alaska side of the boundary.

In the Western Arctic, the JOHN P. TULLY (B. Lusk) carried out surveys in Dolphin and Union Strait, Coronation Gulf, and Victoria Strait. These surveys were carried out to calibrate and supplement LIDAR data collected in 1990 and 1993, and TIBS data collected in 1993. Fortunately, ice conditions were favourable and almost all of the survey objectives were met.

Closer to home, a revisory survey party (V. Crowley) spent several months surveying Canoe Pass, which runs from the Main Arm of the Fraser River across Roberts Bank to the Strait of Georgia.

All four of the survey parties used differential GPS for at least part of the field season. The acquisition of additional GPS receivers is a priority for the next field season.

Several research or development related projects are presently underway. Mike Woods is the scientific authority on a contract to fit NAD83 coastline onto an Arctic chart (7083) using Landsat TM imagery. This chart (1:500,000) has coastline which is in error by a mile in some places. A Reson SeaBat shallow water swath system is presently being tested by Jim Galloway, and Rob Hare is comparing the strengths and weaknesses of swath and sweep systems for shallow water hydrographic applications. He has also recently examined the biases and errors in the 1990 LIDAR data from Dolphin and Union Strait, using the acoustic ground-truth data set collected by this year's TULLY survey party. The biases and errors in the TIBS data near Coppermine were examined in a similar way.

Chart Production / Distribution
In 1992, as part of the multidisiplinary hydrographer training program, many Chart Production staff spent part of the summer on field surveys. This year three members of Chart Production joined the field staff for surveys in the Western Arctic.

Chart Production staff were very active in providing guidance and assistance to Institute of Ocean Science staff during the time leading up to the Open House in September. Preparation of displays and production of required type also utilized a considerable amount of staff time.

The Digital Chart Archive was reorganized during the summer. Several hundred old format files were converted to new NTX format and run through an update program. Some obsolete and duplicate files were deleted, while others were renamed in a more logical and consistent system. Some work was also done on file conversion from NTX to AUTOCAD.

Relative success was achieved, but basic incompatibilities mean that much is lost in conversion, including feature codes.

Tides and Currents

The GPS data collected during the "Profiling of the Fraser River with Precise GPS" project was received in August. The lack of a choke ring on some of the reference station antennas has unfortunately reduced the amount of usable data, but an accuracy of less than 0.1 metre in the vertical was achieved. One as yet unexplained discrepancy is a 26 cm height difference at Iona Island (North Arm of the Fraser). A survey party was sent to Iona Island in September to level from the bench mark used during the survey to a nearby Geodetic deep bench mark. The closure was excellent, so if there is bench mark instability it is quite extensive.

The annual servicing of the permanent water level stations in the Western Arctic was carried out in July and August. In addition to carrying out this work, our field party also participated in the hydrographic surveys carried out by the JOHN P. TULLY. While on the JOHN P. TULLY, temporary gauges were installed at four locations in support of the hydrographic surveys. A Revlis LPTG installed at Jenny Lind Island for the surveys in Ice Breaker Channel was left in place at the end of the survey for use by the Central and Arctic Region survey party.

A three week survey to measure surface currents (Lagrangian drifters) and water properties in Juan de Fuca Strait was carried out in June and July . A total of 245 CTD casts and 50 drifter tracks were obtained without loosing any drifters in spite of the heavy shipping traffic in Juan de Fuca Strait. The Juan de Fuca work, particularly the drifter results became a major feature of our IOS Open House display. A one year program to measure surface currents and bottom pressures in Active Pass was successfully completed in November. The information collected during this survey will be used to improve the Active Pass current predictions in the Tide and Current Tables.

The development and testing of the ARGOS Oil Spill Marker continued with the construction of a prototype and successful drop, testing the prototype from a height of 15 m at the IOS dock. The next step after making some design modifications will be to conduct tests from an aircraft.

The Fraser River model program was modified to use the hourly interpolated discharge at Hope as input. Formerly, the discharge was updated once per day, causing a shock wave in the calculations. The new code produces noticeably smoother results for upstream locations. The predictions produced by this model are used for navigation, as well as engineering applications, litigation etc.

Engineering Services

A flowmeter has been deployed in the Fraser River at Annacis Island since April 1993. It was placed in the river to attempt to measure fish passage. Results to date have been unanticipated. The tidal rise and fall cause the river current to speed up or slow down, and the turbulence and sediment carried by the river causes fluctuations in amplitude which are easily detected. Also, an upstream industrial input has been detected due to clearly manmade causes. The source is presently a mystery, and DFO Habitat are investigating further. Finally, the raw data is now being examined for fish count purposes.

A 'Store And Forward Repeater' system, designed and built by technologists in Engineering Services for differential GPS correction transmission, was deployed in the Arctic and on the West Coast with enormous success. Differential GPS corrections were transmitted from the shore Reference Station to the Tully, and rebroadcast to launches in the vicinity of the ship. Ship to Reference Station distances in excess of 70 km were achieved with negligible dilution of precision, resulting in a great productivity enhancement.

A very high speed digitizing card for the CHS lidar system was designed and built. Operating at 250 megasamples per second, it was verified to be generating approximately seven effective number of bits (ENOB). By comparison, the existing digitizer operates at 500 MHz at about 2.4 ENOB. This will result in much better definition of the optical backscatter, and may result in much better performance in shallow water. Design material (consisting of sampling considerations, hardwarction) has been forwarded to Terra Surveys and Optech. Also, a six-layer "brassboard" digitizer was delivered to Terra for final packaging and implementation into their system for 1994.

A backscatter correlation device, similar to an echosounder but using the reflections to determine velocities, was deployed on the seafloor off Tuk in August. It will be recovered in Spring 1994, and the data used to determine ice motion and scattering phenomena from the under ice surface and from within the water column.

Work is underway with the University of Calgary Department of Geomatics, to develop a stereo video underwater viewing system. The requirement for 'stereo' video, as opposed to conventional 'sequential' stereo pairs, arose because the initial application was to view fish in motion. Unlike airphotos, the objects being viewed have a motion independent of the viewing platform. This causes unacceptable errors in measurement and display. The project is leading to a system for detailed video mapping and terrain modeling of the seafloor, with significant hydrographic applications.

Automne 1993

Lighthouse

Revue de l'Association canadienne d'hydrographie
Journal of the Canadian Hydrographic Association

Originalement à l'hiver 1969, **LIGHTHOUSE** était le journal de l'Association canadienne des hydrographes (ACH). Il représentait un moyen pour stimuler les discussions entre les Sections de l'ACH. De par les années, **LIGHTHOUSE** est devenue la revue hydrographique nationale du Canada. Elle reste fidèle à son but original de fournir une source d'information technique, historique et sociale à ceux qui s'intéressent à l'hydrographie au Canada. Son tirage a augmenté pour inclure au-delà de 1000 membres, compagnies et organisations hydrographiques au Canada et dans le monde entier.

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Journal of the Canadian Hydrographic Association
Revue de l'Association canadienne d'hydrographie

LIGHTHOUSE originally began as an internal newsletter of the Canadian Hydrographers' Association (CHA) in the winter of 1969. It was conceived as a means of stimulating discussion between the branches of CHA. Over the years, **LIGHTHOUSE** has become Canada's national hydrographic journal. It still remains faithful to the original goal of providing a mix of technical, historical and social information of interest to those associated with hydrography in Canada. But its circulation has expanded to include over 1,000 individuals, companies and hydrographic organizations in Canada and around the world!

1994 Advertising Rates

POSITIONING

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.

MECHANICAL REQUIREMENTS

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).

PUBLICATION SIZE

	(Width	x	Length)
Publication Trim Size:	8.5"	x	11.0"
Live Copy Area:	7"	x	10"
Bleed Size:	8.75"	x	11.25"
Single Page Insert Trim Size:	8.25"	x	10.75"

Standard Ad Sizes:			
Full Page:	7"	x	10"
1/2 Page:	6.875"	x	4.75"
or:	3.375"	x	9.75"

CLOSING DATES

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

PRINTING

Offset screened at 133 lines per inch.

RATES

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

	B &W	Colour	
		Spot*	Four
Outside Back Cover	NA	NA	$1025
Inside Cover	$300	$400	$825
Body, Full Page	$275	$375	$675
Half Page	$200	$300	$675
Single-page Insert	$275	$375	$675
Professional Card	$125	$225	NA

*Spot Colour (Orange, Red or Blue)

RATE PROTECTION

Advertisers will be protected at their contract rates for the term of their contracts up to one year. Cancellations are not accepted after closing date.

All advertising material should be directed to:

Mr. K. Weaver, Advertising Manager
LIGHTHOUSE
P.O. Box 5050
867 Lakeshore Road
Burlington, Ontario
CANADA L7R 4A6
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