WORLD HYDROGRAPHY DAY 2014

Hydrography – much more than just nautical charts

WHD IN MONACO

CELEBRATION OF WORLD HYDROGRAPHY DAY
AT THE INTERNATIONAL HYDROGRAPHIC ORGANIZATION HEADQUARTERS

Monaco, 18 June 2014

World Hydrography Day was celebrated in Monaco with a reception at the headquarters of the IHO on 18 June. The theme for this year's celebration is "*Hydrography - much more than just nautical charts*" - highlighting the significant value of hydrography to all human activities that take place in, on or under the sea.

Local dignitaries, government and diplomatic representatives, and other invited guests were graced with the presence of HSH Prince Albert of Monaco. The celebration also received a significant boost from the French Navy whose surveying vessel *La Pérouse* (Commanding Officer Christophe Thomassin) was berthed in Monaco's main harbour, Port Hercule.

President Ward addresses HSH Prince Albert and guests at the WHD celebration

The Hydrographer of France, Ingénieur général Bruno Frachon, also attended the celebration. In addition, the IHO was hosting a meeting of the IHO-IOC Sub Committee on Undersea Feature Names (SCUFN), which enabled the immediate past Hydrographer of Japan, Mr Shin Tani, and the Deputy Hydrographer-General of Canada, Dr Kian Fadiae, to be present, together with the other members and observers of the Sub Committee.

HSH Prince Albert meets Dr Hans Werner-Schenke (Germany), Chair
and Ms Lisa Taylor (USA), Vice chair of SCUFN

The welcoming speech delivered by IHO President Robert Ward presented the theme of this year’s celebration and was concluded with a toast to all the world’s hydrographers and their professional colleagues.

WHD IN BRAZIL

DIA MUNDIAL DA HIDROGRAFIA

No dia 21 de junho, comemora-se o Dia Mundial da Hidrografia, instituído em 2005 através da Resolução da Assembléia Geral das Nações Unidas. O objetivo desta data é divulgar a relevância da Organização Hidrográfica Internacional (OHI) e dos Serviços Hidrográficos dos seus Estados-Membros, em prol da segurança da navegação e da proteção do meio ambiente.

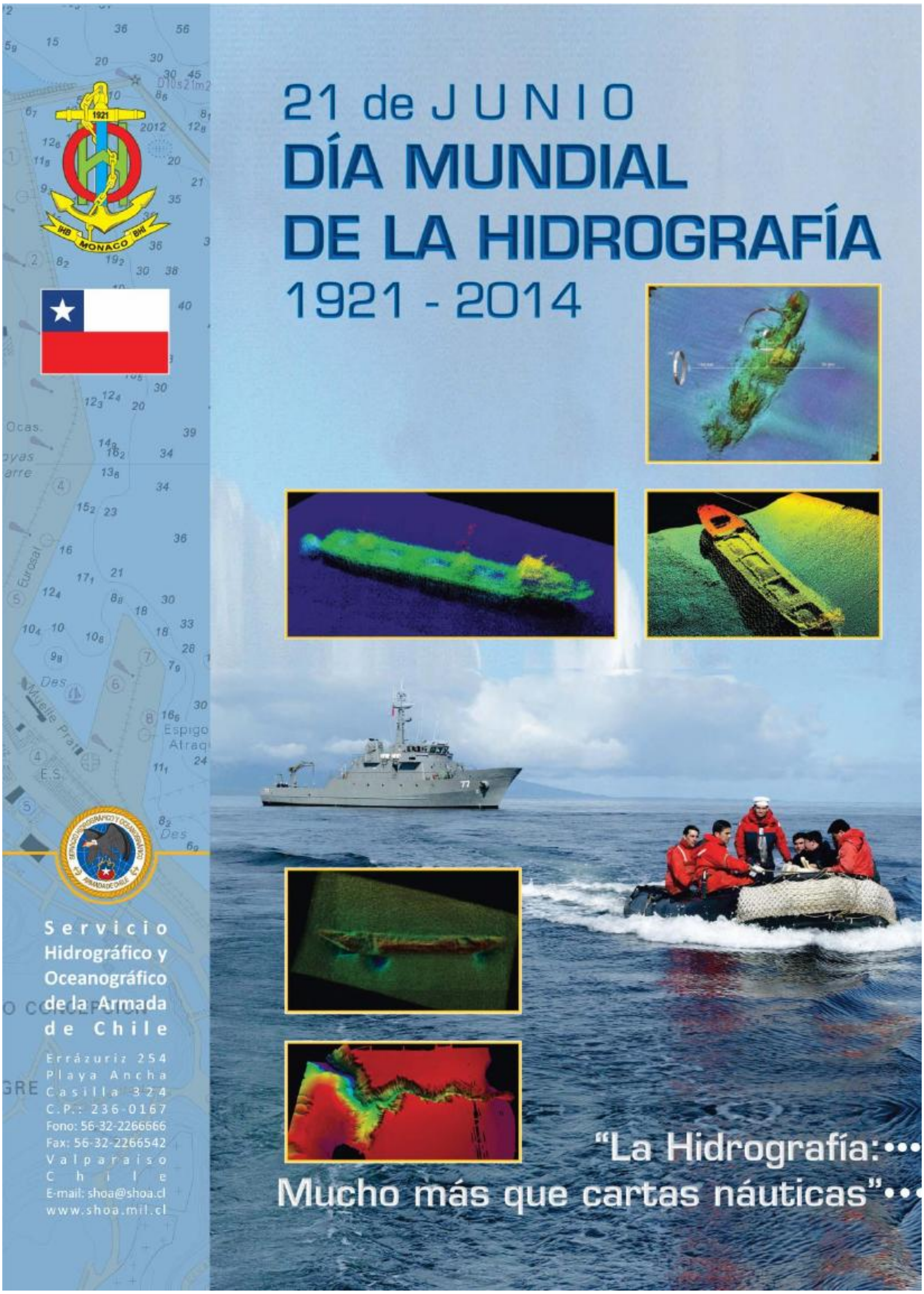
Em 2014, a Diretoria de Hidrografia e Navegação (DHN), localizada em Niterói (RJ), realizou em 20 de junho, a Cerimônia Militar alusiva à data, presidida pelo Diretor da DHN, Vice-Almirante Antonio Reginaldo Pontes Lima Junior e celebrou também o 93º aniversário da criação da OHI. A solenidade contou com a presença dos ex-Diretores, Almirante-de-Esquadra (RM1) Marcos Augusto Leal de Azevedo e Vice-Almirante (RM1) Edison Lawrence Mariath Dantas, além do Diretor de Assistência Social da Marinha, Contra-Almirante Marcos Lourenço de Almeida, de militares da ativa, da reserva e de Servidores Civis.

Durante o evento, foi lida a Ordem do Dia do Diretor de Hidrografia e Navegação, VA Pontes Lima, que destacou as atividades humanas desenvolvidas no mar pelos hidrógrafos e cartógrafos náuticos de todo o mundo. "Este trabalho é de extrema relevância, para os navegantes, pois possibilita o uso seguro e eficaz dos mares, oceanos, zonas costeiras, lagos e rios." – ressaltou em suas palavras.

O tema escolhido pela OHI, para este ano, é "Hidrografia – muito mais que Cartas Náuticas". A produção das cartas permite aos navegantes conduzir, com segurança, as suas embarcações, evitando todos os perigos conhecidos nos seus percursos pretendidos. Entretanto, o rápido crescimento e o desenvolvimento da chamada economia azul tornou a hidrografia mais importante do que nunca, em diversas outras atividades.

Por fim, o Diretor agradeceu e prestou homenagem aos hidrógrafos pela perseverança, o espírito de cooperação e o comprometimento de todos para que o serviço hidrográfico atingisse o atual patamar de excelência perante a sociedade brasileira.

WHD INCHILE



21 de JUNIO
DÍA MUNDIAL
DE LA HIDROGRAFÍA
1921 - 2014
Servicio
Hidrográfico y
Oceanográfico
de la Armada
de Chile
Errázuriz 254
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"La Hidrografía:
Mucho más que cartas náuticas"

MEDIA RELEASE
WORLD HYDROGRAPHY DAY - 2014

As every year since 2006, this year the International Hydrographic Organization (IHO) celebrated, along with its Member States, World Hydrography Day with the theme: "**Hydrography - Much more than just Nautical Charts".**

It may be be recalled that on 29 November 2005, the United Nations General Assembly adopted Resolution A/60/30, welcoming the adoption of "World Hydrography Day", to be held annually, on 21June, date when the IHO was established in 1921, at that time with the name of International Hydrographic Bureau.

The aim of this celebration is to highlight the work carried out by the Member States of the International Hydrographic Organization (IHO), in order to raise public awareness of the vital role of Hydrography in and for our society. The United Nations urges all States to work with the IHO to improve safety of navigation, particularly in the zones of international navigation, ports and where there are vulnerable or protected marine areas and also recognizes the contribution made by Hydrography to the socio- economic development of mankind.

Indeed, Hydrography is almost exclusively concerned with the production and availability of nautical charts covering the seas and oceans and providing the basic data to navigate from port to port, carrying and supporting? giving life to? maritime trade. Hydrography holds a very important place ? granted a prominent position? in the knowledge required to successfully conduct naval operations. However, although these activities remain very important, they are not the only ones taking place in the oceans and seas.

It should be borne in mind, and we should be aware, that all human activity carried out in, on or under the sea depends on the knowledge of the depth and of the nature of the seabed, the identification of the hazards that may exist and on an understanding of tides and currents. Obtaining and disseminating this hydrographic information is the role of the world's hydrographic surveyors and nautical cartographers.

The Benefits of Hydrography

- Hydrography contributes directly to the efficiency of maritime transport allowing shorter trips if new routes are surveyed, and allows the optimal loading of ships if the minimum depth of critical areas is known. Reliable hydrographic information also has an impact on the development of the cruise ship industry and recreational boating;

- Hydrography allows fishermen to not only navigate safely but also to avoid the loss of fishing gear on uncharted obstructions, to identify fishing zones and to avoid the zones where fishing is restricted or prohibited;

- Hydrography is a critical element in identifying habitats for fish ? the characterization and delineation of the habitats for fishes??, such as the right place for aquaculture areas;

- Hydrography supports defence and maritime security, allowing freedom of action for search and rescue operations and for naval operations - surface, submarine, anti-submarine, amphibious and locating of mines;

- Hydrography provides the main essential data for coastal zone management and development, including the construction or the development of ports and other coastal infrastructures, the dredging operations for the maintenance of the access to ports, and the monitoring and control of coastal erosion;

- Hydrography contributes directly in the identification and discovery of mineral resources under the sea. It is also critical for the selection of the routes for laying pipelines and submarine cables, for the selection of places to install wind power plants and oil and gas rigs as well as for all submarine construction and development;

- Hydrography supports the delimitation of the maritime boundaries as defined in the United Nations' Convention on the Law of the Sea (UNCLOS);

- Hydrography is the main ? control parameter in the dynamics of the oceans and supports the models for the prediction of natural phenomena such as tides, ocean currents and flooding caused by tsunamis, like the meteo-oceanographic forecasts. Hydrography supports the prediction of the possible spread and movement of oil slicks as part of plans to deal with hydrocarbon spills .

The role of Hydrographers in the world

Hydrographers work in both the public and private sectors.

Hydrographers working for the government are normally involved in hydrographic surveying carried out to improve nautical charts and for defence and security purposes, as well as to provide a reliable database for maritime geospatial information systems. Hydrographers in the private sector are often involved in specialized tasks that include high resolution surveys for the laying of pipelines and submarine cables, the installation of offshore structures, including wind power plants, oil and gas rigs and investigations for the creation of new ports. They also conduct studies, under contract, to improve nautical charts.

Hydrographers use echo sounders, high definition sonars in boats and ships, lasers from aircraft and sometimes satellite imagery to obtain accurate and precise depth measurements. They also need to be experts in precise positioning and in the measurement of currents and tides.

For their part, nautical cartographers compile the data from hydrographic surveys and from other sources and reflect it on the nautical charts and in other marine geospatial products and services. Traditionally, charts are printed on paper but now, increasingly, they are also produced in the form of digital electronic charts. Nautical charts follow international standards, established by the IHO, to ensure that they can be used and understood by all mariners - anywhere in the world. To make optimal use of all the available hydrographic data, it is important to make it readily accessible through interconnected digital georeferenced databases, whose data can be obtained via web-based interfaces.

The Role of the IHO

The IHO has 82 Member States and its main role as an intergovernmental organization competent for hydrography, nautical charting and related matters, is to ensure that all the world's seas, oceans and navigable waters are properly surveyed and charted.

The role of the IHO includes the maintenance of international standards, which are wide-ranging from those defining the training and experience required by hydrographers and nautical cartographers to the reliable and timely dissemination of information concerning Maritime Safety to ships at sea. Publications related to hydrographic information applications for purposes other than navigation, such as the Guidance in the Establishment of Infrastructures for Marine Spatial Data and the Manual on the Technical Aspects of the UN Convention on the Law of the Sea, are published and also maintained by the IHO.

As part of its objectives to have hydrographic data used as widely as possible, the IHO has a number of data standards. The latter is known as the *S-100 – The IHO Universal Hydrographic Data Model.*

The S-100 is based on, and is compatible with, the ISO 19100 standards for geographical data and allows to easily merge hydrographic data with other geographic non-hydrographic data - especially in the Geospatial Information Systems (GIS). Like the IHO, a growing number of international organizations with various maritime interests are adopting the S-100 as the standard for data exchange, amongst them the International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA), the World Meteorological Organization's (WMO) Joint Technical Commission for Oceanography and Marine Meteorology (JCOMM) and the Intergovernmental Oceanographic Commission (IOC) of UNESCO.

The IHO also publishes other publications relating to hydrography, such as the Hydrographic Dictionary in three languages and a Manual of Hydrography.

Developing standards, obtaining their official approval and use requires far-reaching international cooperation and the involvement of many other organizations.

The Inter-Regional Cooperation

Another role of the IHO is to help to coordinate and improve cooperation in hydrographic activities among countries at a regional level and between the regions to provide consistent and reliable services to the mariners and decision-makers. This is mainly achieved through the creation, by the Member States, of the 16 IHO Regional Hydrographic Commissions that coordinate the charting services in the world. Chile participates actively in two of them: the South East Pacific Regional Hydrographic Commission and the Hydrographic Commission on Antarctica.

The IHO has an active Capacity Building programme helping countries to develop and improve their hydrographic capabilities. The Capacity Building projects are often carried out in cooperation with other international organizations and through the increasing participation of industry and academia.

As you can understand, Hydrography is really much more than just Nautical Charts.

SHOA's Main activities

Chile, by means of the law 16771, published in the Official Journal N° 27.000 dated 22 March 1968, established that SHOA would be the Official, Technical and Permanent Service of the State in all that relates to Hydrography, Nautical Charting, Oceanography and other related disciplines. The former Hydrographic Office, today SHOA, was established in 1874 and, since then, has systematically carried out hydrographic surveys of our sea leading to the production of nautical charts and generating a marine spatial database constituting a valuable national heritage. It should be noted that the first hydrographic survey on record in our country is the surveying of Rio Bueno in 1834, which illustrates the early and permanent maritime vocation of our country. On the other hand, Chile as one of the 19 founding members of what is now the IHO agreed and decided its establishment to coordinate global hydrographic activity, which reveals Chile's vocation in terms of international collaboration and cooperation.

SHOA is composed of professional, technical and administrative staff, Officers and Civilian Employees and Mariners, as well as personnel under contract, that together form a highly specialized body trained in the latest technologies characteristic of their role.

Hydrographers working at SHOA participate in surveys undertaken to improve nautical charts and to provide a reliable database for marine geospatial information systems; they use echo sounders, high definition sonars in boats and ships and satellite imagery. They are also specialized in precise positioning and in the measurement of currents and tides.

But as is implied in the theme of this year's World Hydrography Day, Hydrography is much more than just Nautical Charts and that is why at the national level, the hydrographic efforts of SHOA have also been focused on supporting the delimitation of the maritime boundary with neighbouring countries; on the search of stricken aircraft and ships; on the determination of the Continental Shelf and the management of the coastal zone; in addition to the constant support to maritime transport and to the safety of life at sea.

WHD INJAPAN

Following the theme of World Hydrography Day 2014, “Hydrography–more than just nautical charts", various approaches were taken in Japan, in not only Japan Coast Guard Headquarters but also each Regional Coast Guard Headquarters, and were taken up by the newspaper and so on, which contributed to the enlightenment of the World Hydrography Day.

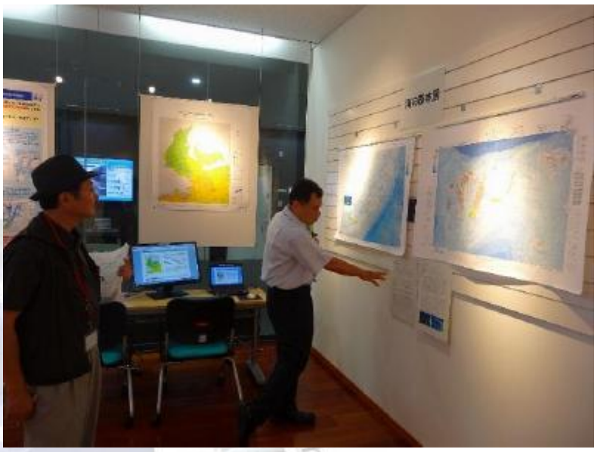
In Tokyo, at the meeting of the Directors of Regional Hydrographic and Oceanographic Departments June 23-24, the discussion on "The regional hydrographic services and what their future should be" were done given the theme of the World Hydrography Day, especially on the efficiency of services and human resources development.

Furthermore, aiming at enlightening the World Hydrography Day, a special exhibition was held during June 2-30 in the Hydrographic and Oceanographic Museum at the JHOD building. The exhibition showed the charts of major ports in the world in addition to the introduction of the JHOD approaches to the marine cadaster, the tsunami hazard map, and the international cooperation taking this year's theme.

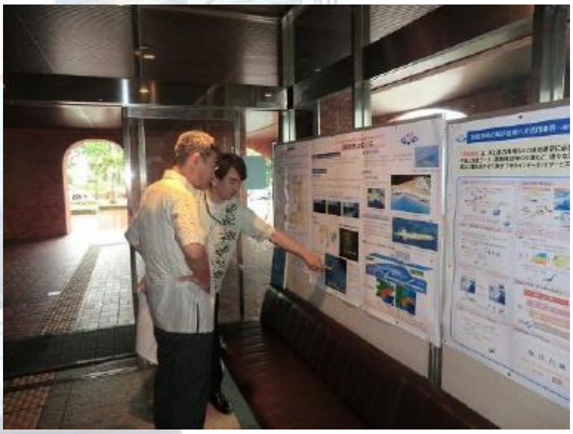
Poster of WHD in Japanese

Meeting of the Directors of Regional Hydrographic and Oceanographic Departments

Also in each Regional Hydrographic Department, various events for public awareness of WHD were done such as displaying poster and hands-on study of the survey ship to the public, being taken up by the newspaper etc., which greatly contributed to the enlightenment of the hydrographic services, the role of IHO etc.



Exhibition at the Hydrographic and Oceanographic Museum



Exhibitions at Regional Hydrographic Departments

Hands-on study of the survey ship

JCG mascot "Umin"

WHD IN MAURITIUS

His Excellency the High Commissioner of India, Mr Mudgal
Senior Chief Executive,
Distinguished Guests,
Ladies and gentlemen,

It is a matter of pride for me, to be associated with the Hydrographic community to celebrate the World Hydrography Day this morning. This year the theme as promulgated by the International Hydrographic Organisation is "Hydrography – much more than just nautical charts."

Mauritius being an island nation with a large Exclusive Economic Zone requires the expertise in the field of Hydrography for overall national development and has the responsibility to provide safety of navigation services in its area of jurisdiction. Sea borne trade, one of the key elements of our national development largely depends on the safe navigation of sea going ships engaged in trade, at our ports, along the coast and across the seas. I wish to mention that Mauritius is also signatory to the International Maritime Organisation (IMO) and Convention of Safety of Life at Sea (SOLAS).

The source data to the charts available in Mauritius dated back to the 19^{th} Century. As you may be aware, the hydrography surveying has evolved from hand led and line to modern day digital bathymetric equipment. Although this transition from manual methods to new technology has been gradual, Mauritius was left behind in this field due to lack of expertise.

In October 2005, following the visit of the Honourable Prime Minister to India, a Memorandum of Understanding on Hydrography was signed between the two countries. The MOU provides for the setting up of a hydrographic infrastructure in Mauritius; the purpose of which is to develop a national maritime policy with a basic knowledge of the geographical, geological and geophysical features of the seabed and coast, as well as the currents, tides and certain physical properties of the sea water.

This Memorandum of Understanding has been a very fruitful one and has resulted in successful completion of 26 hydrographic surveys in our waters with the assistance of yearly visit of Indian Naval ships. As a result 6 charts were published covering areas of mainland Mauritius, Agalega, St Brandon and Rodrigues and are available for sale at my Ministry to common public and the maritime community. It is worth mentioning that such hydrographic survey exercises are very expensive and the Government of India has gracefully provided these services free of cost. The charts produced for Mauritius are world class and the technology available for production of Nautical Charts are State of Art products and are *at par* with international standards and specifications. These charts are on display at this exhibition and are also available for sale.

A safe navigation requires an accurate and up to date navigational chart, the basic and indispensable instrument of marine navigation. Mauritius is geographically and strategically positioned. Accordingly, development of maritime trade can be exploited and expanded, hence the importance of having our own set up to streamline the vast requirements of mariners.

In February 2013, an Inshore Survey vessel "Pathfinder" was donated by the Government of India. The vessel is equipped with modern acoustic underwater sensors, high precision positioning fixing systems, automated data logging system and other conventional and contemporary survey equipments. During this exhibition, you will have the opportunity to witness the capability of these equipments.

Furthermore in October 2013, the Indian Government provided the assistance of a hydrographic team led by a Commander and 2 Petty Officer Surveying Recorders to give the necessary push towards developing infrastructure for hydrography in Mauritius. Since its set up, the Hydrographic Unit has completed many important tasks. Just to mention a few:

(a) streamlining of survey equipments and procedures for using the Inshore Survey Vessel Pathfinder;
(b) hydrographic survey of Port Louis Harbour and its Approaches;
(c) Helicopter Coast lining of Port Louis area;
(d) precise delineation of Islets off Mauritius Container Terminal;
(e) training of Land Surveyors and other stakeholders; and
(f) rendition of data for delimitation of maritime boundary.

This exhibition also shows the works undertaken by officers of the Hydrographic unit of my Ministry since its setting up and the various facets of hydrography contributing to the economic growth of our country.

To conclude, I would like to emphasize that hydrographic surveying and services have a crucial role in the safety of life at sea, as well as in economic growth and the sustainable development of a Nation. In furtherance to the concept of the blue economy, it is essential for the capture of basic hydrographic information, towards exploring the oceans for food, biomedical research, natural and mineral resources and coastal development, thereby contributing significantly to national development.

It is now my priviledge and honour to hand over to his Excellency, the High Commissioner of India, Mr Mudgal, the first indigenous sheet produced by the Hydrographic Unit of my Ministry.

KEYNOTE ADDRESS ON THEME OF THE YEAR BY HONOURABLE MINISTER OF HOUSING AND LANDS, MAURITIUS

PRESENTATION OF FIRST INDIGENOUS FAIR SHEET FOR MARITIME COMMUNITY

EXHIBITION OF SURVEY EQUIPMENT

OPEN DAY- INSHORE SURVEY VESSEL PATHFINDER

WHD IN NIGERIA

https://www.youtube.com/watch?v=yy7wNcXSkTA

WHD IN POLAND


HYDROGRAPHIC OFFICE OF THE POLISH NAVY

Polish version

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Birthday: Amadeusza, Gwidy i Sylwiny.

12 September 2014

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News

25th July 2014
NEW EDITION OF CHARTS NO 53, 63, 65, 68, 256 & 257

10th July 2014
World Hydrography Day Celebrations in Poland

30th May 2014
NEW EDITION OF CHARTS NO 15 (INT1299), 48 (INT1298), 251 (INT1218), 252 (INT1219) & 500 (INT1021)

29th April 2014
THE NEW, № 6 C PERIODICALLY PROHIBITED ZONE !

10th March 2014
NEW EDITIONS OF SMALL CRAFT CHARTS NO 3020 AND 3021

31st January 2014
NEW EDITION OF CHARTS NO 47 (INT1297) & 75 (INT1296)

30th October 2013
New № 55 Chart

23rd August 2013
NEW EDITION OF CHARTS NO 74 (INT1295), 154 (INT1294), 113 & 255

Main Office Location

A A A

Gdynia 10th July 2014

WORLD HYDROGRAPHY DAY CELEBRATIONS IN POLAND

This year, the theme for the World Hydrography Day was *Hydrography – much more than just nautical charts.* In Poland, extraordinary, the Day was celebrated on 28 June and was combined with the nationally celebrated Maritime Days.

In that day, 28 June, in the most prestigious part of the City of Gdynia, the Kosciuszko Square, next to the ORP Błyskawica Polish Navy museum ship, an exhibition of hydrographic achievements, instruments, and the way they are deployed was arranged. The exhibition also presented a wide range of hydrographic works from the self-evident that secure the safety of navigation to the supporting the development of green energy like surveying areas for the future farms of wind generators. Four hydrographic boats were open to the public, including the MH1, the newest and state-of-the art one.

As another development, a conference was held devoted to the status of current hydrographic works. During the conference, many interesting presentations were given, all including references to the 2014 WHD theme.

It should be emphasised that all events of the WHD were open to the public and were a joint project of the Hydographic Office of the Polish Navy, Maritime Office of Gdynia, and Polish Hydrographers Society.

Wersja do druku   Prześlij artykuł

WHD IN THE USA

HYDROGRAPHY–
MORE THAN NAUTICAL CHARTS

June 21, 2014

Every year, the international hydrographic community celebrates World Hydrography Day on June 21. This year's theme, established by the **International Hydrographic Organization**, is "Hydrography – More Than Nautical Charts." To further the discussion, NOAA's Office of Coast Survey invited the public to contribute articles that illustrate the theme. This publication is the result.

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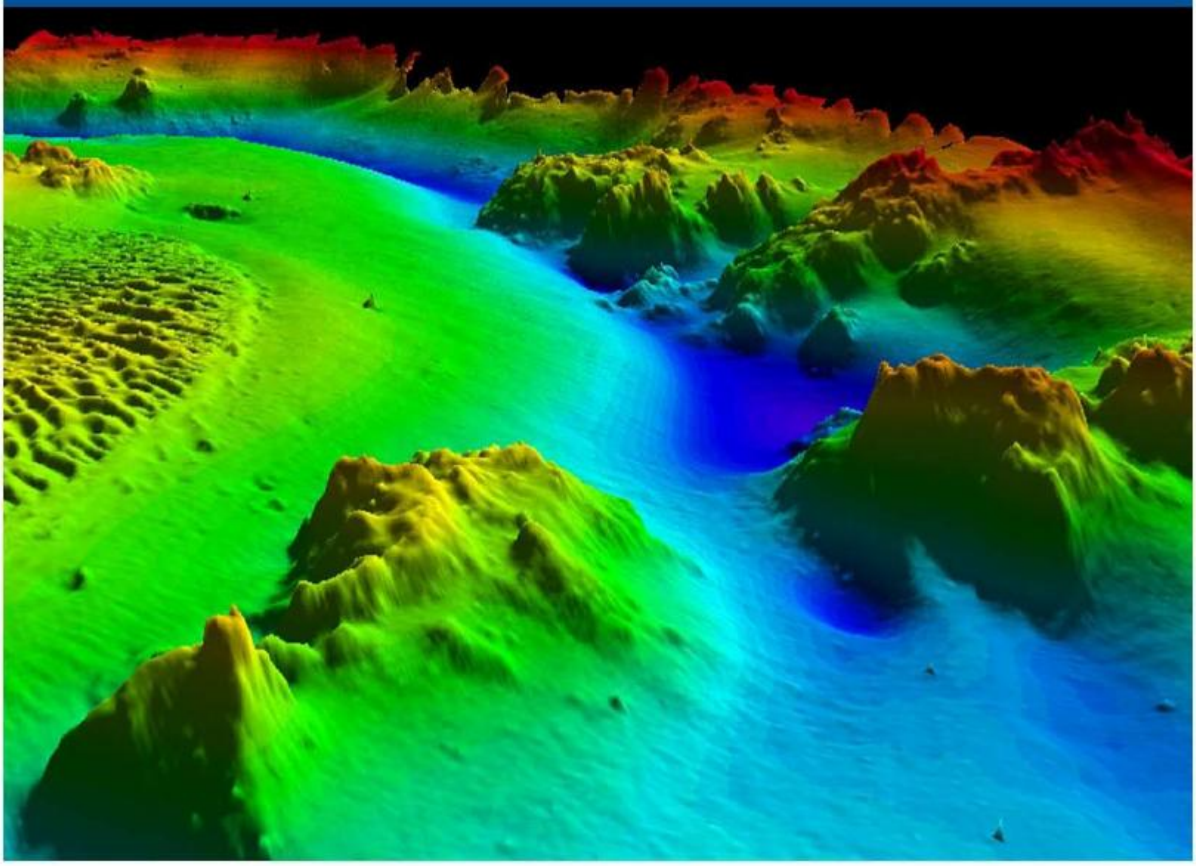

NOAA's Office of Coast Survey is the nation's nautical chartmaker. Originally formed by President Thomas Jefferson in 1807, Coast Survey updates charts, surveys the coastal seafloor, responds to maritime emergencies, and searches for underwater obstructions that pose a danger to navigation. Follow Coast Survey on Twitter **@NOAAcharts**, and check out the NOAA Coast Survey blog at **noaacoastsurvey.wordpress.com** for more in depth coverage of surveying and charting.

NOAA
Office of Coast Survey
1315 East-West Highway
Silver Spring, Maryland 20906
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HYDROGRAPHY– MORE THAN NAUTICAL CHARTS

June 21, 2014

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Introduction

Human activity conducted in, on, or under the sea is made safer by knowing the depth and the nature of the seafloor, identifying dangers to navigation, and understanding the tides and currents. Hydrographers obtain this knowledge and use it to contribute to the maritime economy and coastal resilience.

Marine chart makers are probably the most familiar users of hydrographic data, but this data is also valuable to many other industries and communities. The 2014 World Hydrography Day theme—"Hydrography – More Than Nautical Charts"—raises awareness of the widespread benefits of hydrographic data beyond its traditional use for navigation.

The articles in this collection, contributed by government and private experts, reflect the diversity of users of hydrography, with interests from marine ecology, archeology, energy and water resource management, and emergency response.

John Cloud tells how hydrography helped restore oyster beds in the late 1800s – and how that early work may help to restore oyster beds in North Carolina today. **George Cole** reports on using LiDAR hydrography to develop minimum flow standards for Florida water management districts. **James Delgado** and **Vitad Pradith** describe how hydrography helped NOAA positively identify the 1860 wreck of the U.S. Coast Survey steamer Robert J. Walker, and brought long-delayed honor to the 21 lost crew members. **Paul Donaldson** recounts the contributions of hydrographic operations to local economies after hurricanes. **John Hersey** and **Paul Cooper** discuss the emergence of crowdsourced bathymetry as a next-generation hydrographic tool. **Joyce Miller** explains how a continuing collaboration is using hydrography to conserve coral reefs in the Pacific. **Alison Pettafor** provides two articles: one describes how bathymetry data can determine damage to underwater pipelines, and the other shows the use of hydrography to monitor and detect problems with wind turbine seafloor foundations. **Aurel Piantanida** provides an overview of the use of hydrography in speeding the resumption of commerce at ports hit by hurricanes. Finally, **Kevin Tomanka** winds up the collection with a provocative question: are you a hydrographer? You might be surprised at some of the answers.

Oysters, Hydrography, and Francis Winslow

By John Cloud

It was 1876, and Carlile Patterson, the Superintendent of the Coast Survey, had a problem. American fisheries were declining rapidly, on every coast, and the federal government had finally begun to address maritime conservation. The Survey had been ordered to study the distributions of oyster beds in Chesapeake Bay. The Survey was the oldest federal scientific agency, but it knew nothing about oysters. Patterson had another problem: his only daughter had married Francis Winslow II, a young Navy officer who needed a mission. Patterson solved both problems by charging Winslow to lead the oyster research. The methods he developed are still standards in oyster ecology, and his original distribution data, especially from the coast of North Carolina, are now foundational for oyster bed restoration 130 years later.

Young Francis Winslow II. One of Winslow's descendants gave this photograph of young Navy officer Francis Winslow II to the NOAA Photo Library.

The Beginnings of American Oyster Research

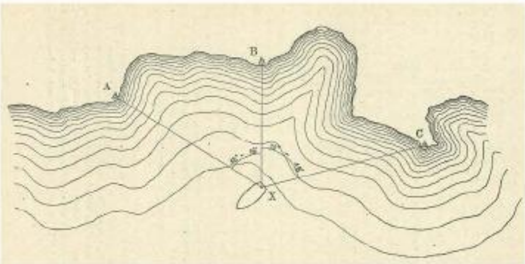
In a real sense, sophisticated knowledge of oysters and other American shellfish by Native Americans goes back many centuries or even millennia. But their harvesting levels and methods were scaled for local consumption and/or small regional trade and commerce. By the nineteenth century in the United States, oysters were food for the masses, both rich and poor, and they could travel in barrels of salt water in railroad cars, across the country. Oysters filter-feed in murky water, making it difficult to observe them directly. Oysters were encountered by dragging dredges and cages through the water, or gathering them with tongs from directly above. Oysters live on top of other oysters, both living and dead. The very act of harvesting them disrupted these beds, leading rapidly to a strange state of affairs. Oysters were harvested and consumed in staggering quantities, yet their distributions and habits and life cycles were little known. Further, those watermen who did know oysters didn't talk much about them, to safeguard "their" beds from harvest by others. "Oyster pirates" have worked American midnight waters for a very long time.

Francis Winslow, once tapped to begin Coast Survey research on oysters, began a two-pronged strategy: he would apply the by-now familiar skills of Coast Survey geodesy and hydrographic mapping to these mollusks, and he would begin fundamental studies in the biology and development of oysters, a research frontier completely beyond anything the Survey had ever attempted.

The Geodesy and Hydrography of Oysters

Oysters, like all creatures, inhabit three-dimensional habitat, but the three dimensions are very different. Oyster beds are in fixed locations with specific horizontal positions, relative to the lands and water around them; but everything about their vertical positions is different and dynamic. The oyster beds are more or less deep in waters whose depths change constantly with the tides and winds. The waters flow in shifting currents, essential to filter feeders for their very existence, as the nutrients they need must come to them. The substrates of the beds also change over time, sometimes slowly and progressively, sometime catastrophically, as when a hurricane passes over.

Francis Winslow first addressed the horizontal positions of the oyster beds by linking the science of Coast Survey geodesy to the knowledge of watermen. From the beginning, he stressed finding local knowledgeable oystermen who could and would locate the oyster beds as they worked the dredge lines on the Survey boat. At the same time, Survey personnel would "shoot" angles between prominent features on shore or on islands visible from the boat. These angles and lines could then be used to determine the position of the boat in the water at the spot where oysters were found.



Shooting angles from the boat. Image from the 1912 annual report of the Maryland Shell Fish Commission.

The key to the process was that the Coast Survey had already developed a geodetic triangulation network for Chesapeake Bay and its major tributaries, making prominent points "known" and mapped. Boat positions calculated relative to these same prominent points then themselves became known, and hence also the oyster bed below. Winslow's first oyster trials were on stretches of the lower James River in Virginia. The James had been positioned and mapped the year before, in 1877. The maps were meant as aids to navigation, emphasizing shoreline details and river depths and shoals, but nothing further. In 1878, Winslow and company used the very same prominent points, and the maps, to drag dredges and seek out the full extent of the oyster beds. His resultant maps are not aids to navigation, but are aids to oysters. Shoreline features are omitted, but great attention is given to mapping the positions and extents of specific oyster beds.

The 1877 chart of a section of the James River, and the same section and its oyster beds, as mapped in 1878. Coast Survey chart 401A, James River, 1877, and the 1878 special version of the chart with oyster data.

Both maps show similar sounding numbers, meaning the mean depths of the river's waters at those specific spots, as determined by "sounding" with a lead weight on the end of a line. A small cup on the bottom of the lead allowed a tiny sample of the bottom to be brought back up, indicating the bottom there was sandy, or hard, or sticky. But in the second effort, Winslow began to gather other data as he dropped the lead lines, such as instruments to capture samples of the water at different depths. Uniform volumes of water that weigh slightly different weights do so because they are more or less salty- salt water is heavier than fresh water – so by determining the density of the water, called "specific gravity" in Winslow's day, Winslow could calculate how salty the water was at different depths and times. This was essential data about the biology of the bivalves.

Oyster Biology Comes to Light

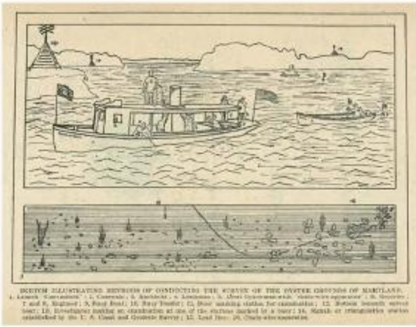
Winslow's boat for oyster work was a schooner, the Palinurus, built in 1873 for hydrographic surveying. By 1879, Winslow had fitted the boat with aquariums and was raising oysters from their tiny, all but invisible beginnings as spawn. He acquired compound microscopes to observe and measure the developing spawn, and their subsequent stage as spat, and learn all that he could about them. He discovered that other even smaller and seemingly benign mollusks were in fact vicious predators of young oysters – a fundamental discovery, far beyond the observing powers of even the most dedicated oysterman.

Much of Winslow's work in its initial phase, in the waters of Chesapeake Bay, culminated in Winslow's 1881 report on the oyster beds of the James River, and Tangier and Pokomoke Sounds in Maryland and Virginia. It was a landmark in oyster science.

Cluster of oysters and sponge. Image from Appendix No. 11, Annual Report of the Superintendent of the Coast and Geodetic Survey for 1881, "Report on the Oyster Beds of the James River, Virginia, and of Tangier and Pokomoke Sounds, Maryland and Virginia," by Francis Winslow

The Winslow/Coast Survey Method

The Palinurus was a sail-powered schooner, which was ultimately impractical for oyster research. The key to determining the beds and the densities of the oysters was the ability to drive the boat through the water with sufficient force to drag dredges and other samplers and acquire bottom samples reeled back to the boat. Those samples, and their horizontal positioning through triangulation, were the heart of the process. Winslow acquired powerboats and refined his techniques.



Schematic diagram of oyster work. Image from the 1912 annual report of the Maryland Shell Fish Commission.

This schematic diagram of how and by whom the oyster bed mapping was done was actually published by the Maryland Shell Fish Commission in 1912, four years after Winslow died in Connecticut, long retired from his oyster work. But Winslow's methods were still used universally, and remained in practice until the end of the 20th century, when cheap differential GPS positioning allowed the sextants and signal flags to be retired. The foundational positioning is that of the signal towers, tied into the larger geodetic network. Some crew members shoot angles for the horizontal positions, while the leadsman drops the lead to determine the depth and nature of the bottom. But a key to the oyster research is still the "local oysterman attending chain-wire apparatus" because it is he who is determining the oyster beds. The crew member in the small trailing boat then puts weighted buoys in the water to outline the beds, so that the beds are "mapped" both on the water, and in the resultant maps. Far behind in the schematic is a tiny boat, with the caption "Launch 'Investigator' anchored at station for examination."

Launch "Investigator." From the NOAA Photo Library.

Always paired with the boat mapping the oyster beds was the biological survey boat, in this case the "Investigator." It was a powered launch that could pull a dredge and winch samples from the bottom. Oysters could be counted, weighed, examined for health and disease, or any other kind of field work appropriate to that boat and its crew. Both boats functioned together, to determine position and biology, a practice that became universal.

Winslow Goes to North Carolina

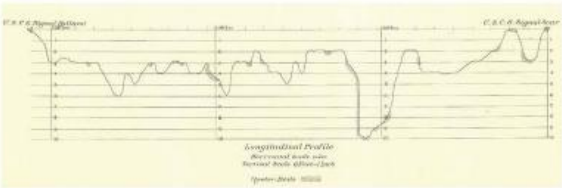
By the 1880s the Winslow methods, if not Winslow himself, were at work all along the Atlantic coast. Winslow himself shifted to a major collaborative project between the Coast and Geodetic Survey, as it was now called, and the state of North Carolina. Their plan was to map and analyze the oyster beds of all twelve of the great sounds of the North Carolina coast.

Northeast Portion, Chart of Sections, County Lines, and Public and Private Oyster Grounds in North Carolina, 1888. Image from NOAA CDMP project, original map in the Coast and Geodetic Survey's Library and Archives Collection, in National Archives II.

Winslow's descriptions of oyster beds grew increasingly sophisticated and fine-grained. He had started with the horizontal positions of the beds – now he was defining their three-dimensional structure and relationships to the bottom substrates and current.

Section of the White Oak River estuary between stations Holland's Point and Scar, 1886. Image from NOAA CDMP project, original map in the Coast and Geodetic Survey's Library and Archives Collection, in National Archives II.

In the estuary of the White Oak River, for example, he sounded the depths and mapped the oyster beds as usual. But then he established a survey line between two stations, Holland's Point and Scar. Keeping his survey boat steadily in-line between the points, he did minute sampling of the bottom terrain and where oysters were situated relative to the bottom topography.

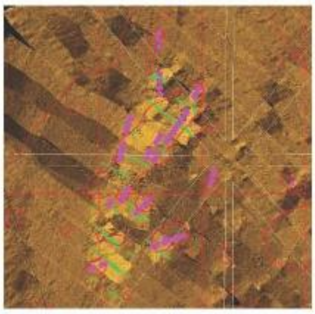


Longitudinal profile of the oyster beds between Holland's Point and Scar. Image from NOAA CDMP project, original map in the Coast and Geodetic Survey's Library and Archives Collection, in National Archives II.

Many of the oysters were clustered in small beds on the tops of small rises, all about the same depth below the surface. But the largest beds were associated with the deeper channels running through the river bottom, where Winslow documented stronger currents and more nutrients streaming by. Examination of the profile reveals the results of years of dedicated and successful research.

Winslow Returns to North Carolina

The oyster beds of North Carolina, like those of all other states, declined from over-harvesting, poor management in general, and the effects of increasing coastal development and pollution. Almost a century after Winslow's death, projects for oyster restoration began in North Carolina. A modern waterman there, Gene Balance, re-discovered the oyster maps and reports of Winslow and his staff, and decided to "bring them back" into contemporary research and practice for oyster restoration. Oysters favor growing on sites already inhabited by other oysters. But if the oysters have been depleted and lost, then where are the best sites to attempt to relocate new oysters? Ballance reasoned the best contemporary sites would be the same sites where Winslow had mapped the most oysters over a century before. But how could underwater beds mapped in the 19th century based on temporary signal stations set up on sand dunes and barrier islands be correlated with modern maps and GPS?



GIS Display correlating Winslow's oyster beds as mapped (red polygons) and oyster densities spot-sampled by Winslow (pink blobs) with present oyster beds mapped by side-scan sonar (golden areas) compared to bottoms without oysters (light and dark browns). Courtesy Gene Balance, Okracoke, North Carolina.

Gene Balance's answer is that it can be done, once one has mastered the same kind of geodetic skills that Winslow and company possessed to do the maps in the first place. In particular, Balance has concentrated on the raw data survey books of angle measurements and soundings, with their associated data on the nature and size of the oyster beds obtained by dredging from boats like the "Investigator." Balance has found that the fine survey data is more accurately positioned than the mapped oyster beds, although far more difficult to correlate with the modern positional frame than the maps. But as the figure shows, Winslow's 1888 data, derived by eye and by hand, correlates quite well with Balance's contemporary GPS-driven side-scan sonar mapping of the very same oyster bed.

Lieutenant Francis Winslow, U.S. Navy and Coast and Geodetic Survey, in his last known photograph. One of Winslow's descendants gave this photograph of Francis Winslow II as a mature oyster scientist to the NOAA Photo Library.

And thus Francis Winslow, who began American scientific oyster research in the nineteenth century, has now returned, through his maps and notebooks, to guide and assist oyster ecology and restoration in the twenty-first century. The world remains his oyster.

About the author

John Cloud grew up in West Texas and the great arid west. He didn't see the ocean until he was 18 years old, so he has been making up for it since, with a research focus on maritime cultural landscapes. He has a Ph.D. in geography from UC Santa Barbara and is now a NOAA contract historian of the Coast and Geodetic Survey and the other legacy agencies that became NOAA.

Test of Airborne LiDAR Hydrography for Managing Florida's Water

By George M. Cole, PE, PLS, Ph.D.

Florida's water management districts are required by statute to develop minimum flows and levels for all of the state's waters for regulatory purposes. The levels serve as a baseline for regulation as well as for any remedial measures necessary to protect the waters. To establish the levels, hydrographic models of the waters and the bordering flood plains are used to develop the hydrological models used in the regulation process.

Because a large part of the state's waters are located upstream of the coverage of existing hydrographic surveys performed by NOAA and its predecessor, the Coast and Geodetic Survey, additional surveys are required. Many of these waters, especially those in North Florida, are under or bordered by heavy tree cover and have areas of rocky shoals and shallow depths. In some areas, the rivers even go underground into the karst subsurface. Thus, conventional hydrographic surveys are difficult, expensive, and sometimes impossible. For example, the tree canopy makes GPS technology impractical for control purposes, and the long sinuous waterways restrict the use of conventional control by traverse and levels. Further, the shallow water and rocky shoals restrict the use of multibeam and even single-beam fathometers. As a result, survey teams have had to consider non-traditional means to acquire the necessary hydrographic data.

Airborne LiDAR (Light Detection and Ranging) is an obvious consideration for such surveys, with its capability for mapping the topography of tree-covered areas, and the technology is currently widely used to map the flood plains bordering Florida's waters. However, the LiDAR systems more commonly used for such topographic mapping use lasers with a wavelength in the infrared spectrum, which tends to reflect off water surfaces. Thus, data from infrared mapping is not useful for hydrographic measurements.

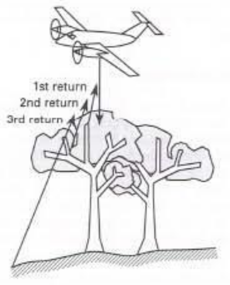
Recently, LiDAR systems that are reportedly capable of bathymetric measurements have become commercially available. This may be a good solution for obtaining both the bathymetry and the topography with one system under the existing adverse conditions. As a result, the Suwannee River Water Management District (SRWMD), with technical support from the Southwest Florida Water Management District (SWFWMD), has tested one such system in an area along the Suwannee River.

Based on preliminary data from the survey and very limited analysis, it appears that LiDAR hydrography offers a useful tool for surveying clear water bodies with results in the test area obtained in depths greater than 25 feet. However, it appears that problems result in areas with more turbidity, such as the Suwannee River. Some bathymetric measurements in the problem areas look reasonable, but others do not. Hopefully, as we analyze the results from this test in greater detail, including examining the intensity values and ground truth comparisons, it will be possible to derive a method to sort the "wheat from the chaff" for such areas and obtain bathymetric measurements from the river portion of this test area. In addition, the analyses we have planned will hopefully result in a good feel for the accuracy of this new technology as well as limitations on its use. Stay tuned for exciting news.

It is interesting that this approach to hydrography, although it uses the latest technology, follows the tradition of early Coast Survey charting efforts. Those surveys typically incorporated not only bathymetry, but also the topography of the surrounding coastal land. Today those early surveys, which included producing the well-known "T Sheets" covering the bordering coastal areas together with bathymetric soundings, provide an amazingly detailed and foresighted graphic description of the coastal areas of the early United States. The technology that is the subject of this article also does that, all in one operation.

Bathymetric LiDAR Systems

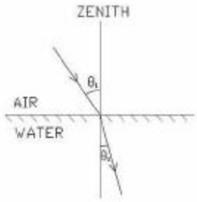
Airborne LiDAR is a relatively new technology for aerial mapping. LiDAR systems transmit timed laser pulses and measure the time delay for a portion of the pulse to be reflected off the ground or aboveground feature and return to the source. The laser is projected by means of a mirror that rotates rapidly from side to side perpendicular to the line of flight. Airborne LiDAR systems typically include a geodetic grade airborne GPS receiver that measures the position of the aircraft every second, together with an inertial measurement unit (IMU) that determines the aircraft's orientation (pitch, yaw and roll) about 200 times a second. Information from these components allows the system to determine a precise position and orientation for each point from which a pulse is reflected. That information, together with the scan angle and the time delay for the pulse to reach and return from a point on the ground, is used to calculate a 3D position for each ground point by trigonometry. Although the laser beam is only about a micron wide at its source, it expands to as wide as two feet or more before it reaches the ground. Therefore, the beam may hit several surfaces, such as tree branches, as it approaches the ground. As a result, several different reflections may be recorded from a single pulse.



Multiple returns for a LiDAR pulse

The use of LiDAR for hydrography has been frequently discussed in literature (e.g., Guenther 2000, LaRocquel et al. 2003, Wozencraft and Millar 2005). Nevertheless, commercially available systems for that application have only very recently become available. One factor that restricted earlier airborne LiDAR systems from such use was the wavelength of the laser pulse. Most commercial airborne LiDAR systems for land applications use lasers with wavelengths between 800 and 1550 nm. The pulses from such systems tend to be reflected from the water surface. In contrast, LiDAR systems designed for bathymetry use two systems: one in the infrared spectrum, with a typical wavelength of 1064 nm, and another in the green spectrum, with a typical wavelength of 532 nm. The infrared wavelength signal is reflected by the water surface and thus determines the distance to the water surface. The green wavelength penetrates the water and is reflected from the submerged land surface. Since the longer wavelength LiDAR may also work in the topographic mode, both the submerged land as well as the bordering upland topography may be surveyed using the same system. With claimed penetration depths of up to 50 feet with favorable turbidity conditions, LiDAR bathymetry could reduce operational costs and increase productivity considerably compared with sounding with hydrographic vessels (Vosselman and Maas 2010).

One important consideration with bathymetric LiDAR systems is refraction. Light waves bend when they enter water because of the difference in the speed of light in air and water. Therefore, to calculate a precise position for a bathymetric measurement, it is necessary to apply a correction for the angle of refraction based on Snell's Law as well as for the different speed of light in water. Since the green laser pulse is also subject to absorption and scattering as it passes through the water, bathymetric LiDAR systems also need higher energy than systems for
land applications.



Refraction

Project Site

The test project area is centered on Manatee Springs State Park near Chiefland, Florida. That park area includes a first-order spring with an average flow of over 100 million gallons per day that is home to numerous manatees each winter. From the spring basin, the water flows through a run for about a quarter of a mile to its confluence with the Suwannee River proper. The spring basin, the run and the surrounding flood plain have a dense tree canopy. The coverage of the test included the spring basin itself, the spring run leading from the basin to the Suwannee River, and the river for about 1000 feet above and below the confluence. The area was chosen to provide a wide range of depths and turbidity conditions ranging from the clear spring water at the springhead to the more turbid Suwannee River, as well as to represent an area with adverse tree cover conditions.

Limits of test area (lines crossing the project limits indicate flight paths for the LiDAR survey)

LiDAR Data Acquisition

The mapping firm of Aerial Cartographics of America, Inc., under contract to the SRWMD, performed LiDAR data acquisition and processing for this test. For this task, a Riegl VQ-820-G hydrographic airborne scanner was used. That system uses a lower-frequency signal of 532 nm in the green range and an infrared system with a wavelength of 1064 nm. The system is reportedly capable of water penetration of up to 10 meters in less-than-perfect water conditions as well as good results through dense vegetation.

The test area was flown on February 3, 2014, using the Riegl scanner together with a Microsoft Vexcel UltraCamX large format digital camera. The LiDAR Data acquisition was flown at an altitude of 550 meters above ground level for a minimum point density of two points per square meter in open areas. The photography was flown at an altitude of 7500 feet for a seven-inch pixel. Airborne GPS and inertial measurement unit (IMU) technology controlled the position and orientation of the sensors during the flight. A GPS base station was operated during the flight at the near-by Cross City, Florida, airport for differential corrections. In addition, several photo-identifiable ground control points were established for control of the mapping by SWFWMD and SRWMD personnel using GPS observations referenced to the high-accuracy Florida Permanent Reference Network.

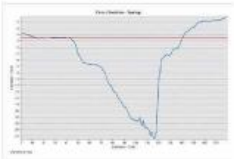
Keith Rowell (left) and Jim Owens established ground control for survey.

LiDAR Date Processing

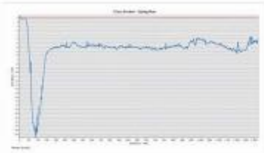
The LiDAR measurements were processed using the Riegl RiProcess software for mobile and airborne applications. Using the infrared signal, that software models a polygon on the surface of the water around where the green signal enters, and then it uses Snell's Law to correct the green path for refraction based on the slope of that polygon. As a result, if there are waves in the water, the most correct path for the signal is determined. That software also uses a differing value for the speed of light in the water path than in the air and applies a particulate filter to remove stray returns along the path through the water. The LiDAR products resulting from the processing included a digital elevation model (DEM) and a standard LASer (LAS) file with points classified as to the nature of the object per ASPRS standards.

Graphic Review of LiDAR Data

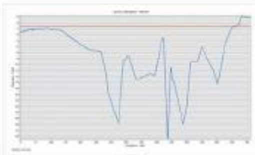
Using the DEM, typical cross-section was created in ESRI ARCGIS across the spring basin, along the approximate center line of the spring run, and across the Suwannee River. As may be seen from the three cross-sections, the LiDAR data appear to reasonably reflect the true profile in the basin and run for Manatee Springs, but not in the adjacent Suwannee River.



Cross-section of Manatee Springs Basin from LiDAR-based DEM

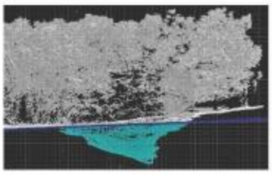


Cross-section of approximate center line of Manatee Springs Run from LiDAR-based DEM

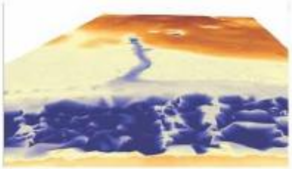


Cross-section of Suwannee River from LiDAR-based DEM

A cross-section of the classified LiDAR data contained in the LAS file was also plotted (Figure 7) as well as a view of the "bare earth" layer of the entire test area (Figure 8). As may be seen, results similar to those derived from the DEM were obtained. The "bare earth" LiDAR bathymetric measurements in the spring basin look reasonable while those in the river are erratic.



Cross-section of Manatee Springs Basin from LAS file



Overview of "bare earth" LiDAR for test area from LAS file

Ground truthing

To evaluate the results, we sampled turbidity in the Suwannee River portion of the test area. In the river, turbidity ranged from 3.8 to 6.4 NTU with an average of 4.8 NTU. Measurements with a Secchi disc in the river resulted in visibility ranging from 12.8 to 14.9 feet with an average of 14.9 feet. Water clarity was considerably better in the spring basin and run, although we have not yet taken actual turbidity readings in the springs; access was restricted because of the concentration of manatees in the springs during the flight and the subsequent flooding of the river. Once the flooding subsides and turbidity conditions in the springs are similar to those when the flight was made, we will take readings to quantify the effect of turbidity.

A preliminary analysis of the accuracy of the bathymetric elevations obtained by this technology has been performed by comparing the LiDAR measurements with soundings made with a sounding rod at 31 locations in the spring basin and run. That analysis indicated a mean error of 0.10 feet, an error range of -0.63 to 0.35 feet, a skew of -0.28 feet, and a Root Mean Squared Error of 0.26 feet.

Additional ground truthing and analysis is planned after the results are examined in greater detail to see if filtering can improve the data, especially the data covering the river portion of the test area. That analysis will be forthcoming in a follow-up paper and will include not only a comparison with the check ground elevations, but also a correlation of soundings with turbidity and depth.

ACKNOWLEDGEMENTS

Sincere appreciation is expressed to Paul Buchanan and Keith Rowell, PSM of the Suwannee River Water Management District; and James Owens, PSM and Al Karlin, Ph.D., of the Southwest Florida Water Management District, for their work with this project.

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About the author

George M. Cole, a professional engineer, surveyor and geographer, began his career conducting hydrographic surveys with the U.S. Coast & Geodetic Survey, now part of NOAA. Subsequent assignments have included service as the state cadastral surveyor for Florida and many years directing private firms with projects including LiDAR mapping in Latin America. Recently, he has served as a professor of surveying and mapping at the University of Puerto Rico. Currently, he serves on the governing board of the Suwannee River Water Management District and as an adjunct professor at Florida State University. He is the author of several textbooks including Water Boundaries (Wiley & Sons, 1996) and Surveyor Reference Manual (Professional Publications, 2010).

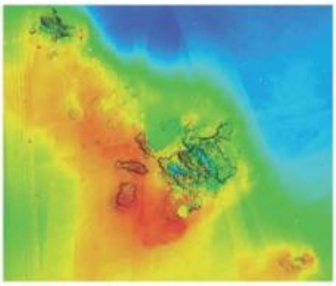
Identification of the Wreck of the U.S. Coast Survey Steamer Robert J. Walker

By James P. Delgado and Vitad Pradith

From June 21 to 24, 2013, NOAA teams from the Office of Coast Survey and the Office of National Marine Sanctuaries conducted a joint mission to explore a shipwreck off the coast of New Jersey near Absecon Inlet and Atlantic City. That wreck has proved to be the oldest known wreck of a hydrographic survey ship yet found: Robert J. Walker, a U.S. Coast Survey ship wrecked in 1860 with the loss of 21 crewmembers. The tragic story resonates within NOAA to this day.

NOAA Historian Albert "Skip" Theberge unearthed the disaster while researching the early years of the U.S. Coast Survey, and he was determined that NOAA should pay the crew the honor they deserved. A team of NOAA experts, with the assistance of Joyce Steinmetz, a maritime archaeologist from East Carolina University, brought their expertise to the project, to honor the lost Robert J. Walker sailors by locating the wreck.

In a bit of serendipity, the NOAA Ship Thomas Jefferson was conducting hydrographic surveys off the New Jersey coast, within the general vicinity of Robert J. Walker's last reported location. Rear Admiral Gerd Glang of the Office of Coast Survey asked Thomas Jefferson to spend a day surveying the area believed to be where Walker sank. Vitad Pradith, a physical scientist with Coast Survey, accompanied by Steinmetz, led mapping operations aboard the Thomas Jefferson, using both multibeam and side scan sonar.



The Thomas Jefferson's multibeam survey found the bow facing northwest, one of the checkpoints in confirming the wreck's identity.

The Thomas Jefferson survey was followed by a higher resolution and close proximity side scan sonar survey and archaeological SCUBA dives conducted from the Office of National Marine Sanctuaries vessel SRVx, which further characterized the shipwreck and its debris field. The data gathered by the project confirmed that the shipwreck was U.S. Coast Survey steamer Robert J. Walker, lost off Absecon Inlet on June 21, 1860.

Hydrography Meets Nautical Archaeology

The search for the Walker required an interdisciplinary approach pulling expertise from hydrography, nautical archaeology, maritime history, and cartography. The Walker would not have been discovered and identified otherwise. With this amalgam of perspectives, two search areas were selected for investigation: "Site A," where wreck divers have dived for decades on an unidentified iron-hulled steamer wreck; and "Site B," a location 1.7 nautical miles away where historical information suggested Walker had been lost. Site A was represented on the nautical charts as a wreck site and has been "known" since the Second World War as an obstruction from a previous hydrographic survey. It was also targeted as a "poss. WWI freighter" (NOAA AWOIS database 2480), and finally as a fisherman's hang-up that was known and transmitted to local wreck divers in the early 1970s – when it became known as the "$25 Wreck." Site B was further designated the "Bache Site" as this was the approximate position of the vessel reported to the Coast Survey superintendent, Alexander Dallas Bache, in 1860.

Previous survey data provided information about the unknown wreck's basic characteristics and orientation. This data was acquired in 2004 during a routine hydrographic survey to update the nautical chart. That survey determined that the wreck was approximately 40 meters or 134 feet in length. Coast Survey designated the wreck as an obstruction and updated navigation charts to reflect this hazard. At the time, Coast Survey cartographers, who maintain a wrecks database for nautical charts, did not suspect the identity of the wreck.

Given the probability that Site A was likely the Walker and based upon the congruence of data, Site A was designated a high priority. Using the 2004 multibeam survey position as an origin, the survey plan created concentric one-mile and two-mile diameter search areas with line planning methods characteristic to the sensors that hydrographers employ today. The actual survey took place on June 21, 2013, the 153rd anniversary of Robert J. Walker's loss, in conjunction with a shipboard memorial service and the lowering of a memorial wreath into the sea. Thomas Jefferson deployed its modern hydrographic sensors, including high-resolution side scan sonars and multibeam echosounders.

To match the objective of the survey, 100% coverage was provided. The only shipwreck located in the Site A survey area matched a number of key characteristics for Robert J. Walker. The higher resolution sonar allowed for discrete mapping and measurement of features such as length, which was defined at 131 feet. The data suggested that the vessel's hull was articulated with material projecting into the water column at its ends and in a central mass suggestive of engine(s) and boiler(s). The Bache site returned results that were inconsistent with the structure of the Robert J. Walker.

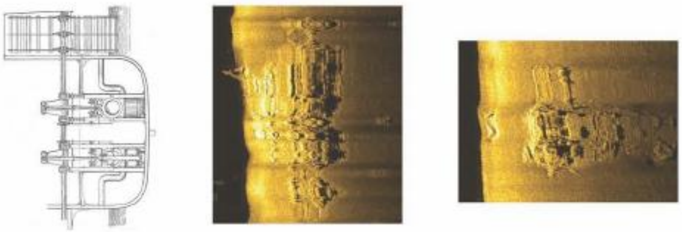
With the sonar survey completed, and with an indication that Site A likely represented the wreck of Robert J. Walker, the next phase of diving observations, documentation and recording commenced on June 22-23. The Thomas Jefferson relayed the sonar survey results and the wreck coordinates to the Office of National Marine Sanctuaries Research Vessel SRVx, which was en route to New York in response to a request to locate remains of an historic lighthouse swept off its base during post tropical cyclone Sandy.

NOAA Ship Thomas Jefferson meets the NOAA ONMS SRVx

Work began with an additional high frequency side scan sonar survey of the site. Optical visibility in this area can be notoriously poor, but through contemporary acoustic remote sensing techniques, difficult key features were readily identifiable and a more discrete sense of the site was obtained.

Moving beyond the realms of hydrography required additional insight by the NOAA Maritime Heritage Program, which added context to the data and provided further analysis, interpretation, and understanding.

The subsequent analysis showed the bow and the starboard side of the hull emerging from the sediment. Sand or mud has mounded and obscured the port bow. A mass of machinery was visible, with structure rising above the seabed behind it. Closer passes better defined the machinery as two engines linked to a paddlewheel shaft with an upright wheel on the port side, and the hubs of the starboard wheel bare on the shaft, but with what may be side-wheel parts lying aft of the hub.



Sonar images compared with plans of Walker's machinery showed a likely match.

Investigative dives on the wreck on June 23 focused on the machinery and the forward areas of the wreck due to limited visibility and current. The dives confirmed that the wreck had the same variety, number, and dimensions of the engines as installed in that of Robert J. Walker.

A poignant discovery was made in the area of the bow on the port side, where a portion of the hull is exposed. The sediment in this area was disturbed, and in this area, coming out of the mud, were a number of blue woolen blankets. The blankets did not appear to be modern, and were in various stages of disintegration. In the contemporary report of the sinking, the crew was noted as having attempted to stem the incoming flow of water by stuffing blankets and mattresses into the opening. The blankets are tangled in the wreckage. The area in which they lie is where the schooner Fanny probably collided with Robert J. Walker; the lack of hull here may be indicative of the collision damage.

150+ year old wool blankets were likely uncovered during the previous year's Sandy event.

A Father Calling His Children Home

We now know that this wreck is Robert J. Walker. The wreck appears to be in its original position when it sank, aligned toward the shore and the Absecon Lighthouse, and resting slightly to port. The vessel appears to have
sunk by the bow, with the bow striking the bottom first and bending or breaking at the keel, leaving the bow oriented upward.

As fate would have it, the name Thomas Jefferson, the founding father who also signed the United States Coast Survey into law in 1807, graces the ship that was present to lead mapping operations. But more importantly, the Thomas Jefferson helped bring its colleagues home and honored their service to a fledgling nation.

The wreck will be prominently marked on official U.S. nautical charts and other notices. NOAA will ask the fishing community to avoid trawling or dredging near it; NOAA will also work with others to help preserve the shipwreck as an historic site and avoid any activities that might harm it.

NOAA intends to work closely with the wreck diving community on projects to map and document Walker in recognition of the community's assistance in finding and identifying Walker, and its continued interest in diving the site, which will be maintained with no restrictions on non-intrusive access.

The story of Robert J. Walker is an important one in the development of the United States and, in particular, ensuring safe navigation for those who work on the nation's waters, and for the facilitated and safe flow of commerce by water. It is a story of innovation, of science at sea, and of long hours of service to the nation. It is also a story of those who paid the ultimate price for that service and devotion to duty.

NOAA'S Office of National Marine Sanctuaries SRVx and the project team from the dive mission.

About the authors

James Delgado is the director of Maritime Heritage in NOAA's Office of National Marine Sanctuaries. Trained as an historian and archaeologist, he has participated in shipwreck exploration, discoveries and excavations throughout the world, including Titanic, USS Arizona at Pearl Harbor, the lost fleet of Kublai Khan, the atomic-bombed warships at Bikini Atoll, and buried ships from the California Gold Rush along the former waterfront of San Francisco. Author or editor of more than 30 books, prior to his time with NOAA, Dr. Delgado was the president and CEO of the Institute of Nautical Archaeology for five years, executive director of the Vancouver Maritime Museum for 15 years, and an historian with the National Park Service for 13 years (five of those as the maritime historian).

Vitad Pradith is a physical scientist with NOAA's Office of Coast Survey and is currently the technical adviser of the Navigation Response Branch. He received his B.A. from San Francisco State University in geographic analysis and an M.P.S. from the University of Maryland, College Park, in geospatial science. His latest projects apply innovative technologies such as cloud and distributed computing to hydrography during emergency response operations as well as hydrographic applications toward nautical archaeology and maritime heritage.

A Local Economic Perspective of Hydrography

By Paul L. Donaldson

The discipline of hydrography has many applications. The mention of hydrography first conjures images of nautical charts and the act of collecting information for the purpose of safe navigation. While this is a vital component of hydrography, the process of conducting a hydrographic survey is far more reaching. Three major weather events within the Gulf of Mexico and northeastern United States – Hurricanes Katrina and Gustav, and post tropical cyclone Sandy (unofficially known as "Superstorm Sandy") – not only impacted marine navigation with shifting sediments and newly deposited uncharted debris, but also had significant impacts on the local community. This article provides a look at several examples of how federally funded hydrographic surveys positively impacted local small businesses after major weather events.

Hurricane Katrina

On Monday, August 9, 2005, Hurricane Katrina made landfall in southeastern Louisiana as a Category 3 hurricane and was one of the most devastating and costly natural disasters in U.S. history. Under the Conference Report on H.R. 4939, Emergency Supplemental Appropriations Act for Defense, the Global War on Terror, and Hurricane Recovery, 2006 (ESAA), NOAA tasked Leidos, Inc. (formally Science Applications International Corporation) with conducting hydrographic surveys to detect items and map debris within Lake Borgne, Louisiana.

Lake Borgne

In July 2006, Leidos scouted the area to develop an approach for conducting the survey effort and quickly determined that much of the infrastructure and resources remained scarce, with a majority of businesses still struggling to recover. Leidos made a purposeful decision to use local businesses for lodging, vessel support, fabrication, hardware and other needs to put as much money into the local economy as possible.

Fishing Vessel Lacey Marie

The search for a vessel to conduct a hydrographic survey in the shallow waters of Lake Borgne proved challenging after the hurricane. Leidos found a small, family-owned business located in Shell Beach, Louisiana, named Campo Marine. Despite having lost homes and sustaining major damage to its marina business because of Hurricane Katrina, it was able to save its oyster boats. Leidos identified the 42-foot Lacey Marie as the best available survey platform.

Reconfiguring the fishing vessel into a hydrographic survey vessel required modifications and upgrades. The pictures below show before and after images of Lacey Marie's interior spaces. A local carpenter who furnished the materials refitted the interior.






Various mounts were also required to support the survey efforts. To the extent possible, materials were purchased locally and the mounts were fabricated on site. Because of the stringent need to steer straight lines for a hydrographic survey, a local marine company outfitted the Lacey Marie with an autopilot. This benefited Leidos in collecting hydrographic data, and it continues to benefit Campo Marine's fishing business by increasing their line-keeping capabilities.



Survey Approach

For the four-month survey effort, Leidos deployed a two-boat scenario, with each vessel and survey team residing in two different locations around the lake. One team had hotel accommodations in Slidell, Louisiana, while the other stayed in a mobile home in Shell Beach. The mobile home was installed specifically for the survey effort, along with a processing van, on a concrete slab that previously had been Robert Campo's home. The vessels were split between Campo Marine and a small marina located at Lake Catherine that was also damaged by the storm. Spreading the survey assets around the lake not only made the survey more efficient, it also distributed federal contract funds to small businesses and families affected by the hurricane.

Shell Beach accomodations

Lake Catherine Marina

Hurricanes Katrina and Gustav

In 2008, Leidos was again tasked under Hurricane Katrina's ESAA to conduct hydrographic surveys and map debris in the near-shore waters of Terrebonne Bay, Louisiana. By coincidence, before the survey began, the area was impacted by Hurricane Gustav. Hurricane Gustav made landfall near Cocodrie, Louisiana, located at the northern end of Terrebonne Bay, the morning of September 1, 2008, as a Category 2 hurricane. Leidos decided to employ the same approach of supporting the local community as it had the previous year in Lake Borgne.

Survey Approach

In late October, 2008, Leidos and its subcontractor made arrangements with Coco Marina, a small business within Cocodrie impacted by Hurricane Gustav, to occupy three two-room suites on a long-term basis, rent dockage for its vessels, and purchase fuel and provisions during the survey effort. This approach provided the small business with an immediate steady stream of revenue during the off-season that it could use to rebuild and prepare for the upcoming high season. Having recently outfitted the Lacey Marie one year earlier, Leidos once again employed the services of Campo Marine, whose familiarity with the process reduced the mobilization time, effort and cost associated with the sonar mounts, equipment layout and survey approach.

Coco Marina after Gustav

Outreach

Cocodrie is home of the Louisiana Universities Marine Consortium (LUMCON), which provides coastal laboratory facilities to Louisiana universities and conducts in-house research and educational programs within Terrebonne Bay and the Gulf of Mexico. Leidos contacted LUMCON and made arrangements to set up a field office at the facility to support post-processing of the hydrographic data. In doing so, Leidos not only provided LUMCON with additional revenue but also made the survey team available to anyone visiting or working at LUMCON to answer questions and discuss the survey effort, which lasted more than eight months.

Sandy

On October 29, 2012, post tropical cyclone Sandy made landfall near Brigantine, New Jersey, and became the second most costly hurricane to hit the United States. With funding from the Hurricane Sandy Recovery and Rebuilding Supplemental Appropriations Act, Leidos was contracted to conduct hydrographic surveys west of Sandy Hook within the Lower New York Bay, including Raritan Bay and the Navesink River. Capitalizing on lessons learned from the previous two post-hurricane surveys, Leidos approached the Sandy Hook surveys following a similar model of using small businesses when possible and utilizing a variety of resources within the affected community. Leidos' approach was for a three-boat survey scenario, with each vessel being able to target specific strategic depth regimes.

Survey Vessels

Divemasters is a small veteran-owned business out of Toms River, New Jersey, that has worked with Leidos for 20 years providing a 110-foot survey vessel in support of near-shore hydrographic surveys. With the need to survey to the 2-meter depth curve, Divemasters made a business decision to purchase a newly built smaller vessel to expand its capabilities and therefore support the inshore shallow water portion of the survey effort. However, to get the new vessel ready for survey, it still needed interior modification, fabrication of a bow-mount and an over-the-side-mount to support a variety of sonar equipment. Budget Boat Towing and Salvage in Brick, New Jersey, conducted or oversaw this fabrication work. These mobilization efforts not only supported Budget Boat Towing and Salvage but also a variety of local companies who provided materials and outside expertise.



Survey Approach

Once survey operations started, Leidos staged vessels at two separate marinas—one small business and one municipal marina—in the Highlands, New Jersey, area. This approach allowed Leidos to have a broader effect in the local community, purchasing fuel and provisions from a variety of businesses. Leidos established a field office at a local hotel co-located with the survey crew. This provided the hotel with five or more long-term room rentals for the duration of the four-month survey effort.

Summary

These three post-hurricane hydrographic survey efforts provide a few examples of how hydrographic surveys can benefit communities beyond making our waterways safe for navigation. Based on the approach taken, hydrographic surveys can help support local communities and can have a significant and immediate impact for some businesses following major storm events. This is especially true for small businesses that may be struggling in the aftermath of a major weather event. Survey efforts also allow small businesses to grow their capabilities and be able to compete for new work. For example, Campo Marine was able to upgrade its systems, which was beneficial not only for supporting its fishing business, but also for making its vessel more versatile, which ultimately led to additional follow-on survey work with Leidos the next year. During the off-season, in the months directly following Hurricane Gustav, Coco Marina was able to generate revenue to use to rebuild and prepare for the upcoming fishing season. Following Sandy, Divemasters was able to diversify its fleet of vessels and start supporting surveys in the inshore shallow water niche, where it had previously not had capability.

About the author

Paul L. Donaldson is a certified hydrographer with over 25 years in the marine industry. After receiving his master's in marine biology, he ran the remotely operated vehicle program for NOAA's National Undersea Research Center in support of various research projects throughout the U.S. as well as Russia and Greece. Donaldson has been conducting hydrographic surveys with Leidos (formally SAIC) for 15 years, collecting data for cable and pipeline route surveys, and to update NOAA's existing nautical charts.

Crowdsourcing Enhances Navigation Awareness

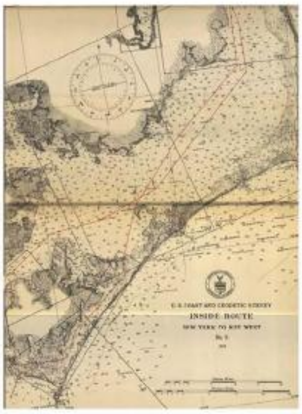
Leveraging Technology and Social Media for Intracoastal Waterway Reconnaissance

By John A. Hersey and Paul M. Cooper

In this Internet age, crowdsourcing is fast providing practical contributions to our understanding of the world around us. Whether it be software developed in an open-source environment, inputs from "those in the know" to create and maintain wiki pages, or the provision of weather and traffic data through the mobile devices we use every day, society as a whole benefits from what we each "know" and the ability to communicate that information with today's technology.

In observance of World Hydrography Day 2014, it is fitting to report on the application of 21st century technology and social media, both now an integral part of our everyday lives, as some of the newest tools in the hydrographer's toolbox. While high-end surveying equipment is still unmatched in precision and accuracy in the hands of a professional hydrographer, very capable surveying technology is now low cost, readily available, and already distributed worldwide in the form of standard-equipment vessel electronic charting systems, or chartplotters. Combined with the wireless and cellular networks that we are all constantly connected to, we have the ready means to aggregate and share this distributed coastal intelligence. Thus, the science of crowdsourced bathymetry is emerging as a next-generation tool that mirrors the connected mindset of the next generation of hydrographers.

Crowdsourced bathymetry is being successfully implemented as a reconnaissance tool for boaters on the Intracoastal Waterway. The regional maritime community is taking advantage of crowdsourced bathymetry as a self-enabling technology through a creative collaboration with industry. Leveraging the availability of modern technology and the public's natural desire to be well-informed – as well as to benefit society – mariners are providing data that bestow unprecedented insight into conditions and resources along the Intracoastal Waterway.



The **Salty Southeast Cruisers' Net (SSECN)** is an online social media forum focused on the Atlantic Intracoastal Waterway, and is a treasure trove of useful reports and articles provided by and consumed by waterway cruisers. The SSECN website informs others via familiar chart displays provided by EarthNC, enhanced with access to information such as fuel prices, marina accommodations, and navigation hazards like misplaced buoys and shoaling. These reports are also enhanced by the millions of water depth measurements made by cruisers during their routine Intracoastal Waterway transits, autonomously delivered and processed through the ARGUS™ crowdsourced bathymetry innovations of SURVICE Engineering and CARIS USA. What was previously a fleeting number on a chartplotter screen, that may or may not have been looked at and interpreted, is now useful knowledge thanks to this pioneering partnership.

ARGUS™ Crowdsourced Bathymetry

ARGUS™ is a patented (U.S. Patent 8,417,451) autonomous crowdsourced bathymetry system and methodology that provides automated acquisition and processing of crowdsourced bathymetry data. ARGUS™ universally interfaces with vessels' existing GPS and depth-finding systems. The compact, onboard unit automatically processes the GPS and depth signals and wirelessly ports the output to a central server. Post-processing the data from routine vessel traffic provides continuous waterway depth surveying. Crowdsourced bathymetry is a novel, hydrographic surveying approach that uses existing vessel traffic and thus an unlimited, distributed workforce to continuously survey waterways that may not have been surveyed in decades. This virtual, distributed surveying "vessel" acts as a member of the SSECN cruising community, greatly enhancing condition reports provided through the SSECN website with a continuous flow of physical measurements.

CARIS provides powerful post-processing and visualization platforms for the web-served crowdsourced bathymetry solution sets. Feedback to the participating vessels includes real-time position reporting and access to the solution sets processed from all contributing vessels. Process outputs are made available as a selectable layer on SSECN chart windows with specific coverage of each problem area of the Intracoastal Waterway. The individual chart windows provide not only the ARGUS™ layer, but also a wealth of other useful information in the form of articles and user comments related to the problem areas. This is in addition to the layers that point out amenities and other types of hazards

– with the majority of inputs and reviews contributed by SSECN readers.

Crowdsourced Bathymetry Application on the Intracoastal Waterway

ARGUS™ has been in operation since 2010, acquiring over 100 million soundings from a distributed fleet of vessels navigating U.S. and international waters. Over 20 million of those soundings have been processed over the 1000+ miles from Norfolk to Key West, thanks to long-time contributors like Sea Tow, M/V Altair, M/V Chez Nous, Trawler Beach House, and Reality Check Sailing, and the data solution set is continually being refreshed. The charted images of Georgia's Jekyll Creek and Little Mud River show two of the classic Intracoastal Waterway trouble spots highlighted for SSECN readers. These are typical examples of ARGUS™ data providing a real "visual" of the conditions and of the best route of travel through these trouble spots.

Clearly evident in the case of the Intracoastal Waterway, an especially hard-to-reach area for official survey assets, the swath of crowdsourced bathymetry data provides the partnership with a great opportunity to update the magenta line, or preferred route of travel, as currently represented on official charts. The magenta line was last comprehensively surveyed in the 1930s and desperately needs updating. This image shows one of many examples where the swath alone indicates the preferred route of travel, yet without consideration for which is the deepest part of the swath. Endorsed by the Atlantic Intracoastal Waterway Association, this project will add a continuously updated magenta line as a layer in the SSECN chart windows.

The preferred travel route deviates from the charted magenta line.

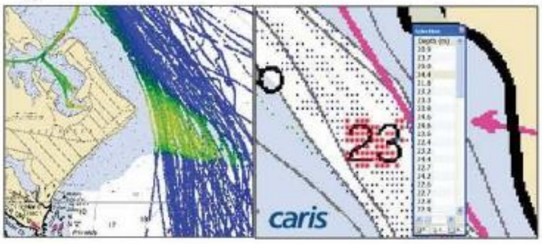
Not surprisingly, the international hydrographic community is taking notice of the potential value of crowdsourced bathymetry, and is rapidly moving to leverage its benefits. Among others, the development of crowdsourced bathymetry has been endorsed and encouraged by both the United Kingdom Hydrographic Office and the International Hydrographic Organization. The application of inevitable hardware improvements along with scientific expertise in the field of hydrography, fueled by interests in big data and information visualization, all promise to only make crowdsourced bathymetry solutions better – in fact magnitudes better than the pre-1940s "soundings" that are the basis for the majority of modern charts.

Who Benefits?

Crowdsourcing provides an opportunity to apply innovative technologies while engaging partners from academia, the public, and commercial entities. It also attracts populations that are currently underrepresented in the hydrographic science workforce. The continuous flow of coastal environmental information will promote stewardship and increase informed decision making by stakeholders, educators, students, and the public who are interested in science. Crowdsourcing is an effective engagement of key stakeholders and the public that will enhance literacy of our coastal environments.

Through this pilot application, SSECN readers are getting the benefit of a state-of-the-art reconnaissance tool that keeps them best informed about the journey that lies ahead. The chart windows and layers allow planning for tomorrow's journey while in a slip or on the anchor with a look-ahead view of current attractions, alerts, and trouble spots. Information is bolstered by local knowledge of the SSECN community as the readers monitor local solution updates, make local chart comparisons, and identify areas of interest (e.g., shoaling), which are then reaffirmed by and for the community. Reader testimonials indicate wide approval of these SSECN reports.

The public benefits from a reduced need to tax current observing systems, which are already 100 years behind schedule and with growing requirements. Steadily decreasing resources have reduced the number of hydrographic survey platforms worldwide to about 65% of what it was 15 years ago. This is in the face of commercial maritime trade that has increased three-fold since the 1970s. Especially in hard-to-reach areas such as the Intracoastal Waterway, crowdsourcing can be used as a supplement to mission planning for official surveys requiring controlled measurements as shown here.



As demonstrated in other application areas such as the Chesapeake Bay, Antarctica, coastal New York and New Jersey, and the ports of Baltimore, New York, and Pittsburgh, one can see additional crowdsourced bathymetry networks being established to support local interests while complementing the work of hydrographic services and surveyors. Combined with the availability of the Internet and wireless connectivity, remote sensing far beyond the capacity of all the world's hydrographers combined is being realized. With the challenge of reduced resources, the use of crowdsourcing bathymetry and other nontraditional methods for collecting data will grow to support the ever-increasing needs and uses for hydrographic data.

This Intracoastal Waterway application demonstrates the use of hydrography as one of a range of activities that benefits the coastal environment and the marine economy. This creative approach and partnership use hydrographic survey data for something beyond creating and updating nautical charts. Modernization and new thinking are being applied to dramatically change the way hydrographic data are collected, processed, and served out to users. The newest members of the hydrographic workforce – the commercial and recreational vessel captains that value the Intracoastal Waterway – are bringing the fruit of their efforts to the benefit of the entire Intracoastal
Waterway community.

About the authors

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Where the Wild Corals Are

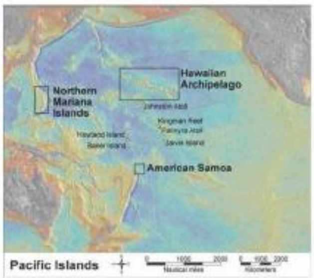
You can't manage coral reefs if you don't know where they are

By Joyce Miller, with John Rooney, Christopher Kelley, John Smith, Frances Lichowski, and Jeremy Taylor

When President Clinton signed **Executive Order 13089** in 1999 to protect, restore, and sustain U.S. coral reef ecosystems, little information was available about the location and extent of coral reefs in the Pacific. In 2000, NOAA's **Coral Reef Conservation Program** established a program to map the location and distribution of coral reef ecosystems in the U.S. Pacific by 2009, targeting Hawaii, the Territories of Guam and American Samoa, the Commonwealth of the Northern Mariana Islands and the Pacific Remote Island Areas for mapping. In an ongoing effort over the past 14 years, scientists from NOAA, the University of Hawaii, and partner organizations have collaborated to collect over 140,000 km^2 of multibeam bathymetry and backscatter data and extensive photographic/video data in U.S. Pacific areas, providing critical information for diverse management and research needs. Fortunately, in many cases the data also were of sufficient quality to update charts in some of the most remote U.S. Pacific islands, where little or no modern data existed.

Working Together

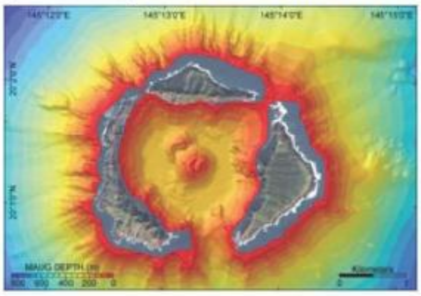
This effort is a continuing collaboration supported by NOAA's Coral Reef Conservation Program, National Marine Fisheries Service, National Marine Sanctuaries Program, Office of Ocean Exploration, and Office of Coast Survey. NOAA assets used for the program include the NOAA ships **Hi'ialakai**, **Oscar Elton Sette** and **Okeanos Explorer**, and an 8-m survey launch, the **R/V AHI**. The **University of Hawaii's School of Earth Science and Technology** has also been a major contributor of data collected during cruises aboard the R/Vs **Kilo Moana** and **Kai'imikai 'O Kanaloa**. In 2014, the Schmidt Ocean Institute provided a significant amount of additional data collected from their ship R/V Falkor during 72 days at sea in the Hawaiian Archipelago. Other federal and state agencies, including the U.S. Geological Survey, the U.S. Fish and Wildlife Service and the Hawaii Department of Land and Natural Resources also make use of the data. Scientists and technicians from multiple agencies and groups work together on most cruises to collect and process the data. The sonar data is quickly sent to **National Geophysical Data Center** and the **gridded data is posted on the Internet** for public access.



How We Survey

Most of the ships and launches we use are equipped with multibeam sonars. These sonars map a swath of data with 100-600 very accurate readings across the vessel's track. Modern multibeams provide depth (bathymetry) and imagery (backscatter) information, allowing us to make detailed maps with information about both the bathymetry and character of the seafloor. Because we map in both shallow and deep water, we use sonars with frequencies ranging from 12 to 300 kHz. As a rule of thumb, lower-frequency sonars have a greater range (a 12-kHz sonar maps to full ocean depth; 300-kHz systems map to ~150 m) than higher frequencies, but higher frequencies provide data with greater resolution. Because low-frequency sonars have a much wider range and swath width (up to ~20,000 m or 20 km) than high-frequency sonars (swath width of 10s to 100s of meters), shallow and moderate depth mapping takes much longer to cover an equal area of sea bottom.

We also collect photographic and video data using towed camera systems, autonomous underwater vehicles, remotely operated vehicles, and submersibles. The photo/video data is analyzed with reference to the multibeam bathymetry and backscatter and then is used to help interpret the multibeam data (for example, to detect the presence of coral, sand, landslides, or lava flows) and to **produce benthic habitat maps**.



How Is the Data Used?

Maps depicting the distribution of coral reefs and associated biological communities and resources are critical tools for effective spatially based planning and management of coral reef ecosystems. Complete and seamless data sets of high-resolution bathymetry, largely generated from multibeam echosounder surveys, provide the foundation for such maps. The primary purpose of the Coral Reef Conservation Program mapping program is to determine the location and extent of light dependent (0-150+ m depth) coral reef ecosystem resources in U.S. waters and to produce habitat maps from the data. However, additional deeper sonar data (to depths as great as 5500 m) has been and is being collected during transits and at night because there might never be another chance to collect data in the remote areas we visit.

One of the first collaborative cruises aboard the Kilo Moana was planned to define important depth contours (25-, 50- and 100 fathoms; 1 fathom = 6 ft/1.8 m) and boundaries of the Northwestern Hawaiian Islands Coral Reef Ecosystem Reserve, now **Papahnaumokukea Marine National Monument** and a World Heritage Site. (**Coast Survey staff participated on this cruise in order to update nautical charts in the area**.) In 2008, boundaries for three additional Pacific Monuments in the **Mariana Archipelago**, **the Pacific Remote Island Areas**, and **Rose Atoll** were determined using data that had already been collected. **Fisheries managers in Hawaii have defined marine managed areas** based partly upon depth and other characteristics of the seafloor. Commercial and state agencies use the data to plan cable routes in the Pacific. Complete bathymetric data has provided the information needed to create accurate models of storm and tsunami inundation areas. Scientists also use the data for geologic, ecosystem, climate and biological research, looking for clues to geologic history and the location of habitats for fishes, sponges, invertebrates, algae and, of course, corals. Although the data was not collected to the highest International Hydrographic Office specifications, due to lack of accurate tide information in most areas, Coast Survey has nevertheless been able to update many remote Pacific charts where little or no modern data previously existed. In addition, collaborative surveys to IHO standards were done in Saipan and Honolulu harbors using Coral Reef Conservation Program and Coast Survey resources.

So Much to Do!

The total area of coral reef ecosystem waters (0-150 m depths) in the U.S. Pacific islands is 20,700 km^2 and, of that, approximately 10,000 km2 (48%) has been mapped. However, the majority of the remaining unmapped areas in this depth range are located in the Northwestern Hawaiian Islands, with only ~3200 of 12,700 km2 or 25% mapped to date. Coral reef ecosystem mapping in the Main Hawaiian Islands is ~86% complete; in Commonwealth of the Northern Mariana Islands and Guam, ~82%; in American Samoa, 100%; and in the Pacific Remote Island Areas, ~70%. In addition to this primary objective, ~56,700 km2 in deeper waters was mapped during coral-centric research cruises through 2013. Several **U.S. Law of the Sea** and **R/V Kai'imikai 'O Kanaloa cruises** and numerous other scientific expeditions have contributed data in Guam, the Commonwealth of the Northern Mariana Islands, American Samoa, the Pacific Remote Island Areas and the Main Hawaiian Islands. Recently, in the first of two 2014 Schmidt Ocean Institute Falkor mapping cruises, an additional ~60,000 km2 of seafloor was mapped in the deeper waters of the PMNM, adding to the ~67,000 km2 previously mapped, and more will be covered during the May/June 2014 Falkor expedition.

It's Fun Too!

Besides meeting many important scientific and management goals, surveying coral reefs in the Pacific can be really fun! We've surveyed around live and dormant volcanoes in the Mariana Archipelago and around some of the most beautiful and untouched coral reefs in the world in the Pacific Remote Island Areas, had dolphins ride our bow wake, and helped to rescue stranded boats. Sometimes we work on board ships for weeks at a time, sometimes we launch the R/V AHI from the ship (which can be quite exciting!), and sometimes we work from shore. Sometimes the weather is beautiful and calm, but sometimes it's not so nice. We get to go to places like Saipan, Guam and American Samoa and to many really remote islands that very few people will ever get to visit. In yet another collaborative effort, NOAA and University of Hawaii scientists will use the R/Vs Kilo Moana and AHI in Tahiti in July/August 2014 to map coral reefs and the deeper ocean floor around the islands of Moorea and Tahiti.

About the authors

Joyce Miller is an American Congress of Surveying and Mapping (ACSM) Certified Hydrographer who has worked in multibeam mapping since the early 1980s. She has held positions with NOAA, the Naval Oceanographic Office, the University of Rhode Island, and Science Applications International Corp. Miller is currently employed by the University of Hawaii, is a member of NOAA's Hydrographic Survey Review Panel, and continues to do multibeam surveying around the Pacific. Dr. John Rooney, Benthic Habitat Characterization Ecologist, Research Corp. University of Hawaii/NOAA Coral Reef Ecosystem Division.

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Scour Protection for wind turbines?

Determining if protection is required around wind turbines

By Alison Pettafor

Wind turbines, particularly the first constructed sites, show noticeable depressions around the turbine base. Hydrographic data can help determine the extent of the scour (scour is where sediment has moved and left a dip in the seabed) and can help planners decide if there is a need for protection for both the turbine base and the surrounding cables. Since wind farms are being developed in dynamic environments, to optimize their use and take advantage of our natural resources, monitoring and protection are required to sustain the stability of the foundations on the seabed.

Surveying Wind Farm Sites

Offshore wind farm sites have been increasing rapidly around the world, offering a source of renewable energy. Hydrographic surveys of wind farm sites are essential before, during, and after construction to check for wrecks, unknown magnetic material, and anything else that might cause a problem with construction. During construction, the surveys check the foundations of the turbines and the conditions of laid cables. After construction, the main issue of concern is scour/seabed depressions around the turbines and the effect this has on the cables entering the turbine. These depressions are regularly surveyed and the changing level of scour is monitored to determine if protection is required. The collected data will be concentrated on the turbine bases to get as much coverage as possible, to obtain the best possible resolution, and to ensure that no sections have been obstructed by the turbine.

Detecting and Identifying Scour

The scour extents are measured both horizontally and vertically around the base of the turbine to determine the maximum scour. Image 1 shows where the scour is determined; the image on the left is a bathymetric image of the base of a wind turbine, using color to show depth. (The data of the turbine itself has been removed.) The yellow horizontal bar shows a selected cross-section, and the image on the right displays that cross-section of data. The scour can then be measured directly from the cross-section. Horizontal scour is measured at the widest point where the seabed falls away to give a maximum diameter around the turbine. The vertical is measured from the top of where the seabed would have been, before it starts to fall away, to the deepest point next to the turbine. The data clearly shows where scouring is around the base, but in some cases it is not as prominent.

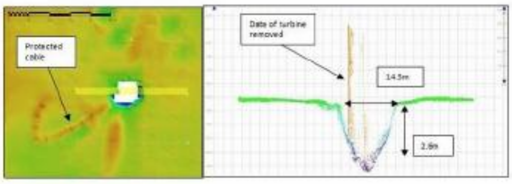

Image 1 - The left image shows the bathymetry of the seabed and a cable that already has protection. The right image shows measurements determined along the cross-section of the turbine.

Image 2 shows both the immediate scour around the turbine and further potential scour. This has most likely been caused by the construction of the turbine; it may not directly affect the turbine's foundation and should not need protection unless the spread of scour exposes the cables coming out of the turbine. This image also shows a seabed feature, which is excluded from the scour measurements as it is a different level than the typical seabed height and so is not part of the immediate scour.

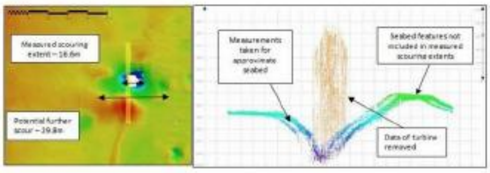

Image 2 - The left image shows the bathymetry of the seabed and how the scour extends out from the turbine. The right image shows the difficulty of determining some of the scour extents and identifying what are classed as features in the data.

Using the Data to Determine Information about the Site

The further scour on image 2 can be used to show more information about the wind farm site; image 3 demonstrates this as well. The direction of further scour predominantly moves out to the east and west of the turbine, and this can tell us a lot about the site. It suggests that the seabed is mobile sediment and that the direction of the running tide will approximately be from either east to west or west to east depending on the time of day. It also suggests that the tide is strong, with a large tidal range (difference between high and low water; the higher the value, the stronger the tide). However, because there is little or no movement to the north and south of the turbine, it suggests that the seabed is less mobile, since otherwise the scour would be expected to stretch out further.

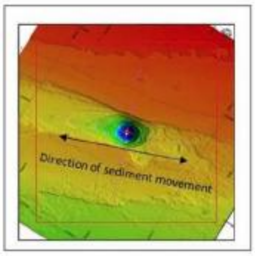

Image 3 - The image shows a bathymetric image demonstrating the direction of sediment movement and therefore explaining where further scour might occur.

Using the Data to Show Changes Over Time

The focus so far has been determining scour. The images have shown the turbines after the scour has started (and this will have been monitored for several years prior). Image 4 shows profiles across the base of a turbine to show the change in the seabed over time.

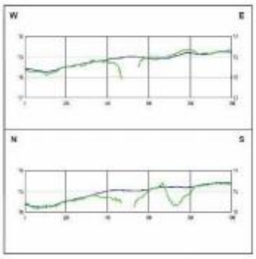

Image 4 - 3D image of turbine base and bathymetric data shows the cables in their J-tubes, and if the cable is exposed.

Image 5 also shows a profile, but with scour protection at the base of the turbine. The turbine base with protection shows hardly any change over the survey years, but the profile without protection shows significant changes after the first year. Because of these changes, turbine inspections have become increasingly intensive, with checks for exposed cables, cable depths, the extent of scour, large seabed variations, problems with protection and seabed hazards and anomalies. Sites with known problems are checked more frequently to build up a timeline for
any changes.

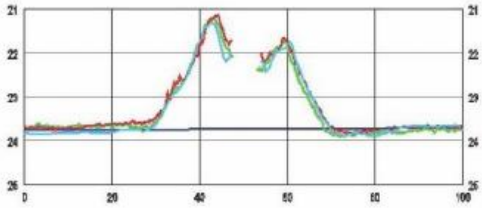

Image 5 - The image shows two profiles over the same turbine, with the top showing a profile from west to east and the bottom showing from north to south. The blue line represents the seabed before construction and the green shows the year after construction.

Monitoring the changes over time means that data can be used to predict the potential scour if more turbines are constructed on the site or on a site with similar environmental conditions. The risk of scour and base protection needs can therefore be considered in the construction stage.

Further Development

New ways to protect the turbine bases and cables are always being developed, as are new ways to visualize the data and the turbine itself. The data measurements showing the depth and diameter of scour can be input to a model created to specifically determine the level of risk to the turbine foundation, and this then would become the deciding factor for considering protection.

Tubes called J-tubes, which offer protection from within the turbine to where the cable is buried so that no sections are exposed, are now protecting cables leaving the turbines.

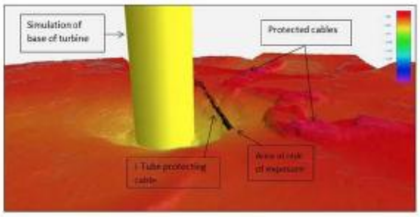

Image 6 - The image shows several years of data collected over the same turbine. The blue line is before construction and the other three are after. This turbine has protection at the base.

The latest high-resolution, shallow-water multibeam sonar systems, when teamed with accurate vertical and horizontal positioning systems, are able to detect any scour around the base of the J-tubes and therefore any damage to the cabling. This protection is ideal for the cable; however, if further scour develops at the base of the J-tube, then the cable will quickly become exposed and may sag into the scour pit around the turbine base. Image 6 also shows rock dumps along the cable further out from the turbine. This 3-D visualization allows the turbine base to be viewed at all angles and can be exaggerated to show data more clearly and builds up a more accurate picture for developers to grasp where issues are likely to occur.

Future Planning

The future for wind farm construction looks set to move closer to scour protection, and more time and resources are being invested in determining the best solution on the current wind farms. Protection is currently considered at the construction stage. Thanks to the advancements in the quality of data, and regular reviews of the changes in the seabed, scour protection can now be considered even earlier, in the planning process. If this continues successfully in a variety of coastal environments, then developers can decide whether the need for protection is required before starting the planning process.

About the author

Alison Pettafor is an experienced senior hydrographic and oceanographic surveyor with EGS International, working throughout Europe. She most recently surveyed as Party Chief for both multibeam and geophysical surveys, including processing multibeam data, both bathymetry (including water column data) and backscatter, for UKHO and CEFAS, having data approved to IHO order1a standard.

Use of bathymetry to monitor pipelines and potential damage

By Alison Pettafor

Pipelines are used underwater for a variety of reasons – i.e., for waste output, oil transfer, gas transfer, water movement, etc. – so it's important that they remain in good condition. Using a multibeam system to monitor the pipeline provides a cost effective image of the pipeline that is difficult to obtain with other systems, particularly in shallow water. (A camera would struggle in murky waters and not offer the level of detail and scale required to effectively show changes to the pipeline.) The multibeam images offer a clear overview of the site and will help with future planning and development along the pipeline without the need to be technically minded. It can clearly show the developing problems along the pipe and, importantly, can show if the pipe is at risk of breaking. This will reduce the risk of unnecessary leaks from the pipe, which is ultimately the main benefit of checking the pipeline.

Pipeline case study – Pipeline before free-spanning

This article outlines the benefits of continual monitoring of underwater pipelines and describes how multibeam bathymetry data can determine damage to pipelines due to dynamic environments. The type of environments shown will typically be in narrow channels with a maximum tidal range (the distance between high and low water) of up to 7m and using a shallow water multibeam system (depth less than 150m). The case study of the pipeline will show how after exposure, the pipeline was left free spanning (meaning the pipe is left unsupported underneath), which resulted in the pipe sagging and, over time, breaking.

In this case, we use a pipeline in water depths of less than 20m, which is situated in a tidally influenced river channel at the narrowest section of the channel, and experiences tidal ranges between 2-7m (2m being the weakest tide and 7m being the strongest). The pipe has been surveyed using a multibeam system every year since 2004 and, during that time, significant changes have been detected. Due to the size of the channel, we generally use a small vessel with a multibeam system mounted underneath the vessel, as this set up improves positioning accuracy and removes the requirement to tow equipment through the water.

Image 1 shows a bathymetric image of the pipeline in 2007 (collected by a high-resolution multibeam system). There are already areas where the pipe is exposed, but only one area where the pipe is unsupported or free-spanning. The area highlighted as rock dump is where a previous section of pipe was exposed and is at risk of free-spanning. The decision was made to protect the pipe by putting boulders on the exposed section (this can also be seen in image 2) – but then previously unaffected areas adjacent to that section started free-spanning.

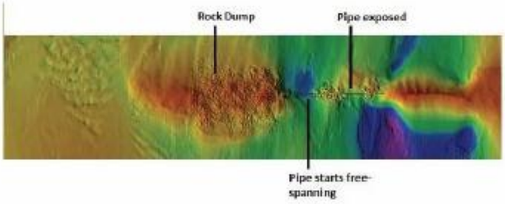

Image 1 - In this bathymetric image of the seabed, the pipeline can be identified at the exposed areas as a thin straight line. The rock dump shows where protection has been laid on the pipeline. This data was collected in 2007.

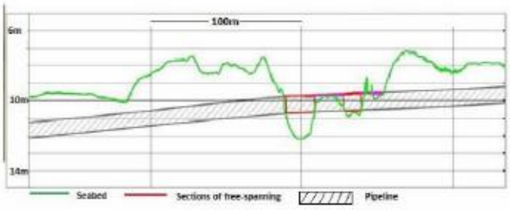

Image 2 - In this profile of the seabed, collected by the multibeam system, the pipeline position is shown as mainly buried. This data was collected in 2007.

Pipeline case study – Pipeline after free-spanning

In 2009, further evidence was collected and showed a large change in the levels of sediment around the pipeline. Due to the dynamic environment, increased sections along the pipeline had become exposed and large sections were left unsupported. Image 3 shows the dramatic change around the pipeline, with up to 6m of sediment removed in some sections.

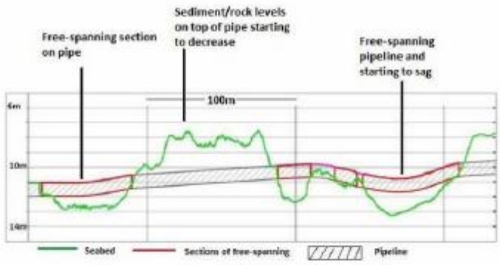

Image 3 - This profile of the seabed, collected by the multibeam system, shows large changes in sediment levels and pipeline free-spanning. This data was collected in 2010.

The extent of the free-span is determined by processing the data collected by the multibeam system. The system used for this survey sends out 512 pings/sound pulses. Image 4 shows an example of the system sending out a collection of pings, where we reduced the angle of data collection to concentrate the data over the pipeline. The data underneath shows an example cross-section of a pipeline and surrounding seabed; the purple shows the top of the 90cm diameter pipe, and the red and green show the seabed. Using this, we can see that if the surrounding seabed is deeper than 90cm from the top of the pipe, then the pipe is free-spanning.

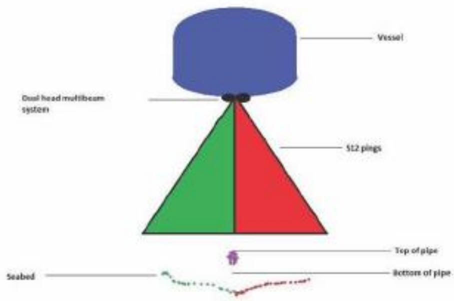

Image 4 - Determining the level of free-spanning, the top of the pipe is detected, as is the surrounding seabed level. Each colored dot represents the distance the ping took to return to the multibeam head.

Once the pipe starts free-spanning, then we need to monitor the extent of the free-span for changes in sediment levels, to see if there is any damage – or chance of future damage – to the pipe. The difference between the data from 2007 and 2009 shows that the pipe has sagged by over 1m.

Pipeline case study – How the data is used

After discovering the extent of the sagging, it was determined that the pipe was at risk from further damage and would break if it continued sagging. The company that owned the pipe was informed and action was taken to construct a new pipeline; the original pipe later developed a break within 6 months after the data collected in 2009. The newer pipeline has subsequently been protected by large mattressing – large bricks of concrete strung together to create a strong and flexible protection – to completely cover the pipeline and protect it from the dynamic environment. Multibeam surveys accurately position the new mattressing to aid the vessel and divers. Image 5 shows the laid mattressing. Note that there are no big gaps between them, which is possible due to the accurate positioning provided by the multibeam data.

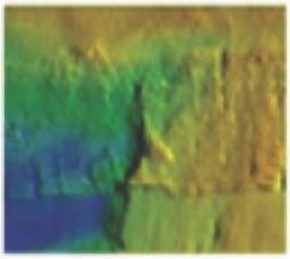

Image 5 - Concrete mattressing laid on pipeline.

The pipeline owners opted to use mattressing for the entire pipeline, after the rock dump on the previous pipeline showed exposure developing on either side of the rocks due to the environmental conditions. Protecting only one section of the pipeline has the potential to cause further problems along the route, so continuous inspection of the changes around the pipeline is a significant way to determine any risks.

Improvements in multibeam high-resolution improve pipeline break detection

Improvements in multibeam systems make identifying these issues increasingly possible. In just the last ten years, the advancements have detected breaks that previously hadn't been detected.

Image 6 shows a high-resolution multibeam image collected from a system sending out 800 pings using a dual swath mode that allows for the same density of data collected at an increased vessel speed. (Dual swath sends the pings out at different frequencies to allow more data to be collected). This works by splitting the data into three sectors, therefore allowing the system to receive a stronger response and reduced interference. The image has a resolution of 30cm and shows a broken pipeline. This is the first image that has been able to detect that the pipeline was broken. Different survey equipment, such as side scan sonar, has been unable to detect the break; surveys with multibeam systems ten years ago also did not detect the break.

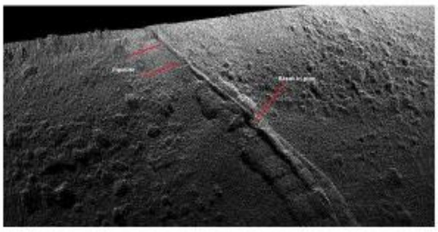

Image 6 - High-resolution data shows each ping return, making it possible to visualize the break in the pipe.

The advances have allowed images down to 5-10cm resolution due to the dense soundings, so detecting and managing any damage has improved substantially.

Future development

These examples have shown changes in multibeam capabilities as well as development in protecting pipelines. When researching the best location to place a pipeline, developers will use multibeam bathymetry and backscatter data (backscatter shows the strength of the return, stronger returns suggest rock features and weaker suggest finer sediment) more vigilantly to base their decisions. The surveys will show the changes in sediment levels in an area and therefore how mobile the sediment is. This can then be used to determine the best location. For instance, a narrower channel will offer a shorter pipeline, however a wider channel might show reduced sediment movement and current velocity and therefore might require less protection.

With technological advancements in the "pipeline" and regular monitoring, free-spanning on pipelines should reduce and potentially be a thing of the past.

About the author

Alison Pettafor is an experienced senior hydrographic and oceanographic surveyor with EGS International, working throughout Europe. She most recently surveyed as Party Chief for both multibeam and geophysical surveys, including processing multibeam data, both bathymetry (including water column data) and backscatter, for UKHO and CEFAS, having data approved to IHO order1a standard.

Hydrography in times of emergency

By Aurel Piantanida

Hydrography is used worldwide to measure and depict seafloor geomorphology. However, it is less known that hydrographic technology is also used for emergency responses. NOAA's **navigation response teams (NRTs)** are 2- and 3-person hydrographic teams based on the east and west coasts of the United States, as well as the Gulf of Mexico and the Great Lakes. These field units operate under the Navigation Response Branch of NOAA's Office of Coast Survey.

NRTs work year round and are tasked with updating NOAA's nautical charts. The technology-ready teams are also deployed after navigational emergencies such as a shipwrecks or hurricanes. Staffed with well-trained responders, NRTs prepare and set up their equipment and boats for emergency situations. With the help of modern **side scan** and **multibeam** sonars, navigation response teams can scan the water column and inspect the sea floor following accidents and natural catastrophes.

Maintaining Readiness Year-Round

A navigational emergency response cannot be improvised: high tech equipment is integrated, calibrated, and tested; technicians train and familiarize themselves with scientific equipment. A NOAA navigation response team boat is equipped with: a single beam sonar that measures under keel vertical depth; a multi beam sonar that forms a swath of measurements, allowing a wider footprint of soundings under the survey boat; and side scan sonars that procure lateral imagery that can be used for object detection on the sea floor or the water column. Along with **sound velocity profilers**, inertial measurement units (an electronic device that measures and reports on a craft's velocity, orientation, and gravitational forces), and other scientific instruments, each NRT prepares its equipment year round so that they can react immediately after a catastrophic event.

Call for Response and Pre-position of Navigation Response Teams:
Before the Hurricane Strikes

Coast Survey's Navigation Response Branch is headquartered in Silver Spring, Maryland. The branch cooperates with other federal agencies (i.e., U.S. Coast Guard, U.S. Army Corps of Engineers, and Federal Emergency Management Agency), state and local agencies, and maritime industry professionals. The purpose of this coordination is to propose diligent and accurate responses to emergencies. Once the information is centralized and a coordinated plan of action is elaborated, Coast Survey tasks one or more NRTs to respond. In the case of a hurricane landfall, the action plan pre-positions the teams close to affected ports. The pre-positioning saves precious response time and allows the NRTs to start their mission on the water as soon as it is physically possible.

Hydrographic Data Acquisition: The Team Springs into Action

In the event of a hurricane landfall, the NRT mission is straightforward: check for dangers to navigation to speed resumption of safe commercial and private navigation. The hydrographic data acquisition part of the mission uses side scan sonars to acquire imagery data and look for shipwrecks, obstructions and other underwater damages caused by the hurricane. Any object detected in navigational channels is investigated further, measured, and precise location of any obstructive danger is recorded. In some instances, multibeam sonar acquires precise information about an object, like its height and more descriptive aspects such as its shape and condition, when possible.

Processing and Analyzing Sonar Data

Once the NRT surveys the area, the teams transfer the data to mobile computer stations where they can fully adjust the data with tide levels and other corrections. The work is done in cooperation with physical scientists from Coast Survey's Navigation Service Division, allowing timely analysis of the processed hydrographic data. At the end of the processing phase, very accurate information about obstructions is derived from the data, permitting the best decision making process possible.

Outcome of the Response: Can the Port Reopen for Safe Navigation?

After the hydrographic data is analyzed, Coast Survey – through its regional navigation manager(s) embedded with the port's hurricane response group – advises the Captain of the Port of the findings, providing the information necessary to determine whether the port can be reopened for safe navigation. In many cases, there are factors to consider. For instance, if obstructions exist, the Captain of the Port will use the hydrographic data to determine if obstructions pose a danger to navigation. The decision may be to remove the obstructions immediately or the port may develop a traffic scheme to avoid the dangers until salvage can begin.

Coast Survey's on-scene navigation manager disseminates the data throughout the cooperating agencies and local interests so they can make informed decisions about the port reopening. Hydrographic data has become, over the years, a crucial and reliable source of information for decision makers at the federal, state, county, city, and organizations levels.

Economic and Safety Benefits: a Port Closure Means an Economic Bottleneck

U.S. maritime commercial activity is a major factor in the country's economy. According to NOAA's **National Ocean Watch**, in 2011 it represented $282 billion in gross domestic product, while employing 2.8 million people and representing $107 billion in wages. The closure of any major U.S. port results in economic loss that can be counted in millions of dollars for every hour of closure. Of course, in the navigational world, safety should always be a priority, and that is the reason why ports have to be closed after hurricanes and other major catastrophic events. Beyond the protection of lives and ships, operational decisions must also prevent further damages to the port area. Navigation response teams recognize their responsibilities in times of emergencies: they must mobilize quickly, collect data safely, and analyze it accurately – while local and regional economies standby for the reopening of ports.

Navigation Response Teams: Small Entities Turned Towards the Future

Navigation response teams are only small entities within the larger NOAA National Ocean Service. A good example of the continuing expansion of the National Ocean Service is the recent opening of NOAA's Gulf of Mexico Disaster Response Center in Mobile, Alabama, which centralizes resources and coordinates efforts during emergencies along the Gulf Coast. Coast Survey's Navigation Response Branch is constantly innovating to provide expedited and reliable hydrographic data. As technology develops, so do emergency operations. In the near future, NRTs will upload – through 4G-LTE internet connections – freshly collected hydrographic data to CLOUD storages for "near real time automated sonar data processing," with the help of super computers. This will allow enhanced, accelerated hydrographic data analysis, and result in better help to coastal communities.

About the author

Aurel Piantanida received a graduate certificate in geographic information science from the University of Arizona in 2006. For over seven years (the first two years as a contractor), he has been a physical science technician with Coast Survey's Navigation Response Branch. He worked on the R/V Bay Hydrographer in the Northeast, and with Navigation Response Team 2 on the Atlantic Coast. Piantanida is now with Navigation Response Team 1, covering the eastern region of the Gulf of Mexico. Over the years, he participated in multiple emergency responses for NOAA's Navigation Response Branch.

Are You Really a Hydrographer?

Opposing views on what it takes to be called a hydrographer.

By Kevin Tomanka

For many in our profession who have handed over a business card to someone outside the industry, if it is met with a furrowed brow, you can almost be certain of the incoming question: "what's a hydrographer?" Depending on the person you are speaking to, you may provide a thorough explanation involving your particular role or just a single sentence and leave it at that. But are we hydrographers so sure that we have a full grasp of the title within our own ranks? What is hydrography and who is a hydrographer? Some may accept a more flexible definition, while others solidify their definition by asserting what it is not. The theme of this year's World Hydrography Day itself has sparked a conversation that has grown heated on both sides.

The background

The combined form containing "**-graphy**" originating from the Greek word graphos, meaning "to write" is described by the Oxford English Dictionary as "a descriptive science, a technique of producing images, or a style or method of writing or drawing." Thus, "**-grapher**" being a person concerned with the given subject. Oxford defines **hydrography** as "the science of surveying and charting bodies of water, such as seas, lakes, and rivers." This could potentially imply that any person creating images of what is beneath the surface would therefore be practicing hydrography, but those who have taken the time to go through the training and certification to call themselves hydrographers will argue that this is clearly not the case.

"I believe that the theme for 'World Hydrography Day' is ill defined by using 'Hydrography: it's more than charts'. It is not," says **Captain Barry Lusk**, an ACSM certified hydrographer and Canada lands surveyor with over 40 years of hydrographic charting experience. In addition to his 61 major hydrographic survey documents for the Canadian Hydrographic Service (CHS), he has also offered expert testimony for several international ship grounding cases.

In a recent interview, Lusk stated that the definition of hydrographer or hydrography is best explained by the position taken and outlined by the International Hydrographic Organization (IHO), and cited a number of their documents that establish standards and competencies for hydrography and nautical cartography. The **IHO defines hydrography** as "the branch of applied sciences which deals with the measurement and description of the physical features of oceans, seas, coastal areas, lakes and rivers, as well as with the prediction of their change over time, for the primary purpose of safety of navigation and in support of all other marine activities, including economic development, security and defense, scientific research, and environmental protection."

The key in the IHO definition is the phrase "primary purpose." This suggests, and is interpreted by some, that if the primary purpose of the measurements is not for a navigation chart, then it falls outside the definition of hydrography.

"The hydrographer and marine cartographer produce a mapping product that answers the question of safe marine traffic," says Lusk, "and at the same time offers their product, the nautical chart, to anyone else who may value its uses and for their own purposes, of which there are many."

So what then happens if a hydrographic dataset was collected for something other than a chart? Is it still hydrography? Brent von Twistern thinks so.

"The presentation of hydrographic data does not change the nature of the data, only the perspective,"
Twistern says.

Brent is the technical director for Universal Sonar Mount and a founder of **Journey Around Happy, Inc.**, a company that combines hydrographic data sets with photography and oil paint embellishments into what they call a "fine art sub-scape." He is familiar with the definitions of hydrography, but he thinks differently about who is included in the practice.

A fine art sub-scape titled "Classic Woody," by Journey Around Happy

"To me, a hydrographer is someone whose core competencies focus on spatial information of aquatic environments," says Twistern. "They are an interesting bunch of folks that come from all walks of life but share in the exploration of planet and life."

Keep Them Separated

Historically, nations' navies and their respective hydrographic organizations have had a special relationship. Knowing the depths of a body of water was a clear strategic advantage when sailing in times of both war and peace. Still today, many refer to the long tradition that exists in the profession. But the list of people who are supported by this data has increased in recent decades into what is now referred to as the "Blue Economy" (which also happened to be the theme of 2013's World Hydrography Day), including oil and gas exploration, wave, wind, and current energy installations, and environmental monitoring just to name a few.

Does this mean that all who map the bottom are hydrographers, or should we separate those who follow this tradition of charting from the new group of people mapping to support the Blue Economy? While several professional groups – like **The Hydrographic Society of America (THOSA)** – currently offer membership to anyone, Barry Lusk calls for a distinction.

"Without these qualification and training, you are not conducting acceptable hydrographic surveys and compiling nautical charts that comply with IHO standards." Lusk says. "It's like engineering the construction of a major bridge over the English Channel without a qualified group of engineers who have training and experience necessary to build this bridge safely and correctly and according to established standards. If you do not have this training then you are not a hydrographer. It's as simple as that."

The **International Federation of Hydrographic Societies** (of which THOSA and CHS are not listed as member societies) states on their website that hydrography is simply "the measurement of various physical characteristics of the oceans (or other waters) such as bottom depth, currents and waves." It then goes on to state that although in the past this was primarily for safe navigation of vessels, it now currently includes "many applications from the oil and gas industry, to leisure activities and the fishing industry."

Twistern seems to agree with this definition more than that of the IHO.

"Hydrographers have historically worked in disciplines that support navigational products," Twistern says, "but with technological advancements, the use of hydrographic data has made its way into non-standard and emerging markets like environmental monitoring, sediment remediation, coastal construction and engineering, hydrologic modeling, oceanographic research, marine archeology, fossil fuels exploration and management. Most of these activities rely on hydrographic data just the same as a navigational product does."

Barry Lusk confirms that while these activities may be included, they remain secondary to the chart.

"It should be noted that within this list of other activities resulting from hydrographic surveys and the resultant charts, these other activities make use of the final product of the hydrographic surveys and none or very few of these surveys were carried out to answer any one of these extraneous activities mentioned," Lusk explains. "The charts, because of extremely valuable and well-constructed bodies of information, become extremely useful to these other disciplines and are useful to them not because of them."

A View from Down-Under

So far, about the only thing that can be agreed upon between these two camps is the fact that hydrographers work on the water, but as we explore the definition around the world, there are still some organizations that aim to include even more people under the banner of hydrographer. The **Australian Hydrographers Association** defines an Australian hydrographer as someone who "monitors, measures, analyses and describes the earth's surface and groundwater resources and many aspects of the water cycle, including human use of water resources." It then states that hydrographers are divided into two sub-groups, land-based and offshore.

Barry Lusk believes this could not be further from the truth.

"Worldwide hydrographers do not analyze and describe earth's surface and groundwater resources," he says. "They certainly do not deal with water cycles that include human use of water resources... We should make it clear to them that they are not what they claim to be and their association is misnamed."

So where do we then draw the line? Is it at those who survey for the purpose of the chart and those who do not? Is it at those who survey from the surface of the water, and those who do not? And, if we apply one of those definitions, then we must work on creating names for all the activities that are now conducted outside of it. Or, could we propose that hydrography is an inclusive title that describes the practice of imaging hydrospace, and all who do it are considered hydrographers?

People like Barry Lusk and his colleagues may feel better if there was a recognized license that would keep those without the training and skills away from chart creation, and allowing those without to serve the rest of the blue economy. Should it really be called a "hydrographers license," or would "licensed bathymetric surveyor" be a more fitting title?

Brent von Twistern closed his comments with an inclusive thought: "The difference is solely the use and presentation of the hydrographic data. For me, all are hydrographers."

About the author

Kevin Tomanka has been in the hydrographic industry for over twelve years and has been a member of the Hydrographic Society of America since 2005. He has experience in a full range of specialized survey services including multibeam installations, data processing, and project management. Most recent projects have included mapping for deep-sea mining, data processing, and QC of charting/navigation surveys for NOAA as well as foreign charting agencies, condition and DTM surveys for the U.S. Army Corps of Engineers, and client representation on oil and gas pipe-lay projects. He received his Hypack software certification in 2011 and his first EIVA instructor certification in 2013. He is currently studying to sit for his ACSM hydrographer certification.