Executive Summary

United States and Mexico Corporative Hydrographic Survey and Charting Projects

Lieutenant Commander Donald W. Haines and Ms. Kathryn Ries
National Ocean Service, NOAA

Recognizing the benefits of a harmonized, cooperative approach to charting and surveying of shared boundary waters on the Pacific coast and in the Gulf of Mexico, the National Oceanic and Atmospheric Administration's (NOAA) Office of Coast Survey (OCS) and its Mexican counterpart (Dirección General Adjunta de Hidrografía y Cartografía -DIGADHICAR) established a Charting Advisory Committee in March 2002. NOAA has long enjoyed a similar relationship with the Canadian Hydrographic Service which has resulted in data collection and chart production efficiencies, improved expertise through technical personnel exchanges and enhanced safe navigation through the respective ports of each country.

The U.S. -Mexico Cooperative Charting Advisory Committee was set up under the auspices of the International Hydrographic Organization's (IHO) MesoAmerican-Caribbean Sea Regional Hydrographic Commission. A primary objective of this Committee is the coordination of respective requirements to achieve maximum compatibility of surveying and charting operations in compliance with IHO standards.

The IHO is an intergovernmental consultative and technical organization that was established in 1921 to support navigation safety and protection of the marine environment. The mission of the IHO is to ensure the provision of adequate and timely hydrographic information for world wide marine navigation and other purposes, through the endeavors of national hydrographic offices. The IHO encourages the establishment of Regional Hydrographic Commissions (RHC), which are integral parts of the IHO and promote the aims of the Organization at a regional level. Committees and/or Working Groups are established under the Commissions to address specific topics at a working level. The results of these discussions are then brought to the Commissions for approval by the National Hydrographers of the Member States.

Specific areas identified for collaboration included: hydrographic survey data acquisition and exchange; paper and electronic chart production; tidal and current data harmonization, associated methods and publications; establishment and maintenance of harmonized horizontal and vertical control; and hydrographic and cartographic personnel exchanges. This paper covers the results of the first hydrographic and cartographic personnel exchanges (September 29-November 22, 2003 and June 13-July 3, 2004), and a joint hydrographic survey (April/May 2004).

International Hydrographic Organization

United States – Mexico
Charting Advisors Committee

MesoAmerican-Caribbean Sea Hydrographic Commission

United States and Mexico Corporative Hydrographic Survey and Charting Projects

Lieutenant Commander Donald W. Haines and Ms. Kathryn Ries[1]
National Ocean Service, NOAA

Introduction

Mariners make important decisions based on information provided by national Hydrographic Offices (HOs) to guide their vessels safely and efficiently to their destinations. Providing the latest and most accurate information in a consistent manner becomes even more important as the mariner traverses national boundaries. Therefore, it is critical that neighboring HOs make overlapping data (both the actual data and the associated symbology) available in a consistent manner to ensure a seamless transition from one country's navigation products to the next.

Recognizing the benefits of a harmonized, cooperative approach to charting and surveying of shared boundary waters on the Pacific coast and in the Gulf of Mexico, the National Oceanic and Atmospheric Administration's (NOAA) Office of Coast Survey (OCS) and its Mexican counterpart (Dirección General Adjunta de Hidrografía y Cartografía - DIGADHICAR[2]) established a Charting Advisory Committee in March 2002. NOAA has long enjoyed a similar relationship with the Canadian Hydrographic Service which has resulted in data collection and chart production efficiencies, improved expertise through technical personnel exchanges and enhanced safe navigation through the respective ports of each country.

The U.S.-Mexico Cooperative Charting Advisory Committee was set up under the auspices of the International Hydrographic Organization's (IHO) MesoAmerican-Caribbean Sea Regional Hydrographic Commission. A primary objective of this Committee is the coordination of respective requirements to achieve maximum compatibility of surveying and charting operations in compliance with IHO standards.

Specific areas identified for collaboration included: hydrographic survey data acquisition and exchange; paper and electronic chart production; tidal and current data harmonization, associated methods and publications; establishment and maintenance of harmonized horizontal and vertical control; and hydrographic and cartographic personnel exchanges. This paper covers the results of the first hydrographic and cartographic personnel exchanges (September 29-November 22, 2003 and June 13-July 3, 2004), and a joint hydrographic survey (April/May 2004).

[1] The authors would like to acknowledge the contributions of Steve Gill, Cathleen Barry, Sean Legeer and LT Marc Moser for certain sections of this paper.

[2] DIGADHICAR has been reorganized since the time of this survey and is now called DIGAOHM (Direccion General Adjunta de Oceanografia, Hidrografia y Meteorologia or General Directorate for Oceanography, Hydrography and Meteorology)

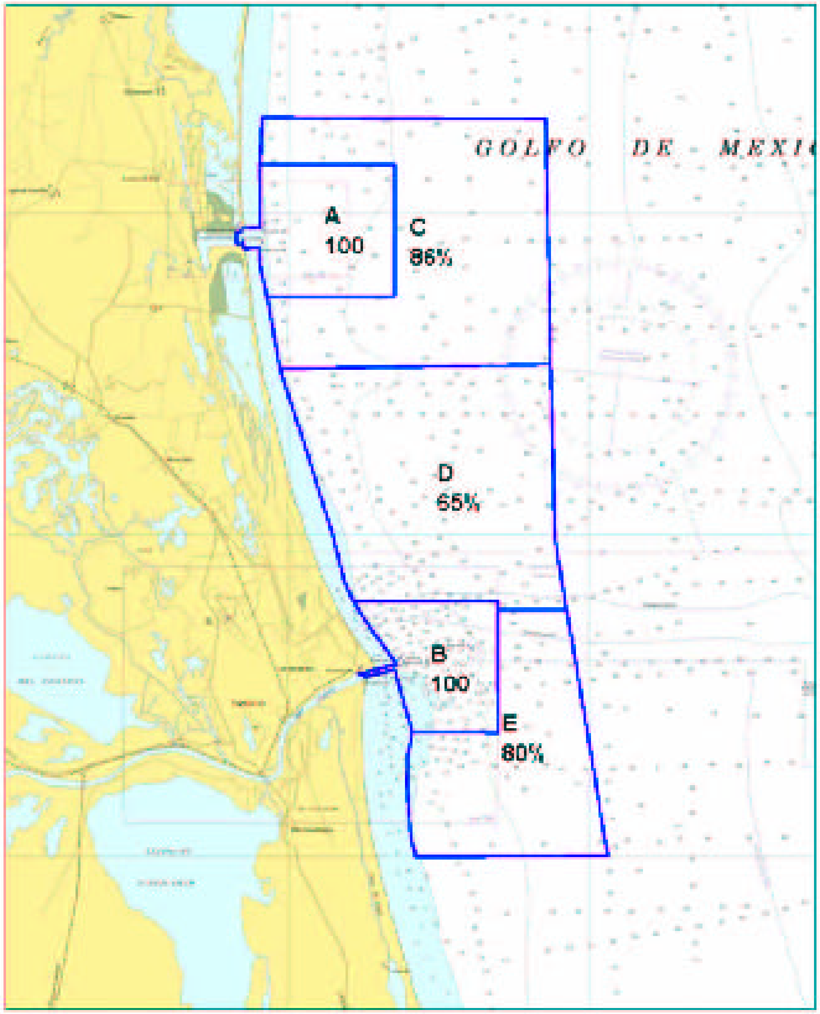
Joint Hydrographic Survey in the Gulf of Mexico

One of the first major successes of this new partnership was a cooperative hydrographic survey carried out for the Ports of Tampico and Altamira, conducted with the NOAA Ship THOMAS JEFFERSON in April-May 2004. Both these ports are heavily transited by large ships, moving some eight and a half million tons via primary container ships of all sizes through Altamira, along with bulk and petroleum ships through Tampico. The Royal Dutch/Shell oil conglomerate has been contracted to build, maintain, and run a 500 million cubic feet per day (MMdfd) liquified natural gas (LNG) terminal near the Port of Altamira in an effort to meet the rising energy demands of the United States and Mexico. The Altamira LNG terminal is scheduled to begin operations during the second half of 2006. This joint survey will help to produce a new updated chart in the Gulf of Mexico and will lead to safer navigation for mariners in an area that is expected to see a significant rise in ship traffic in the next five years.

This survey was a collaborative effort between NOAA and DIGADHICAR that encompassed extensive advance preparations, acquisition of the surveys, data processing, and related cross training. The urgent Mexican requirements for updated surveys of these ports, fortunately coincided with the schedule of THOMAS JEFFERSON's planned work in the U.S. portion of the Gulf of Mexico.

THOMAS JEFFERSON hosted a Mexican Naval officer on board for the duration of the project to provide training on the latest hydrographic technology and data processing software available on the vessel. LT Omar Bracamontes, a Mexican hydrographer, joined THOMAS JEFFERSON in Key West, Florida to assist with the logistics and translation needs associated with entering Mexican national waters, and to learn about NOAA procedures. He sailed aboard the ship for the entire project, assisting in acquisition and processing of the data so that he could follow this data through to application on a Mexican Electronic Navigational Chart. Mexico does not currently use multibeam technology, but is planning to acquire it. Therefore, exposure to U.S. experience in operating such equipment and related data processing proved quite valuable to LT Bracamontes and his counterparts who participated in other personnel exchanges described below. In addition, ten Naval personnel attending the hydrographic training at the Naval Academy in Veracruz participated in a day trip aboard THOMAS JEFFERSON where they received a brief overview of the ship's data acquisition and processing techniques. During scheduled inports in Tampico, several personnel from the Mexican Hydrographic Office also toured THOMAS JEFFERSON.

THOMAS JEFFERSON is a 64m hydrographic survey vessel with two 9m hydrographic survey launches. It is generally operated on the East and Gulf Coasts of the United States by NOAA to acquire near shore hydrographic surveys in support of marine transportation and commerce. The surveys consisted of both multibeam and side scan sonar data acquired simultaneously aboard the ship and independently aboard her launches. The survey area consisted of two 1:10,000 scale surveys in the area around the jetties and three 1:20,000 scale surveys offshore and between the ports (See Progress Sketch below). The depths in the survey area ranged from 5 meters in the vicinity of the jetties to 40 meters offshore.



Project	Sheet_Letter	H_num	HO_Est_SNM	CumlPercCompPrev	CumlPercCompCur	SNM_CompCurMon	CumSNMcom
K902	B	H11312	14	65	100	2	16
K902	A	H11311	17	66	100	1	17
K902	E	H11315	32	60	80	0	35
K902	D	H11314	64	30	65	24	35
K902	C	H11313	61	30	86	23	44

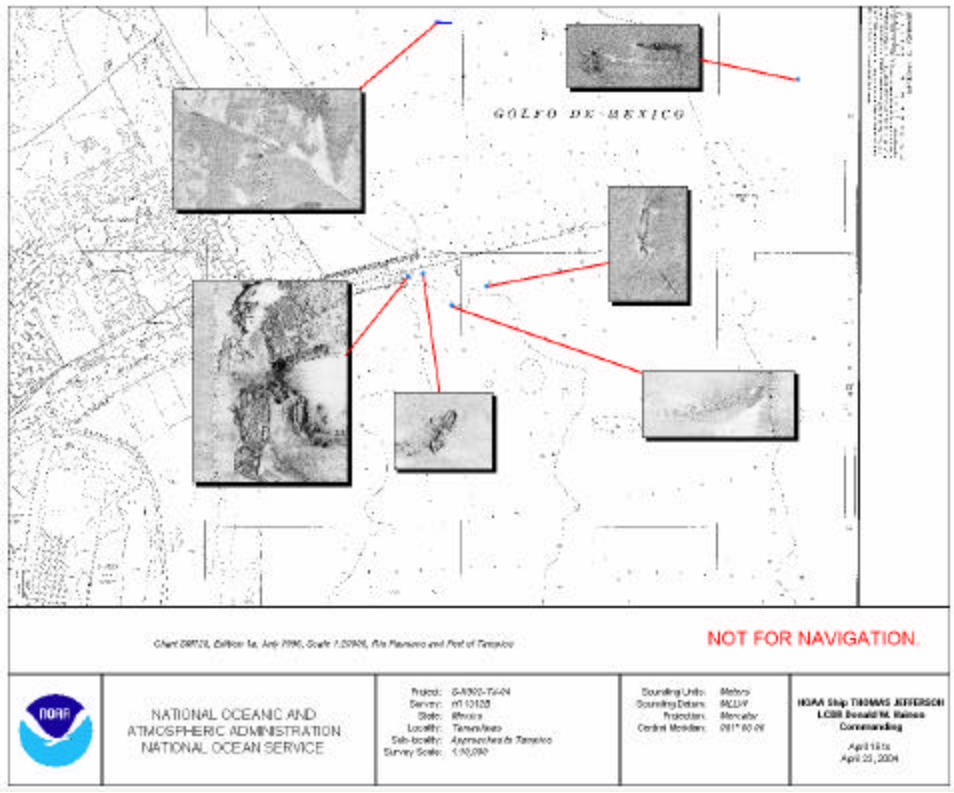
Project	Month	LNM_Hydro	LNM_MB	SV_Casts	Bottom_Sa	AWOIS_It	Tide_Gauge_	DAS	DTime_equip_H	DTime_Weather_	D_Time_other_H	Inport_H
K902	April	[illegible]	[illegible]	84.00	0.00	0.00	0.00	22.00	14.00	19.00	0.00	54.00
K902	May	815.77	746.00	29.00	0.00	0.00	0.00	7.00	12.00	52.00	0.00	66.00

Progress Sketch S-K902-TJ-04
May, 2004

Field Code Changed

Survey Results

THOMAS JEFFERSON completed 135 square nautical miles of multibeam and side scan sonar surveys in the approaches to Tampico and Altamira, and discovered numerous uncharted wrecks and obstructions. Below are several side scan sonar images of the previously uncharted wrecks. The data from these surveys will be transferred to Mexico to create new up-to-date charts in the area.



Vertical Control

One of the most important correctors for hydrographic data are tides and water levels in order to correctly identify safe navigable waters. Vertical control for the survey was planned and implemented using standard NOAA procedures[3]. Historical data from nearby operating Mexican tide stations at

Comment: Steve could you define NOAA procedures (foot note)?

Deleted: [3]

[3] NOAA Procedures and NOAA Specifications are found in NOS Office of Coast Survey Specifications and Deliverables March 2003 (http://nauticalcharts.noaa.gov/hsd/specs/specs.htm)

Tampico and Altimira were obtained from Mexican counterparts and analyzed to produce preliminary tidal zoning for the survey using the NOAA tide station at Port Isabel, Texas as control. Because real-time data relative to datum could not be obtained and quality controlled in a timely manner for THOMAS JEFFERSON field operations from the existing Mexican tide stations, NOAA contracted with Texas A&M to install and operate a station to NOAA specifications during survey operations. Data from this tide station were transmitted over the NOAA GOES (Geostationary Operational Environmental Satellites) system for daily review and quality control. Datums were computed, tidal zoning was adjusted based on the new measurements, and final zoning and tide reducers from the tide station were provided to THOMAS JEFFERSON prior to leaving the survey area. This new tide station was also established closer to the harbor entrance to provide tighter control than the existing Mexican station, which was located further up the river.

Comment: Site specs contained where foot note?

Deleted: [3]

Deleted: gauge

Deleted: gauge

Deleted: the

Deleted: them

Deleted: gauge

Tide Data Integration

During the planning of this survey, Mexico provided NOAA with details of their tide station installations and several months of data from the two stations (Tampico and Altimira). NOAA processed these data and computed preliminary Mean Lower Low Water (MLLW) datums for each. Prior to this survey, Mexico and the United States used two different Chart Datums making use of chart products going between countries difficult for the mariner. This integrated effort resulted in the use of a single Chart Datum (MLLW) for common surveys.

Harmonic analyses were performed to help construct the preliminary tidal zoning for the survey. These data were also used in the technology transfer and training program described below with the visiting hydrographers using data from their station to learn data processing tidal datum computation procedures. Bench marks were established at the new station described above, and tidal datum elevation information has been shared with the Mexican hydrographers for their future surveys.

Hydrographic and Cartographic Personnel Exchanges

The first hydrographic personnel exchange occurred during the Fall of 2003. Mexico sent one of its hydrographers, LT Leonardo Tun, to spend four weeks aboard NOAA Ship RAINIER and subsequently two weeks in the processing and production offices of OCS headquarters. While aboard RAINIER, LT Tun learned multibeam data acquisition and processing methods used by NOAA. NOAA Ship RAINIER is a 70m purpose-built hydrographic survey platform with six 9m launches aboard. He experienced the operations of a multi-platform vessel and learned how to best utilize each asset. LT Tun then visited NOAA's Pacific Hydrographic Branch in Seattle, Washington where he observed the data being processed, quality assured and creation of products such as Smooth Sheets, H-Drawings[4] and chart applications. He then followed the process through to NOAA Headquarters, visiting the Marine Chart Division (MCD) to observe the creation of products for the mariner including: Electronic Navigation Charts (ENC), Raster Charts and Lithograph Charts. He also received a better understanding of all the data that MCD ingests to create an end product. LT Tun's time at OCS headquarters was also advantageous for beginning to plan the joint hydrographic survey discussed above.

Deleted:

Deleted: s

Deleted: s

Deleted: and

Deleted: where he

Deleted: ed

[4] Smooth Sheets are a product created from the verified and corrected bathymetric and feature data of recent hydrographic surveys, generally at 1:10,000 scale. The smooth sheet is a primary source for creating an H-Drawing at chart scale that is used to update the chart.

LT Juan Ramirez was provided detailed training in tides from the NOAA Center for Operational Oceanographic Products and Services over a two-week period. This training included an overview of national water level program operations, and detailed training in tides support for hydrographic survey operations. This included project planning, tidal zoning, tide station operations, tidal data processing and quality control, tidal datum computation, final tidal zoning and tide reducer determination, harmonic analyses and tidal prediction. Data from the Mexican tide stations were used in support of the training. The training included a visit to the nearby NOAA tide station in Baltimore, Maryland. Future exchanges will include additional data exchange and assistance in determination of MLLW datum at other Mexican tide stations.

Deleted: training

Deleted: and

Deleted: that included

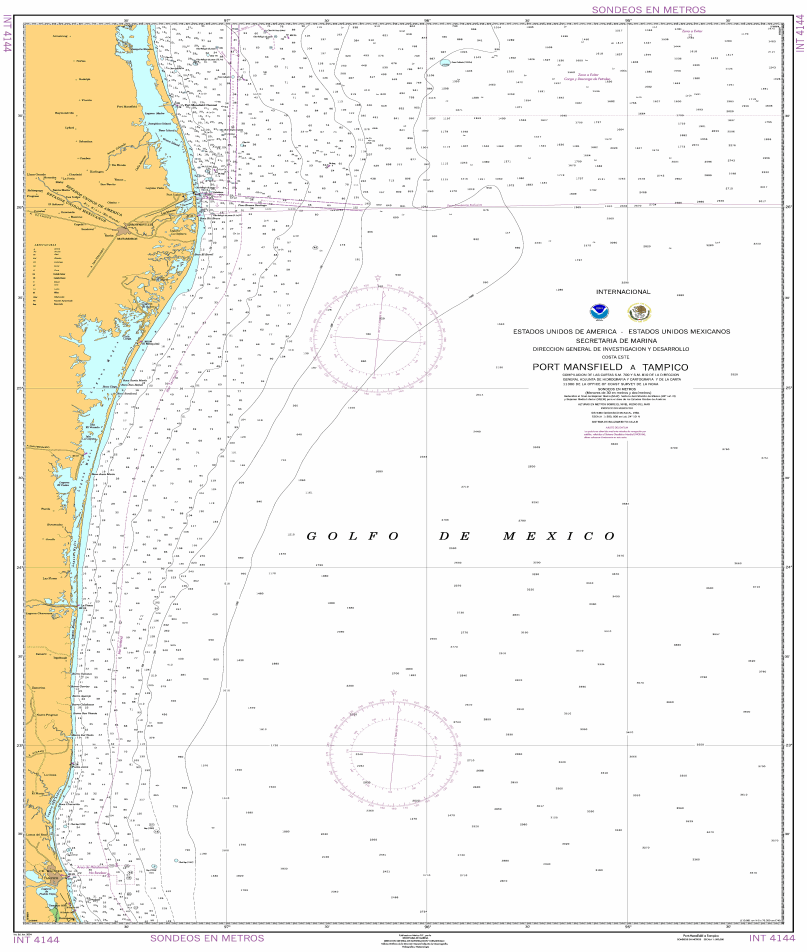
In June 2004, a team of four NOAA hydrographers and cartographers (Sean Legeer, Cathleen Barry, Castle "Gene" Parker and Ada Otter) spent three weeks working directly with their counterparts at the DIGADHICAR headquarters in Mexico City. The primary objectives were to learn more about each country's respective programs and procedures, to provide training in hydrographic data processing and to initiate the co-production of an International Chart (4144). This chart is part of a scheme designed by the IHO MesoAmerican Hydrographic Commission to provide seamless regional chart coverage through the collaborative efforts of member countries. The United States and Mexico had agreed to co-produce this particular chart as one of the initial activities of its joint Charting Advisory Committee.

Deleted: hydrographers and cartographers

Deleted:

Deleted: .

Deleted: .



INT Chart 4144 is of the Gulf Coast from Port Mansfield, TX to Tampico, Mexico at a scale of 1:500,000

The U.S. cartographic team was introduced to DIGHADICAR Cartographic Department's methods for paper chart, raster and ENC production. Their process involves importing bathymetric data and topographic/shoreline information into a CARIS Geographic Information System (GIS) environment. Their method relies heavily on CARIS GIS for vectorization of the paper chart information. The digital file that results from this vectorization for the paper chart then becomes the basis for creation of both the raster chart (using a CARIS BSB Wizard) and production of the ENC (using CARIS HOM.)

Deleted:

Deleted: g

Deleted: i

Deleted: s

It was particularly important for the U.S. team to see how Mexico is building their suite of charts because they are completely vector based. The Mexican program uses CARIS tools from start to finish. NOAA is in the process of moving to a vector database system, so it was beneficial to see it being used operationally and the associated pros and cons. These became apparent as challenges arose for the CARIS system in dealing with the NOAA data used to help build the International Chart. NOAA ENCs

are currently produced using a Lazerscan system. A similar exchange of Mexican cartographers at NOAA headquarters in Silver Spring, Maryland is expected towards the end of 2005.

Training in Alternative Data Acquisition and Processing Methods

Two of the cartographers, who also specialize in hydrographic data processing, spent a week giving a special seminar at the Oceanographic Institute of the Naval Academy in the Mexican city of Veracruz on the Gulf Coast. Mr. Gene Parker gave a series of lectures to five Mexican Naval officers and a civilian oceanography student that included an overview of the U.S. hydrographic program with a specific focus on shallow water multibeam, side scan sonar acoustic principles, and processing. The integration of multibeam methodologies into the hydrographic process adds a new dimension in the complexity of data processing. There are many significant lessons learned from U.S. experience that the Mexican Navy can take advantage of as they prepare to acquire and use these technologies. An abridged version of the Veracruz presentations were also provided to those Naval personnel at the Mexico City office with an interest in the hydrographic aspects of data acquisition. Information was also provided on new directions NOAA is taking in data processing using BASE (Bathymetry with Associated Statistical Error) and CUBE (Combined Uncertainty and Bathymetry Error), which is a transition to using a model of the seafloor vice discrete measurements. In addition, current and future cartographic processes being used by NOAA were presented.

Deleted:
Deleted: y
Deleted: one
Deleted: and
Deleted: and
Deleted: s

Building Capacity for Hydrography

On December 10, 2004, President Bush signed into law legislation authorizing the transfer of the decommissioned NOAA hydrographic survey vessel WHITING to Mexico. Public Law 108-456, Title II, Section 202 states:

> "The Secretary of Commerce shall convey to the Government of Mexico, without consideration, all right, title, and interest of the United States in and to the National Oceanic and Atmospheric Administration vessel WHITING –
>
> (1) for use as a hydrographic survey platform in support of activities of the United States - Mexico Charting Advisors Committee; and
>
> (2) to enhance coordination and cooperation between the United States and Mexico regarding hydrographic surveying and nautical charting activities in the border waters of both countries in the Gulf of Mexico and in the Pacific Ocean."

At the time this paper was written, the planning for the official transfer of WHITING to Mexico is underway and is expected to take place by the end of April 2005. This is the first dedicated hydrographic vessel that Mexico will have and it will enhance the country's ability to address national and binational hydrographic priorities considerably.

Deleted: considerably

Results and Conclusion

This important binational collaboration has gotten off to a very promising start. The initial activities described above have served to familiarize NOAA and DIGADHICAR personnel with how their

Deleted:

respective organizations operate: established appreciation of the similar challenges each faces with the value of learning from each other; produced tangible results (joint hydrographic survey, cross-training of personnel, co-production of an international chart); and set the stage for continued, long-term collaboration that will benefit both countries.

Deleted: ,

Deleted: and

Deleted: ,

The commitment to continued collaboration was affirmed through the re-signing of the cooperative charting agreement by new leadership in both NOAA and DIGADHICAR in April 2004. Future accomplishments are expected to parallel those achieved with Canada, where the two nations have efficiently utilized resources and eliminated duplication of effort by dividing responsibility for chart production in boundary waters, harmonizing techniques, methods and publications, and increasing technical expertise and capacity through shared experience. Ultimately these binational activities serve to promote safe, efficient and environmentally sound navigation that is so essential to the well being of North America.