International Hydrographic Review, Monaco, LV (1), January 1978.

HISTORY OF THE GREAT LAKES CHARTING ADVISERS

(COOPERATIVE CHARTING BY CANADA AND THE UNITED STATES)

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SUMMARY

Canada and the United States, recognizing the need to achieve compatibility in the marine charts produced along their boundary waters, have been cooperating during several decades in exchanging navigational information and working towards common charting standards. The mechanism for effecting these cooperative charting efforts has been the Great Lakes Charting Advisers.

Standardization is one of the main aims of most maritime countries involved in the production of marine navigational charts, through their membership in the International Hydrographic Organization. The efforts of Canada and the United States are intended to complement the work of the International Hydrographic Organization in this regard and, in particular, the work of the North Sea International Chart Commission in its preparation of international specifications.

The main purpose of this total effort is to provide the marine community with navigation documents that have been prepared to internationally agreed standards. The aim of this paper is to describe the international efforts of Canada and the United States in achieving these goals.

INTRODUCTION

The largest system of fresh water lakes and interconnecting waterways in the world is located on the North American Continent, midway between the Equator and the North Pole (Figure 1). This system, known as the

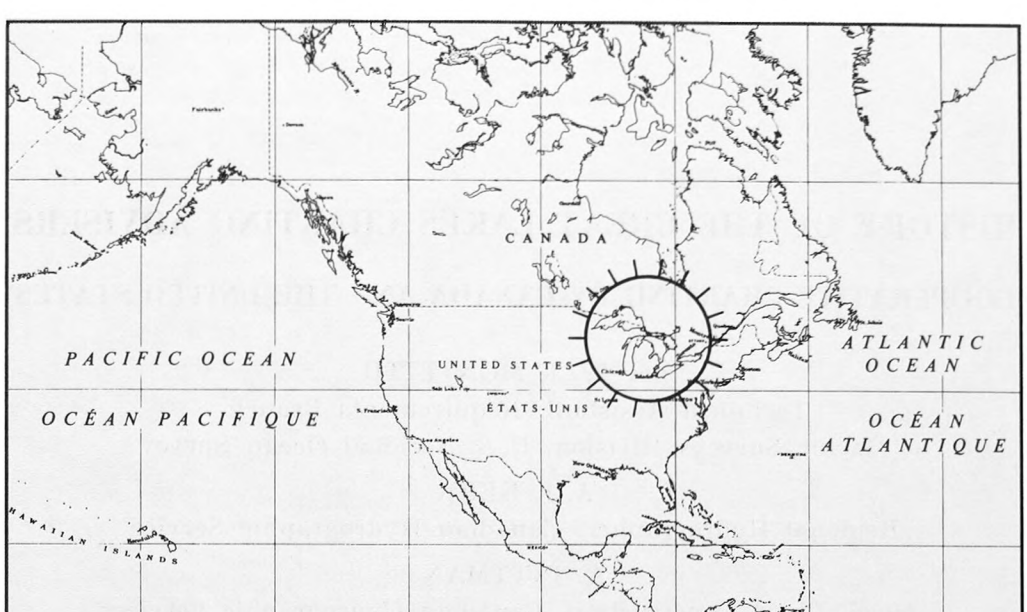

FIG. 1

Great Lakes Basin, is comprised of the international section of the St. Lawrence River (above Cornwall, Ontario, Canada), Lake Ontario, Niagara River, Welland Canal (totally in Canada), Lake Erie, Detroit River, Lake St. Clair, St. Clair River, Lake Huron, Lake Michigan (totally in the United States), St. Marys River, and Lake Superior (Figure 2).

The drainage basin for these waters encompasses a land and water area of more than 764,000 square kilometers, of wich more than 246,000 square kilometers are water surface. More than 158,000 square kilometers of this water surface area are located within the boundary of the United States. These waters have a shoreline length of about 15,500 km (8,850 km are within the United States) [1]. The several lakes and rivers form a continuous water boundary between Canada and the United States of 2,070 km [2]. An additional 680 km of water boundary are located along the lakes and rivers to the west of Lake Superior [3]. From the mouth of the Pigeon River on Lake Superior, these waters are known respectively as the Minnesota-Ontario Border Lakes, Rainy Lake, and Lake of the Woods. The drainage basin also includes Lake Nipigon, north of Lake Superior.

The system of the Great Lakes and their connecting rivers ranges in elevation from about 46 metres above sea level at its easterly basin limit along the St. Lawrence River, to about 183 metres above sea level on Lake Superior (Figure 3). Major locks and canals have been constructed to facilitate waterborne commerce within these international waterways, as well as to open these waters to oceanic commerce from all corners of the world. Of particular importance has been the construction of the St. Lawrence Seaway, Welland Canal, and the Soo Locks; the deepening of navi-

gational channels between the lakes; and the maintenance of channels in the shallow water areas of the lakes [4]..

The Great Lakes historically have contributed to the rate of migration to the interior lands of both countries and to their subsequent commercial development. The respective economies of each country, particularly the

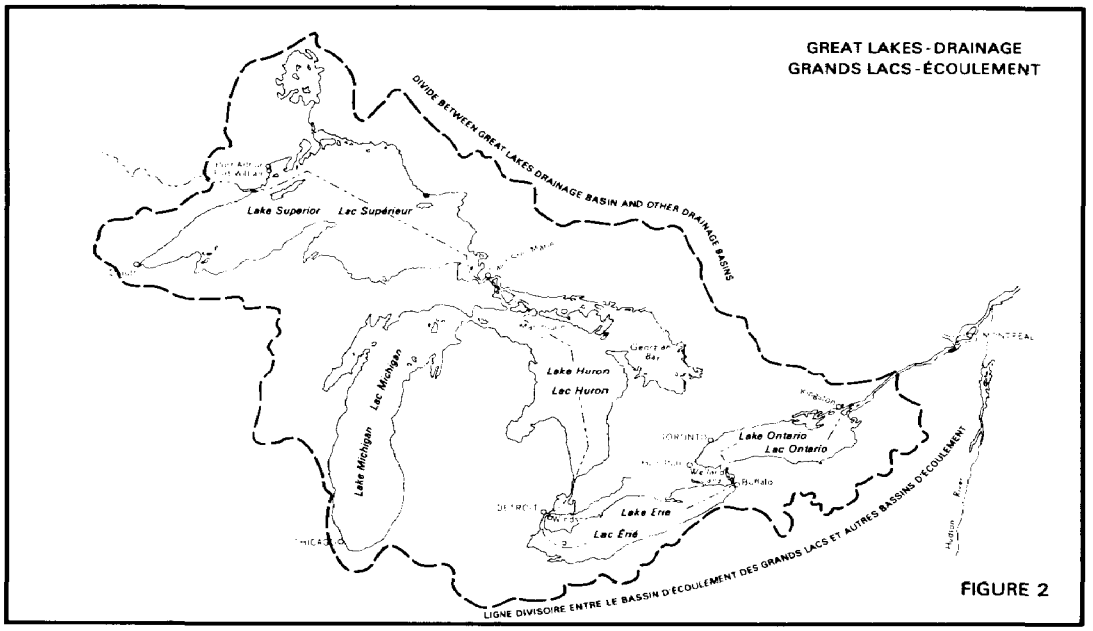

FIG. 2

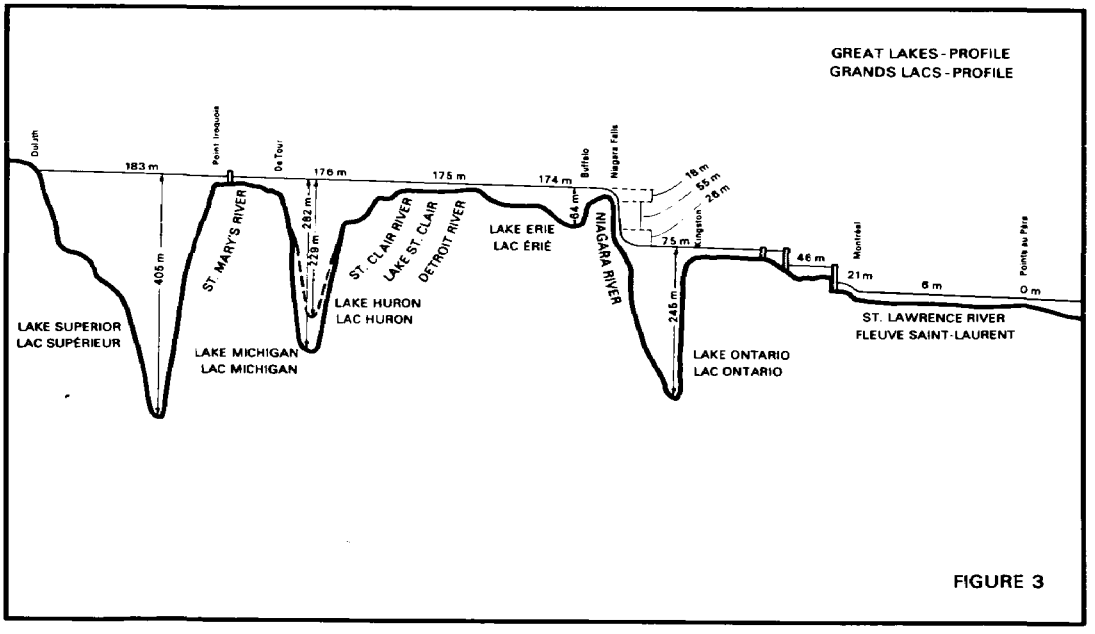

FIG. 3

Canadian Provinces and the American States contiguous to these waters, today are still heavily dependent upon waterborne commerce *into, out of,* and *within* this system. In 1975 almost 181,000,000 tons of foreign and domestic freight were shipped over these waters, with iron ore, grain and coal being the dominant commodities. The main route of commerce between the sea and the lakes is through the St. Lawrence Seaway. A ship leaving the Atlantic Ocean and entering the Gulf of St. Lawrence can sail more than 3,700 km of navigable waters, with limiting depths of 12.5 m to Quebec City, 10.7 m to Montreal [5], and 8.2 m to the westerly limits of the Great Lakes on Lake Superior [6]. Along this route are a number of large industrial cities of Canada and the United States. Three other important connections between this system and the sea are : 1) via the Mississippi River from the Gulf of Mexico, through the Illinois Waterway and ultimate junctioning with Lake Michigan at Chicago, Illinois, a total distance of more than 2,400 km; 2) from the Harbor at New York City via the Hudson River and the New York State Barge Canal System to *Lake Ontario* at Oswego, N.Y., a distance of 550 km; and 3) from the harbor at New York City via the New York State Barge Canal System and the upper Niagara River to *Lake Erie* at Buffalo, N.Y., a distance of about 800 km. In addition to their use by commercial shipping, the Great Lakes and several of its tributaries are a mecca for recreational boaters of both countries.

There are a total of 246 charts published of the Great Lakes and their connecting waterways : 101 by the Canadian Hydrographic Service, and 145 by the National Ocean Survey.

CHARTING THE GREAT LAKES

General Charting History

Transportation by water in the early 1800s was recognized as perilous for the limited number of shallow-draft vessels plying these lakes. Since nautical charts were not available, the mariner had to rely on his own sailing experience and that of others, to acquire knowledge of known hazards. He was faced with long stretches of open-lake shoreline devoid of suitable natural refuge or man-made harbor areas. The mariner had little choice in adverse seas but to hope he could weather the often severe lake storms. Equally rare were lighthouses and floating or permanent navigational aids to assist him in his travels.

The first recognized efforts at charting the Great Lakes occurred in 1828 when the British Admiralty published charts based on reconnaissance hydrographic surveys performed between 1816 and 1822 by Capt. H. W. Bayfield, of the British Royal Navy [7]. Five small-scale charts were published, which covered the coastal areas of Lake Huron and Georgian Bay. Portraying a remarkably accurate depiction of the shoreline, these charts contained very little hydrographic information, as depths were widely spaced and few of the existing reefs and shoals had been located.

The United States Engineer Offices in 1816 began surveying areas along the American lake and river shorelines to support the construction

of harbors and other commercial facilities. These surveys, located principally in regions where the large migrations of settlers had come to reside, provided useful, although limited, information to the mariner.

The Congress of the United States enacted legislation in 1841 creating the U.S. Lake Survey as the first agency specifically responsible for conducting surveys and cartographic operations necessary to produce nautical charts of the Great Lakes and their connecting waterways [8]. Systematic surveys were begun under the first Officer-in-Charge, Capt. William G. WILLIAMS, who was a member of the U.S. Army Topographical Engineers. When the Topographical Engineers merged with the U.S. Army Corps of Engineers in 1863, the Lake Survey became an agency of the latter and remained so until 1970 [9]. By 1890 the Lake Survey had produced a series of 76 charts covering these waters. These charts generally contained hydrographic information only to depths of 3 to 5 meters, but were considered adequate for the lake vessels of that era. A total of 99 charts had been published by 1904, 59 of which were in color [10]. In later years the added responsibility for charting waters tributary to, or conterminous with, the Great Lakes, such as Lake Champlain, the New York State Barge Canal System, Lake of the Woods, and Rainy Lake, resulted in the U.S. Lake Survey producing a suite of more than 140 large and small-scale charts [11]. During this period hydrographic surveys were expanded to provide complete hydrographic information for U.S. waters and for the Canadian deepwater areas. Today, as the result of a major U.S. governmental reorganization in 1970, the charting responsibility for the Great Lakes is under the jurisdiction of the National Ocean Survey (NOS), National Oceanic and Atmospheric Administration (NOAA), Rockville, Maryland [12].

The sinking of the steamer *Asia* in Georgian Bay (Lake Huron) in 1882, with the unfortunate loss of 150 lives, provided the major impetus for the Dominion of Canada to undertake surveys of Canadian waters. In 1883 the *Georgian Bay Survey Office* was established and surveys were started under the direction of Staff-Commander J. G. BOULTON, on loan from the British Royal Navy. The name of this office was changed to the Great Lakes Survey in 1894. By 1904, Canadian surveys of the Great Lakes had been completed and a total of 23 charts had been published by the British Admiralty. The Canadian Government took over full responsibility for surveying and charting Canadian waters in 1904 and formed a new agency, the Canadian Hydrographic Survey, with its headquarters in Ottawa. Systematic charting of Canadian waters along the Atlantic and Pacific Coasts was begun under the direction of the first Chief Hydrographer, Mr. William J. STEWART. The name of this agency was changed in 1928 to its present title — the Canadian Hydrographic Service [13].

The Great Lakes charting programs of the Canadian Hydrographic Service and the National Ocean Survey have continued to develop throughout their respective periods of existence, responding to the increasing national and international requirements for nautical charts. Resource constraints annually imposed on each agency have continued to require a review of operating methods, procedures, and instrumentation to assure that all charting operations are accomplished efficiently. For example, such

evaluations of operations have contributed significantly to each agency employing automation in the acquisition and processing of hydrographic data. Also, systems have been developed for the use of automated techniques in the compilation and drafting procedures required in the production of a nautical chart.

Early Cooperative Charting

Prior to the conception of the Great Lakes Charting Advisers, both agencies exchanged basic data and related charting information. These exchanges of data were, of course, visible cooperative charting efforts. The exchanges were solely in response to the charting needs of the requesting agency where their chart coverage included an area within the national waters of the other country. However, these exchanges did not have a direct impact on the charting operations of either agency.

The first significant cooperative charting effort concurrently affecting both agencies resulted from the decision by Canada and the United States in 1954 jointly to participate in the construction of the St. Lawrence Seaway and Power Projects. This program consisted of the replacement of 22 small locks with 7 large ones, and the construction of several power dams and associated control structures. Within the international waters of the St. Lawrence River, the seaway and power construction included :

a) Moses-Saunders Power Dam,
b) Long Sault Spillway Dam,
c) Snell Lock,
d) Eisenhower Lock,
e) Iroquois Dam,
f) Iroquois Lock,
g) dredging of the Wiley-Dondero Canal,
h) erection of levees or dikes to restrict the water area under post-flooding conditions.

The Moses-Saunders Power Dam, Long Sault Spillway Dam, and the Snell and Eisenhower Locks collectively raised the former elevation of the river by 26 metres. The raising of the river created Lake St. Lawrence, which is 40 km long. With these two new locks and the Wiley-Dondero Canal, vessel traffic can easily move through this abrupt, large elevation change in the river. The upriver land areas to be inundated were cleared of all natural or manmade features which would have been hazards to navigation. Since it was considered impractical for meaningful hydrographic surveys to be conducted prior to flooding, the Canadian Hydrographic Service and the U.S. Lake Survey produced "PROVISIONAL" charts of the Seaway. These charts were compiled from hydrographic data extrapolated from engineering drawings of the area to be flooded. The charts were available for all marine traffic before the Seaway was opened and officially dedicated in June 1959 by Her Majesty Queen Elizabeth II and President Dwight D. EISENHOWER. The publication of these charts culminated more than two years of close technical planning and coordination between the two charting agencies. Interagency cooperation continued as definitive hydrographic surveys were conducted of these newly formed waters. This

cooperation assured that the survey data were acquired in a timely manner to meet the respective agency charting requirements. As a result of these surveys, newly compiled seaway charts were published in 1961.

Each agency exchanged basic survey and reproduction negatives in 1967 to facilitate the production of new charts of Rainy Lake. Coordination of standards for depicting the maintained channels in the international section of the St. Lawrence River was also accomplished in 1967.

As previously stated, the U.S. responsibilities for charting the Great Lakes were transferred in October 1970 from the U.S. Lake Survey to the National Ocean Survey (NOS), a newly established charting agency under the National Oceanic and Atmospheric Administration (NOAA), U.S. Department of Commerce. The NOS renamed the U.S. Lake Survey the Lake Survey Center, and maintained the Center in the Great Lakes region until 1976 to help meet their charting responsibilities, principally in the acquisition of charting data.

In 1971 the Canadian Hydrographic Service and the National Ocean Survey jointly supported the International Field Year on the Great Lakes (IFYGL), an oceanographic study of the Lake Ontario basin under the auspices of the International Hydrological Decade (IHD). These agencies coordinated and jointly produced a variety of special plotting sheets and charts of the Lake Ontario waters, and maps of the contiguous land areas for use by the research scientists involved in this program. Using basic data coordinated and supplied by both agencies, a small-scale bathymetric chart of the lake was produced which contained the lattice for the Decca 6F electronic positioning system established specifically to support the varied scientific data-collection projects [14].

GREAT LAKES CHARTING ADVISERS

Early Activities (1963 to 1972)

Prior to 1955, charting cooperation between the Canadian Hydrographic Service and the U.S. Lake Survey had been principally in the exchange of basic survey data in support of nautical charting. The successful interagency efforts in charting the waters of the St. Lawrence Seaway (between 1956 and 1961) were especially significant because they included cooperation beyond the mutual exchanges of basic data. Coordination of operations involving both field and office programs was required and achieved. The success of these early cooperative efforts led each agency head to recognize that many other operational or charting areas existed where cooperation could be extended to achieve additional mutual benefits [15].

This resulted in a meeting between the agency heads which led to the formation of a committee to explore and assess the complex technical problems involved in reducing duplication of (charting) effort and in preparing common standards of (charting) presentation and (operational) procedure. It was intended for this committee to "review the differing techniques, procedures, and presentations used by the two charting agencies, and to make recommendations... on the best way to achieve compatibility".

The review would include a detailed study of a variety of subject areas in order to formulate recommendations pertinent to these objectives.

A meeting to explore these objectives was convened in Detroit, Michigan, in May 1963 and agreements were reached on :

1) The formation of an advisory committee to study and report upon areas of common interest;
2) A list of the areas (subjects) to be studied by the committee.

Interagency correspondence resulted in formal "Terms of Reference" officially establishing the *United States Lake Survey and Canadian Hydrographic Service Charting Advisers* on 15 October 1963.

The 1963 initial meeting of the Charting Advisers resulted in five Work Groups being established, with the members on each being selected for their recognized skills or expertise in the specific subject areas of study.

A technical Exchange Program was initiated in the summer of 1972. The necessary coordination and monitoring of the Technical Exchange Program was accomplished through efforts of the Charting Advisers. The Charting Advisers also conducted an annual review of field programs, including appropriate coordination of survey operations wherever possible. These activities by the Charting Advisers had the approval of the Dominion Hydrographer, CHS and the Director, National Ocean Survey.

Recent Activities (1972 to 1977)

Instrumental in the present efforts of the Charting Advisers was the sanctioning of this group by the heads of the National Ocean Survey and the Canadian Hydrographic Service to coordinate field programs in the Great Lakes and to coordinate and monitor the annual Technical Exchange Program [16]. Correspondingly, by 1972 many organizational changes, as well as changes in agency responsibilities, had also occurred and the state-of-the-art in charting had changed significantly. The application of automation in related field and office charting programs had become increasingly visible. Outmoded manual techniques and procedures were continually being examined and, wherever feasible, replaced by better methods. Resource constraints on all operations were increasing the demands for each agency to seek the most cost efficient procedures or mode of producing charts, from data acquisition to ultimate printing and distribution. The Charting Advisers met in 1972 to reassess the validity of the 1963 Terms of Reference and, specifically, the statement of purpose contained therein [17]. Considerable discussion on the past, present, and future role of the Charting Advisers ensued. Progress made towards compatibility was noted in such areas as changes made to the format of the respective Pilots (Sailing Directions), chart distribution, and cooperative charting ventures. The latter was exemplified in the cooperation extended in the production of new charts of Rainy Lake.

Because of the continuing changes to the organizational structure of each agency, it was evident to the Charting Advisers that maximum coordination and cooperation could be achieved only if the existing terms of reference were reviewed and revised to reflect current agency conditions. By

1975 they had made several changes to the terms, the most significant of which were in redefining the "purpose" and "objectives" of the Advisers.

The *statement of purpose* had been expanded as follows :

"To review the differing compilation techniques and procedures, including presentation format used by the two agencies in the production of navigation charts and related publications, concerning the waters of the Great Lakes, interconnecting channels and other waters of central North America of mutual concern, and to make recommendations to the Director, National Ocean Survey (NOS), the Dominion Hydrographer, Canadian Hydrographic Service (CHS), and the Director, Central Region, Ocean and Aquatic Affairs, on the most efficient and effective ways to achieve compatibility and uniformity of product, and to coordinate the operations of the agencies to achieve the optimum mutual benefit thereto".

The following objectives, consistent with this new statement of purpose, had been added :

"a) To explore means of achieving greater compatibility of CHS and NOS charts and related publications and to make appropriate recommendations related thereto to their respective agencies;

"b) To explore the feasibility of publication of international charts and related publications of the Great Lakes and to make appropriate recommendations related thereto to their respective agencies;

"c) To explore means of achieving greater coordination between all operating activities, and in particular to advise on surveying schedules and chart plans and production programs of CHS and NOS, and to make appropriate recommendations related thereto to their respective agencies;

"d) To review annually the objectives and specific subjects of study comprising these Terms of Reference, and at each meeting to assess work group progress, and to make appropriate recommendations to their respective agencies for the revision or expansion thereof to assure effective compliance with, or implementation of, objectives a), b) and c) above;

"e) To explore the feasibility of the creation of a Great Lakes Hydrographic Commission under the auspices of the IHO with the primary objective of studying the benefits of implementing an international series of charts for the Great Lakes;

"f) To monitor other International Boards, Commissions, or Committees whose responsibilities or actions impact or affect present and future charts of the North American waters, and to formally respond to these entities to assure that charting policies or philosophies of CHS and NOS are properly defined".

Co-related to the contemporary purpose and objectives of the Charting Advisers was the need to expand the previously defined statement on Work Groups. By 1975, the 1963 Terms of Reference had been revised and expanded to define the supportive Work Groups as follows :

"Work Groups

"Work Groups shall be established to assist in achieving the objectives of these Terms of Reference, to investigate subjects related thereto, and to

formulate recommendations thereon for consideration by the Advisers. Work groups will initially (1) define and report on differences in techniques, procedures, and presentation format, and (2) make suggestions or recommendations for improving or achieving compatibility of product produced or methodology used by the respective agencies. Once appointed, work group members will communicate directly with each other as required to accomplish their specific objectives. It is considered essential that a minimum of seven work groups be established, each group being responsible for investigating the subjects listed below :

GROUP A. — Chart categories, format, coverage, layout, scale, projections, symbols and maintenance; chart numbering; Notices to Mariners; notational standards including credit lines and datum notes on charts; compilation procedures and standards, exchange of navigational data, catalogs, chart data storage and retrieval.

GROUP B. — Chart distribution and pricing policies; gratuitous issue policy for international distribution of charts and related publications.

GROUP C. — Pilots/Sailing Directions.

GROUP D. — Surveying standards and procedures in hydrographic surveys; revisory surveys, and surveying techniques.

GROUP E. — Horizontal and vertical control including reference planes and datums.

GROUP F. — Determining feasibility and benefits of bilateral production of international charts and of the creation of a Great Lakes Hydrographic Commission.

GROUP G. — Automatic data acquisition and processing; developments in data storage and retrieval; automated cartographic methods; exchange of R&D information".

Accomplishments (1972 to 1977)

Meetings during the past five years have resulted in significant recommendations and contributions to the mutual surveying and charting programs of CHS & NOS in the Great Lakes. A few of the accomplishments of the Advisers have been :

1. The completion of a Chart Characteristics Comparative Data Report by Group A in 1974 [18]. This report fully documented differences between CHS and NOS charts. Where differences were noted, recommendations were made on how compatibility could be achieved. This group was fortunate in being able to make reference to similar work being conducted by the North Sea International Chart Commission. The findings in this report proved extremely helpful in subsequent development of chart standards for the production of international charts discussed later in this paper.

2. The completion of a report by Group B in 1975 which identified the differences in agency pricing and distribution policies [19]. A detailed study was made, revealing differences not only in basic selling prices of charts and related publications, but also in the percentage of discount for

authorized sales agents. Unfortunately, because the responsibility for establishing prices in the U.S. is vested in financial authorities independent of the NOS, no action could be taken to eliminate existing pricing differentials. And in Canada, where changes could have been made, it recently became illegal for wholesalers to establish or regulate retail prices.

3. In June 1974 the Charting Advisers began discussions concentrated on the objective of developing a new scheme of charts of the Great Lakes system. The development of a comprehensive chart scheme satisfying both U.S. and Canadian requirements has taken time and, as of this writing, is nearing completion. Foremost attention has been given to reaching agreement on the scheme and format of charts covering the upper St. Lawrence River and of the general charts of all the lakes where the greatest duplication currently exists. Secondary attention has been given to the larger scale charts (approximately 1:100 000) of the coastal and confluence areas of each lake.

4. Considerable attention has been given to the subject of producing charts of the Great Lakes waters based on bilaterally developed specifications. An agreement was reached by the Advisers, and approval granted by the agency heads in 1973, to coordinate the production of general charts of Lakes Erie and Ontario to these specifications. In 1975 the CHS assumed the responsibility for compilation and production of the chart of Lake Ontario [20] with NOS responsible for the chart of Lake Erie [21]. The compilations for these two metric charts were completed in 1976 *. Because of the significant cooperative charting efforts they represented, these charts formed the basis of the USA-Canada display at the 1977 International Hydrographic Organization Conference.

Significant uniformity was achieved between these charts. More than 40 different charting standards were coordinated in their production. For example, both charts were published on A0-size paper, at a scale of 1:400 000, on a Mercator Projection, and in metric units. Even though each agency was responsible for the production of a specific chart, this coordination permitted the resulting reproduction negatives to be used by either agency.

5. Beginning in 1973, the Charting Advisers annually exchanged plans of field surveys, and reviewed similar operations of the previous year. This has resulted in a number of cooperative survey operations, such as the joint participation in revisory surveys [22] of the charts of the St. Lawrence River in 1973, and the combined hydrographic surveys in Lake Huron in 1977.

6. The Charting Advisers have coordinated the Technical Exchange Program under which key staff personnel are exchanged on a one-for-one basis each year for an assignment period of about four months. Throughout the six years the program has existed, the U.S. exchangees going to Canada have been exposed to operations ranging from the Great Lakes to the Canadian Arctic; while the Canadian exchangees have participated in NOS

(*) Lake Ontario : Canadian chart 2000, published 11 Feb. 1977.
Lake Erie : NOS chart 14280 (metric), published 15 Jan. 1977.

operations ranging from the Great Lakes to surveys along the coast of Florida [23].

UNITED STATES - CANADA HYDROGRAPHIC COMMISSION

In April 1977 the United States-Canada Hydrographic Commission was formed, to provide coordination where the surveying and charting operations of their respective domestic waters overlap. A fuller report on this important new Commission, which works as far as possible to IHO survey and chart standards, was published in the *International Hydrographic Bulletin* of December 1977.

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A ROCK IS A ROCK IS A ROCK

"The July 1977 issue of the *International Hydrographic Review* surpassed itself in general interest to the mariner... But a paper by B. R. PELLETIER of Canada recommends ... a seabed sampling programme : "Certain rock types can be learned easily — shale, sandstone, conglomerate, granite and some metamorphic and volcanic rocks".

Umm ! I'm not sure that I go right along with that. I belong to that bigoted, utilitarian school of mariners who reckon a rock is a rock. But perhaps the Master of a newly-stranded vessel could restore his damaged morale by radioing his owners that he was hard aground on a patch of rock : "actually, gentlemen, a patch of metamorphic rock with the slightest touch of volcanic".

All that my lot of seamen really want from the hydrographer is an indication of those positions where the bottom of their ships is likely to be sliced open. Coral is, of course, an animal growth which has no real right of membership of the authorised rock club. But we don't mind at all if the hydrographers wish to tell a little white lie and mark dangerous coral heads with rock symbols".

J.W. HOGARTH, *in* : *Nautical Magazine*, November 1977, p. 260. Glasgow, Scotland.