INTERNATIONAL HYDROGRAPHIC ORGANIZATION

NATIONAL REPORT FROM THE UNITED STATES OF AMERICA

ARHC-11

Submitted by:

National Oceanographic & Atmospheric Administration
http://www.nauticalcharts.noaa.gov/

National Geospatial-Intelligence Agency
http://msi.nga.mil/NGAPortal/MSI.portal

United States Navy
http://www.navmetoccom.navy.mil/

Contents

1. HYDROGRAPHIC OFFICE/SERVICE

This National Report provides specific information pertaining to individual products and services of primary interest to the Arctic Regional Hydrographic Commission (ARHC). Four government agencies are responsible for the management of U.S. domestic and international hydrographic products, services, and maintenance.

1.1 General

1.1.1 National Oceanic and Atmospheric Administration's (NOAA), primarily the Office of Coast Survey, conducts hydrographic surveys and produces nautical charts and related hydrographic information within the nation's Economic Exclusion Zone (EEZ).

1.1.2 National Geospatial-Intelligence Agency (NGA), primarily Source Operations and Management Directorate, Foundation Group, Maritime Safety Office (MSO), provides nautical charts and related hydrographic information and is the mapping and charting authority for the U.S. Department of Defense (DOD) and commercial mariners in areas outside the U.S. where the U.S. is the designated charting authority.

1.1.3 The U.S. Navy, primarily the Commander, Naval Meteorology and Oceanography Command (COMNAVMETOCCOM) and the Hydrographer of the Navy, conducts oceanographic, bathymetric, and hydrographic surveys worldwide to satisfy DOD and national security requirements.

1.1.4 The United States Coast Guard (USCG), primarily the United States Coast Guard, District 17, provides multifaceted SOLAS support with the responsibility of care and maintenance of maritime aids to navigation used for nautical charting, publishing Local Notice to Marines for hazard avoidance, search and rescue, security, and ice operations in the Arctic. Coast Guard District 17 serves the U.S. Arctic.

2. SURVEYS

2.1 Coverage of new surveys

NOAA provides nautical charts and related hydrographic information for the safe and efficient navigation of maritime commerce as well as providing basic data for engineering, scientific, and other commercial and industrial activities within the nation's 3.4 million square nautical mile EEZ (U.S. EEZ) and along its 95,000 miles of shoreline.

In 2020 and 2021, NOAA surveyed approximately 2400 square nautical miles (SNM) of Arctic seafloor across six separate projects. In 2022, four Arctic hydrographic surveys are planned to provide updated bathymetry in over 3000 SNM of Arctic waters.

2020 NOAA Hydrographic Projects

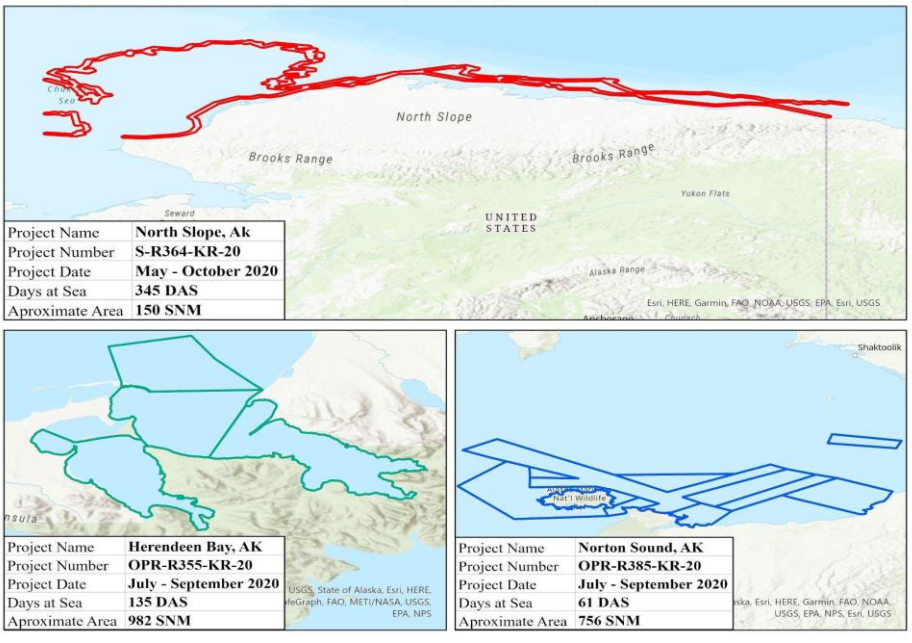

Figure 1. 2020 NOAA Arctic Hydrographic Surveys

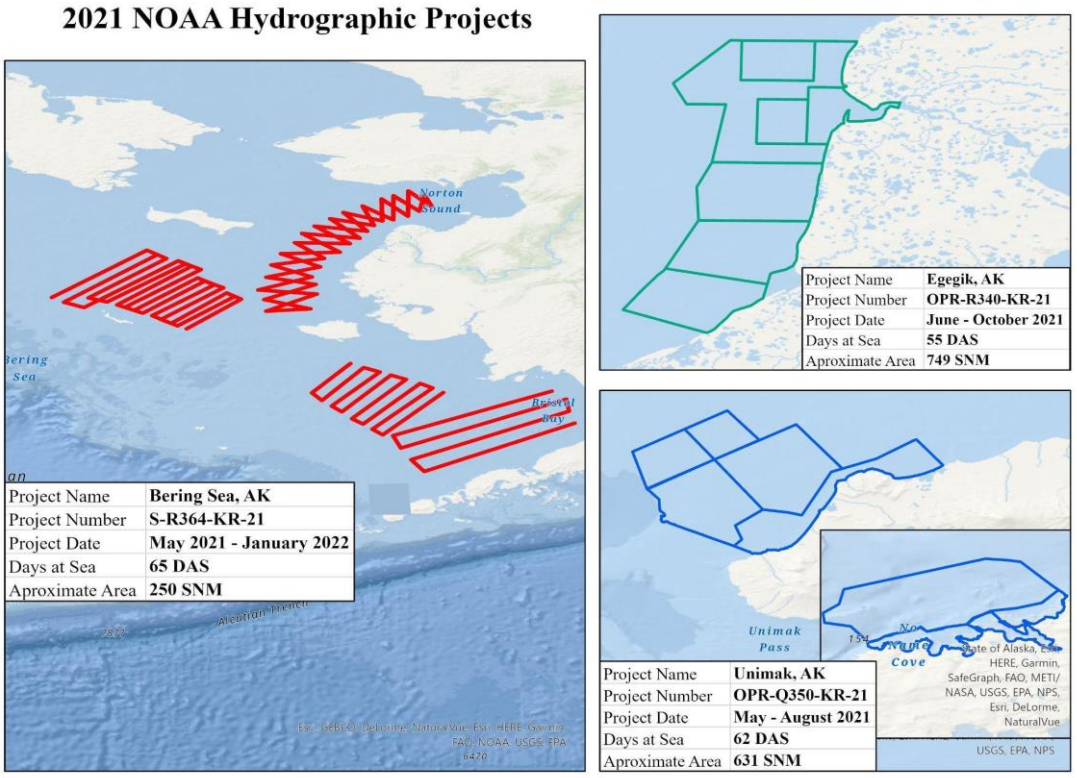

Figure 2. 2021 NOAA Arctic Hydrographic Surveys

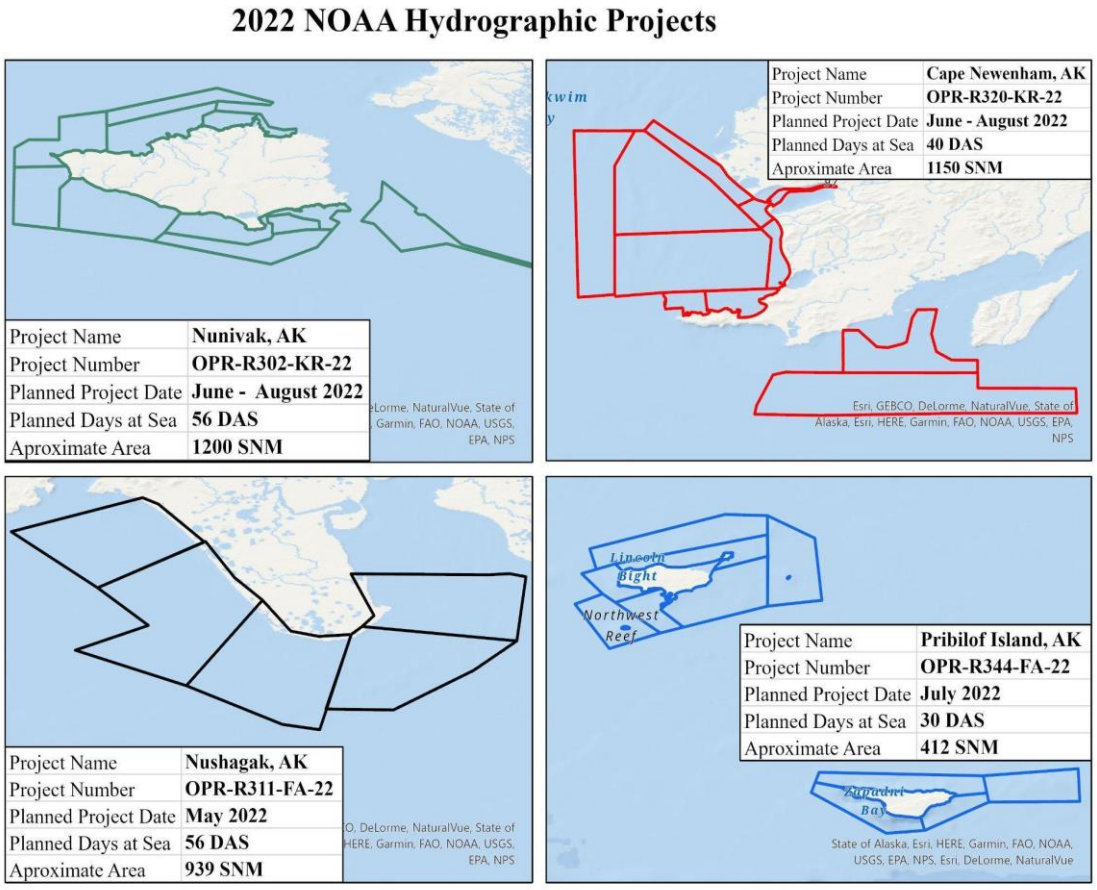

Figure 3. Planned 2022 NOAA Arctic Hydrographic Surveys

The U.S. Navy conducts hydrographic surveys outside the United States in international waters and in territorial waters of partner nations, through diplomatic channels and international agreements. These survey operations enhance maritime commerce and security and support relationship and capacity building initiatives. By U.S. Navy, Commander, Naval Meteorology and Oceanography Command (COMNAVMETOCCOM) Instruction 5510.1, "Disclosure of Information to Foreign Governments and International Organizations," it is policy to treat all data collected through bi-lateral agreements as restricted from public release. Accordingly, the Hydrographic Service or Port Authority of the respective country is the appropriate point of contact for inquiries or requests for data regarding any of these surveys.

2.2 New technologies and /or equipment

As Uncrewed Systems (UxS) and Autonomous Surface Vehicles (ASVs) continue to make strides and emerge from the testing phase into the operational status, NOAA and NOAA Contractors have tested, evaluated, and operationalized several of these technologies within Arctic Alaskan waters. In 2018, NOAA Coast Survey first acquired hydrographic survey data via an autonomous platform using an L3Harris C-Worker 4 owned by the NOAA/University of New Hampshire Joint Hydrographic Center (JHC). The C-Worker 4 was deployed from NOAA Ship *Fairweather* to acquire data near Point Hope, AK and demonstrated the feasibility of acquiring hydrographic data via an autonomous system in high latitude environments.

Currently, NOAA is investigating the potential for converting existing Hydrographic Survey Launches already integrated into the NOAA fleet into Optionally-crewed Hydrographic Survey Launches (OHSL). The testing and evaluation of OHSL is ongoing with long-term benefits of their implementation including increased survey efficiency and new survey capabilities.

NOAA contractors have used two different autonomous systems to further surveying capabilities beyond the traditional methods of crewed hydrographic survey vessels. These technologies include both force multiplying UxS operating with a nearby mothership, as well as ASVs deployed independently to survey remote reaches of the Arctic.

The UxS C-Worker 5, developed by L3-Harris, has been used as a force multiplier on multiple NOAA Hydrographic Surveys in the Arctic to increase efficiency, as well as crew safety when surveying uncharted near-shore waters. The C-Worker 5 has the capability to survey continuously for four to five days without the need to regularly visit the mothership, thus increasing the rate of acquisition when compared to a traditional crewed survey launch operating only during daylight hours.

Saildrones are wind driven vehicles equipped with solar panels that power the bathymetric transducers affixed to the hull. Saildrones have the capability to be equipped with either multibeam or single beam echo sounders, however NOAA has only used single beam echo sounders in the Arctic region. These vehicles have completed two missions, one charting the North Slope of Alaska and the second exploring uncharted areas of the Bering Sea.

The Naval Oceanographic Office (NAVOCEANO), a subordinate command of COMNAVMETOCCOM, currently employs six Pathfinder Class 100-meter multipurpose survey ships to conduct oceanographic, bathymetric, and hydrographic surveys in deep-ocean and coastal waters. Each ship carries two 10-meter hydrographic survey launches (HSLs). NAVOCEANO also maintains the Airborne LIDAR Hydrography (ALH) capability with the Optech, Inc., "Coastal Zone Mapping and Imaging" LIDAR (CZMIL) system. A Basler BT-67, a refurbished DC-3, serves as the airborne system that carries the CZMIL system. NAVOCEANO's subordinate command, Fleet Survey Team (FST), employs various survey vehicles including four 9 meter Workskiffs with amidship transducer moon pools; portable high-resolution multi-beam survey kits for boat of opportunity surveys; four Teledyne Z-Boat 1800 Unmanned Surface Vessels (USV) equipped with multi-beam sonar; two Iver3 580 Unmanned Underwater Vehicles fixed with Bathymetric Interferometric Side Scan Sonar; and rapid littoral survey vehicles (RLSVs) (personal watercraft fitted with a single beam echo sounder and side scan sonar). C-130 aircraft provide rapid deployment transportation capability for all FST craft. FST also maintains a year-round stand by "Fly-Away Team" consisting of four personnel and survey gear to outfit boats of opportunity. This capability enhances standard Navy survey requirements and provides capacity to maintain

navigable approach corridors in support of humanitarian aid and disaster relief

2.3 New ships
NOAA plans to acquire two Class B ships with the primary mission of surveying and mapping. These ships will be able to deploy and recover crewed launches and autonomous survey systems such as uncrewed launches and uncrewed aerial vehicles. The ships and launches will collect multibeam echo sounder, backscatter, and water column data and will have shipboard data processing capabilities.

2.4 Crowdsourced and satellite-derived bathymetry - national policy
Crowdsourced (CSB) and satellite-derived bathymetry (SDB) offer critical insight during the planning phase of hydrographic survey operations and are often used as a reconnaissance tool prior to initiating vessel-based operations. In addition, CSB and SDB can be used to identify where nautical charts may be inadequate and updated hydrographic surveys are needed. When appropriate and with sufficient metadata, these data may be applied to the nautical charts when the source and uncertainties of the data are well understood.

2.5 Challenges and achievements
Arctic mapping missions are faced with a number of unique challenges. The main challenge is related to the limited operational window within these high latitudes. The seasonable accessibility of the Arctic region is constrained by weather conditions, sea ice extents, and limited infrastructure. The limited infrastructure in the Arctic extends transit times to and from survey sites and subsequently increases overhead costs associated with mapping in these remote locations.

It is also imperative to consider how hydrographic operations will impact indigenous Subsistence Activities. All operations must be carefully communicated, planned, and monitored to mitigate adverse impacts. This challenge is only increasing as environmental shifts within the Arctic alter traditional migration patterns. NOAA continues to work with individual indigenous communities, as well as forums such as the Arctic Waterways Safety Committee, to foster open communication and collaboration regarding operational plans.

In 2020 and 2021, Arctic hydrographic operations were further limited due to operational constraints related to the COVID-19 pandemic. In an effort to combat the disruption to operations due to the pandemic, NOAA Coast Survey contracted four Saildrone autonomous surface vehicles to acquire single-beam data along the North Slope (2020) and within the Bering Sea (2021). In addition, NOAA Coast Survey acquired approximately 2,300 SNM of vessel-based hydrographic data within the Arctic in the vicinity of Unimak, Herendeen Bay, Egegik, and Norton Sound.

3. NEW CHARTS AND UPDATES

3.1 ENC coverage, gaps and overlaps
NOAA achieved complete ENC coverage of all U.S. waters several years ago. There are no gaps in coverage. A major program to rescheme the entire suite of NOAA ENCs is underway. This will result in about 7500, often larger scale, ENC cells in 11 standard scales. Some minor overlaps exist with some Russian and Canadian ENCs. These will be resolved as the rescheming proceeds. More information about the ENC rescheming effort is available on the NOAA Coast Survey "Rescheming and Improving Electronic Navigational Charts" webpage. Progress of the rescheming effort is shown on the "Status of New NOAA ENCs" webmap.

3.2 ENC distribution method
NOAA provides nautical products, services, and web deliveries of digital versions of most data, which are available free to the public.

For access to survey data: https://nauticalcharts.noaa.gov/data/hydrographic-survey-data.html
For access to RNC Charts: https://nauticalcharts.noaa.gov/charts/noaa-raster-charts.html
For access to ENC Charts: https://nauticalcharts.noaa.gov/charts/noaa-enc.html
For access to the Coast Pilot: https://nauticalcharts.noaa.gov/publications/coast-pilot/index.html

NOAA produces about 250 RNC and ENC charts over Alaskan waters. All charts are updated weekly with the latest Notice to Mariners and new dangers to navigation information. Raster charts are available for download from the NOAA website for free. Paper copies of Print-on-Demand (POD) products may be purchased from one of nearly three dozen NOAA certified chart printing agents.

U.S. ENCs are available as free downloads from the internet. Mariners who wish to download NOAA ENCs directly and use the data to fuel ECDIS or ECS may do so. ENCs, including newly created NGA ENCs, are distributed directly from NOAA on the web at www.nauticalcharts.noaa.gov. Regulated mariners who intend to fulfil a carriage requirement are encouraged to obtain ENCs through the International Center for ENC's Distributors, http://www.icenc.org/Distribution.html.

3.3 RNCs
No additional RNC have been produced. All existing U.S. RNCs will be canceled by Jan 2025 as part of the U.S. program to transition all "traditional" paper nautical charts and related raster products (see section 3.4).

3.3 INT charts
No additional INT charts have been produced. All existing U.S. INT Charts will be canceled by Jan 2025 as part of the U.S. program to transition all "traditional" paper nautical charts and related raster products (see section 3.4).

3.4 National paper charts
No additional traditional national paper nautical charts have been produced. In a November 2019 notice in the U.S. Federal Register, NOAA announced the transition of its traditional paper and raster nautical chart products. Cancellation of individual charts started in 2021 and will be completed by January 2025. Ending traditional chart production will enable NOAA to devote more resources to improving the electronic navigational chart (ENC) product suite, which is expected to grow from the 1700 ENCs maintained in 2021 to about 7500, higher quality, more detailed ENC cells. More information about the cancellation of traditional national paper charts and efforts to promote the transition to use of ENCs is available on the NOAA Coast Survey "Farewell to Traditional Nautical Charts" and "Rescheming and Improving Electronic Navigational Charts" web pages.

3.5 Other charts, e.g. for pleasure craft
All existing U.S. traditional paper nautical charts, including small craft charts and associated raster chart products will be canceled by Jan 2025 as part of the U.S. program to transition all "traditional" paper nautical charts and related raster products. A paper chart alternative is being made available in the form of the online NOAA Custom Chart application. This enables users to create their own customized nautical charts directly from the latest official NOAA electronic navigational chart (NOAA ENC®) data. The tool outputs Portable Document Format (PDF) files set to the paper size, scale, and location selected by the user. Depths can be displayed in meters, feet, or fathoms and there are other display options, such as changing the depth at which a shallow water blue tint is applied and the depiction of a "safety contour" based on a vessel's draft. More information is on NOAA Coast Survey's NOAA Custom Chart web page: https://nauticalcharts.noaa.gov/charts/noaa-custom-charts.html

3.6 Challenges and achievements
(U) NGA's Maritime Safety Office has begun its transition of Vector Product Format (VPF) Digital Nautical Charts (DNC) to S-57 Electronic Navigation Charts (ENCs). To aid with the transition, they have developed a worldwide (including the Arctic) standard grid to convert the products that will also help NGA's transition to S-100. The scheme provides set boundaries with a rigid model that effectively take out a product-dependent category and become part of the ENC infrastructure.

4. NEW PUBLICATIONS AND UPDATES

4.1 New Publications

The **United States Coast Pilot**, produced and maintained by NOAA, consists of a series of ten regionally- focused nautical books that cover a variety of useful information important to navigators for coastal and intra-coastal waters and the U.S. Great Lakes. For the ARHC region, Coast Pilot 8 (43rd ed., 2021) and 9 (38th ed., 2020) covers Alaska.

The **American Practical Navigator (Pub. 9)**, produced by NGA and first published in 1802, describes in detail the principles and factors of navigation, including piloting, electronic navigation, celestial navigation, mathematics, safety, oceanography, and meteorology. It also contains various tables used in typical navigational calculations and solutions, including the formulas used to derive the tabular data. The 2019 edition of the American Practical Navigator is published in two volumes.

Sailing Directions, produced and maintained by NGA, consists of useful information important to navigators of coastal waters. Information for the ARHC region is contained in the following Sailing Directions:

a. Pub. 145, Sailing Directions (Enroute) Nova Scotia and the St. Lawrence (18th edition 2018).
b. Pub. 146, Sailing Directions (Enroute) Newfoundland, Labrador, and Hudson Bay (18th edition 2021).
c. Pub. 181, Sailing Directions (Enroute) Greenland and Iceland (14th edition 2021).
d. Pub. 182, Sailing Directions (Enroute) North and West Coasts of Norway (14th edition 2018).
e. Pub. 183, Sailing Directions (Enroute) North Coast of Russia (13th edition 2021).
f. Pub. 180, Sailing Directions (Planning Guide) Arctic Ocean (13th edition 2020).

World Port Index (Pub. 150), produced and maintained by NGA, contains the location and physical characteristics as well as the facilities and services offered by major ports and terminals worldwide.

The World Port Index is now also available online as a suite of web applications. See Paragraph 4.4—Challenges and Achievements for further information.

List of Lights, Radio Aids, and Fog Signals, produced and maintained by NGA, contains information on lights and other aids to navigation that are maintained by or under the authority of foreign governments. Information for the ARHC region is contained in the following List of Lights:

a. Pub. 110—Greenland, the East Coasts of North and South America (2020 edition).
b. Pub. 111—The West Coasts of North and South America (2021 edition).
c. Pub. 115—Norway, Iceland, and Arctic Ocean (2020 edition).

4.2 Updated publications

The U.S. Coast Pilot now offers completely updated publications every month.

Amalgamated International and U.S. Inland Rules - this publication is an amalgamation of the International Regulations for Preventing Collisions at Sea (72 COLREGS) and Inland Navigation Rules, their Annexes, and associated Federal rules and regulations. The format of this publication uses a single-page layout that concisely sets out the differences between each set of rules. It is meant to be concise, easy to view online, download, and print.
https://nauticalcharts.noaa.gov/publications/coast-pilot/docs/NavigationRulesStandardSize.pdf

Distances between U.S Ports - 13th Edition (2019) - contains distances from a port of the United States to other ports in the United States, and from a port in the Great Lakes in the United States to Canadian ports in the Great Lakes and St. Lawrence River. Table 33-36 covers areas of interest to the ARHC.
https://nauticalcharts.noaa.gov/publications/docs/distances.pdf

The American Practical Navigator is reviewed and updated on a maximum 5-year cycle. Updates may be issued sooner based on circumstances.

Sailing Directions undergo continuous review. Updates are issued every 3 to 6 months depending on circumstances. Updates may be issued sooner if necessary.

The World Port Index is updated weekly.

The List of Lights, Radio Aids, and Fog Signals is updated weekly.

4.3 Means of delivery, e.g. paper, digital
U.S. Coast Pilots—Downloaded (in PDF and xml format) from the United States Coast Pilot website: https://nauticalcharts.noaa.gov/publications/coast-pilot/index.html

American Practical Navigator—Downloaded as a PDF document from the NGA Maritime Safety Information web site: https://msi.nga.mil/Publications

Sailing Directions—Downloaded as PDF documents from the NGA Maritime Safety Information web site: https://msi.nga.mil/Publications

World Port Index—A PDF of the legacy World Port Index can be downloaded from the NGA Maritime Safety Information website: https://msi.nga.mil/Publications. A .csv of the most up-to-date World Port Index can be obtained from the same web site.

List of Lights, Radio Aids, and Fog Signals—Digital updates are posted at the NGA Maritime Safety Information web site: https://msi.nga.mil/Publications

Publications produced by NOAA are publicly available on our website and also can be purchased through certified Print on Demand vendors.

4.4 Challenges and achievements
Currently, the authoritative version of all NGA publications is the pdf. However, in recent months, NGA released a modernized World Port Index (Pub 150) as a suite of web applications with additional data fields and the ability to crowd-source accurate information from port authorities and other first-hand sources. This version is available through NGA's ArcGIS Online platform and updated weekly. A .csv file containing the complete set of data is updated monthly and posted on NGA's Maritime Safety Information web site.

In early calendar year 2022, NGA will also release a beta version of Radio Navigation Aids (Pub 117) available as a web application.

These web applications allow users to interact directly with the data, querying and searching through entries to find applicable attributes. In the next year, the ability to download customized sets of data will become available to the general public, as well.

5. MSI

The NAVAREA coordinator is the authority charged with coordinating, collating, and issuing navigational warnings for a designated NAVAREA within the IMO/IHO World-Wide Navigational Warning Service (WWNWS). ARHC waters primarily lie within NAVAREA XVII/XVIII (Canada), NAVAREA XIX (Norway) and NAVAREA XX/XXI (Russia).

5.1 Existing infrastructure for MSI dissemination
5.2 Statistics on work of the National Coordinator
5.3 New infrastructure in accordance with GMDSS Master Plan
5.4 Challenges and achievements

6. C-55

6.1 Latest update using the available template or online system

7. Capacity Building

7.1 Offer of and/or demand for Capacity Building

Category-A Competence Training for Hydrography

Training opportunities are available at various institutions in the United States. Two Category A certified hydrographic programs are available through:

- The University of Southern Mississippi (USM) in partnership with U.S. Navy
- The University of New Hampshire (UNH)

Category-B Competence Training for Nautical Cartography

The National Geospatial-Intelligence Agency (NGA) commenced training with an IHO/ICA/FIG IBSC approved portable S-8 Category B Nautical Cartography class in 2017. NGA teamed up with IIC Technologies to provide training to analysts with a comprehensive 20-week instructor led course and a six-week final project. The third session began in July 2020 and has been conducted 100% virtually due to COVID -19 restrictions. The fourth session is scheduled to start in March 2021. A combination of lectures, hands-on compilation techniques, and homework assignments will prepare the students for the final project, the creation of a finished ENC product for NGA users. NGA plans to continue offering this training in the future.

The IBSC approved the NOAA program for Category B in Cartography in 2017. Since 2017, 32 students graduated from the program, including one foreign national student from the Nigerian Navy. The fourth class began in August 2020 with 12 students.

Chart Adequacy Workshop

NOAA's Office of Coast Survey hosts an annual week-long workshop on nautical chart adequacy assessment for approximately one dozen students from around the world. The participants receive training in techniques to evaluate the suitability of nautical chart products using chart quality assessment techniques with publicly available information. For more information, please contact Dr. Shachak Peeri (shachak.peeri@noaa.gov).

Category-B Competence Training for Hydrography

U.S. Navy offers a six-month, IBSC approved Category B International Hydrographic Management and Engineering Program (IHMEP), commencing annually in February, via COMNAVMETOCCOM and the Information Warfare Training Group in Gulfport, Mississippi. This training is available to both uniformed and civilian government personnel. COMNAVMETOCCOM also offers mobile hydrographic training via NAVOCEANO. U.S. Navy's Category A and B programs and mobile training all qualify for Security Cooperation assistance.

Maritime Safety Information (MSI) Training

The National Geospatial-Intelligence Agency (NGA) directly supports the IHO Maritime Safety Information (MSI) training course as well as provides support to nations through on-site and remote guidance and advice as they grow their hydrographic capacity. NGA is currently finalizing a virtual MSI training course which will be available to the IHO and our international partners in the months to come. The MSI course is an important first step for building that phase 1 Capacity Building capability within a country.

7.2 Training received, needed, offered

7.3 Status of national, bilateral, multilateral or regional development projects with hydrographic component (in progress, planned, under evaluation or study)

7.4 Definition of proposals and requests to the IHO CBSC

8. Oceanographic Activities

8.1 General

Crowdsourced Bathymetry

The IHO currently defines crowdsourced bathymetry data as "the collection of depth measurements from vessels, using standard navigation instruments, while engaged in routine maritime operations." These data can be used to supplement the more rigorous and scientific

bathymetric coverage undertaken by hydrographic offices, industry, and researchers around the world. The key to successful CSB efforts are volunteer observers who operate vessels-of-opportunity in places where charts are poor or where the seafloor is changeable and hydrographic assets are not easily available.

NGA and NOAA provide financial support for the IHO-initiated project to maintain a global database for CSB hosted by the IHO Data Centre for Digital Bathymetry (IHO DCDB). The IHO DCDB, co-located with NOAA's National Centers for Environmental Information (NCEI), has established the infrastructure necessary to provide archiving, discovery, display and retrieval of global CSB from mariners around the world.

The online database can be found at ncei.noaa.gov/maps/iho_dcdb/.

NOAA is currently coordinating with the Navico CMAP, James Cook University, the Great Lakes Observing System (GLOS) and the Nippon Foundation-GEBCO Seabed 2030 Project to establish new CSB data transfer mechanisms. The vision is to tap into the enthusiasm for mapping the ocean floor by enabling trusted mariners to easily contribute data to fill the gaps in current bathymetric coverage.

NOAA, NGA and U.S. Navy are active participants in the IHO Crowdsourced Bathymetry Working Group (CSBWG). The working group, composed of international scientific, hydrographic and industry experts, was initially tasked to draft a guidance document meant to empower mariners to collect and contribute CSB data. This document describes what constitutes CSB, the installation and use of data loggers, preferred data formats, and instructions for submitting data to the IHO DCDB. Edition 2.0.0 of B-12 IHO Guidance on Crowdsourced Bathymetry has now been in circulation for over two years and, apart from including feedback from operational use and experience, there was a strong desire to make the document more "equipment agnostic" with the intent of soliciting data from all sources, not just single beam echo sounders. The CSBWG intends to circulate an updated version to MSs for comment in 2022.

8.2 GEBCO/IBC's activities, GEBCO Seabed 2030 activities

In 2020, the United States debuted a National Strategy on Mapping, Exploring, and Characterizing the U.S. Exclusive Economic Zone (NOMEC) and set a call to action for Federal agencies and non-Federal partners to build a national expertise to map, explore, and characterize the U.S. EEZ. In January 2021, the implementation plan for the NOMEC strategy debuted. Paralleling the Seabed 2030 goals, the U.S. has a goal to completely map the seafloor in U.S. waters deeper than 40m by 2030. Recognizing the difficulties in mapping the nearshore, the mapping goal for U.S. waters shallower than 40m is 2040. The plan calls for the formation of regional mapping campaigns to enact the NOMEC goals. In July 2021, ***Seascape Alaska***, a regional mapping campaign supporting the NOMEC strategy, was born. The group has assessed that 72 percent of the nearly 1 million square nautical miles of coastal and ocean waters adjacent to Alaska are considered unmapped (Progress Report on Unmapped U.S. Waters, January 2021). A plan of action to fill those gaps is underway. There is an Alaska Coastal and Ocean Mapping Summit planned for December 1-2, 2021.

8.3 Tide gauge network

8.4 New equipment

8.5 Challenges and achievements

9. Spatial Data Infrastructures

9.1 Status of MSDI

The United States actively supports MSDI within the country as well as regionally, and internationally. The MSDI capability is important for supporting those non-traditional users of Maritime Safety data to allow them to complete their environmental research, port development, or disaster support projects for example. The U.S. MSDI efforts help build a larger community of users for this marine data than the traditionally intended hydrographers and cartographers making Safety of Navigation products and data.

9.2 Relationship with the NSDI

9.3 Involvement in regional or global MSDI efforts

The International Hydrographic Organization Data Centre for Digital Bathymetry (IHO DCDB) was established in 1988 to steward worldwide bathymetric data on behalf of the IHO Member States. The Centre provides long term archive of and access to single and multibeam deep and shallow water ocean depths contributed by a range of mariners. The IHO DCDB welcomes bathymetric data and metadata, accepts descriptions and spatial footprints of data that is already online and of data that are not publicly available to provide easy search and discovery. Information can be obtained at: https://www.ngdc.noaa.gov/iho/

Additionally, the U.S. actively participates in the work of several international MSDI-focused working groups:

- IHO Marine Spatial Data Infrastructures Working Group (MSDIWG)
- United Nations Committee of Experts on Global Geospatial Information Management (UN-GGIM) Working Group on Marine Geospatial Information (WG-MGI)
- Open Geospatial Consortium Marine Domain Working Group (OGC Marine DWG)

9.4 National implementation of the Shared Data Principles – including any national data policy and impact on marine data

9.5 MSDI national portal

The Federal Geospatial Data Committee (FGDC) is an organized structure of federal geospatial professionals that provide executive, managerial, and advisory direction and oversight for geospatial decisions and initiatives across the United States federal government. FGDC works collaboratively with federal, state, tribal, and local governments, non-Federal collaborates, communities, constituents, and professional bodies providing the enabling foundation of standards, data catalogs, partnerships, and tools that make up the National SDI (NSDI). For more information visit: https://www.fgdc.gov/

Related to MSDI in the U.S., "MarineCadastre.gov is an integrated marine information system that provides data, tools, and technical support for ocean and Great Lakes planning." The team for MarineCadastre.gov continually works "to increase access to data through data and map services. The services are designed to deliver data without replication and directly from the source." MarineCadastre.gov supports complementary efforts: Digital Coast, Data.gov, and Geoplatform.gov (a FGDC initiative). For more information visit: https://marinecadastre.gov/

As a follow-on to the OGC-IHO MSDI-Concept Development Study (CDS) sponsored by the U.S. on behalf of the IHO in 2018 which aimed to assess the current state of MSDI by evaluating data/product management and exchange technologies used in the marine domain, identify gaps, and define the core components of an SDI, the United States has expressed interest in supporting the upcoming OGC-facilitated *IHO Federated Marine Spatial Data Infrastructure (SDI) Demonstration Pilot: Connecting Land and Sea across Nations* which aims to demonstrate a multi-country, federated MSDI under land/ sea boundary use cases to showcase how the value of MSDI can unlock data and information for use beyond traditional providers and consumers of hydrographic data, across borders, and across domains inclusive of improved connections between the terrestrial and marine foundational communities.

Direct link to download the 2018 MSDI-CDS engineering report PDF: https://portal.opengeospatial.org/files/?artifact_id=88037

Direct link to Cooperative OGC – IHO Federated Marine SDI Demonstration Pilot press release: https://www.ogc.org/pressroom/pressreleases/4426

9.6 Best practices and lessons learned

9.7 Challenges and achievements

Global Maritime Traffic Density Service (GMTDS) – Leveraging terrestrial and spaceborne

Automatic Identification Systems (AIS) data to support analysis and decision-makers in the global maritime community.

NGA proudly announces the completion and public release of GMTDS. GMTDS leveraged a collaborative design process to comprehensively develop a user-informed service that provides a uniform monthly ship activity density metric represented at a 1-km resolution for the entire global. Data can be filtered in several ways, including by ship type, ship draft, or ship loitering behavior. Users can visualize and filter data via web-map services such as the IHO's INToGIS website, or complete further analysis by downloading data via API. The raster library updates monthly and makes available more than a decade of shipping data.

The completion of GMTDS demonstrates NGA's commitment to supporting safety of navigation by providing free data and powerful tools for analysis directly to the public. With access to information, the global maritime community will be better enabled to understand, characterize, and protect the maritime domain.

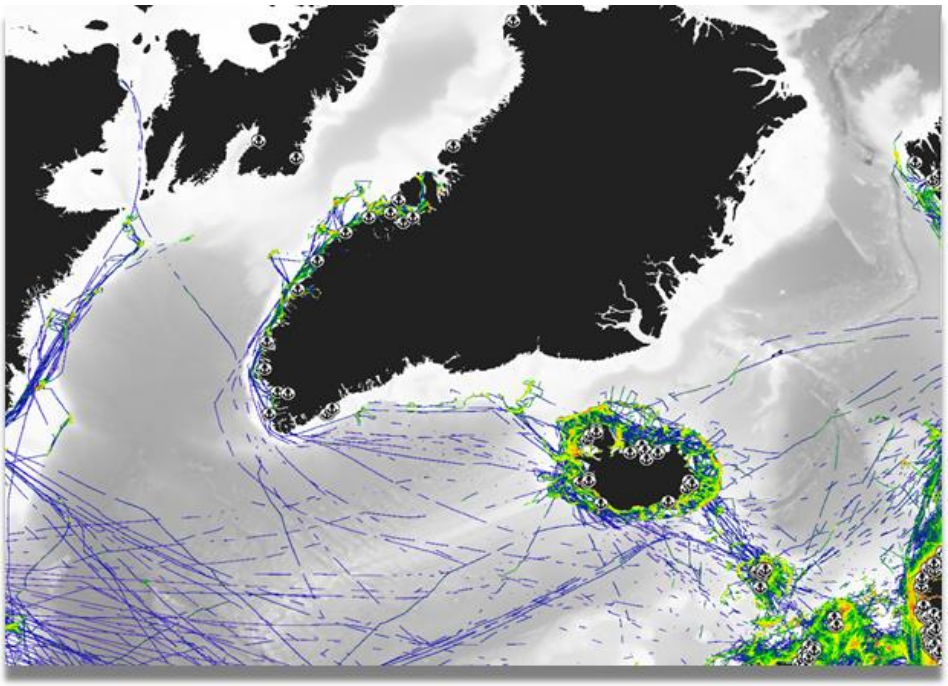

Figure 4. The above screenshot from the GMTDS user interface depicts vessel traffic near Greenland and Iceland under the Polar Projection view.

10.INNOVATION

10.1 Use of new technologies

NOAA's Precision Marine Navigation program aims to seamlessly integrate high-resolution bathymetry, high accuracy positioning and shoreline data with forecast data—such as water levels, currents, salinity, temperature, waves, and weather forecasts—to provide our data in a format that could be easily accessed and integrated into maritime portable pilot units or decision support tools. As a result, mariners will be better equipped to make critical navigation decisions.

This means that by the time this program is fully operational, NOAA's marine navigation data will be available in one location online and it will be available via machine to machine discovery so that it can be easily ingested into navigation systems for use by mariners. The collective value of these datasets is even more powerful when they are integrated than when they are each disseminated separately. NOAA is leveraging the S-100 suite of standards to develop its various product lines and dissemination infrastructure.

Development of a prototype surface current forecast data (S-111) as well as a prototype processing and dissemination system are the first two significant milestones that the program has achieved. In the summer of 2020, NOAA released prototype surface current data via the NOAA Big Data Program

website. Software developers and distributors can visit the links in the side bar to start exploring the prototype data. In addition, NOAA released a beta version of the PMN Data Gateway map viewer which makes it easy to determine where NOAA has data and what type of data is available.

In September 2021, NOAA will be releasing its Marinenavigation.noaa.gov website that will provide a common gateway for all navigation related information under the NOAA umbrella.

10.2 Risk assessment

NOAA provides nautical charts and related hydrographic information for the safe and efficient navigation of maritime commerce as well as providing basic data for engineering, scientific, and other commercial and industrial activities within the nation's 3.4 million square nautical mile EEZ (U.S. EEZ) and along its 95,000 miles of shoreline. To help prioritize out-year hydrographic survey efforts, NOAA used the Hydrographic Health Model.

The Hydrographic Health Model is a model based on the idea of navigational risk. Navigational risk is the product of the likelihood of an adverse event and the consequence of that event occurring. The model incorporates likelihood parameters such as traffic density, known hazards to navigation, and reported ship groundings to estimate the likelihood of an adverse event. To estimate the consequence of an adverse event, the model incorporates parameters such as proximity to search and rescue stations, proximity to reefs or marine sanctuaries. The model also considers the necessary quality of data to support modern traffic relative to what is currently available, explicitly recognizing that the seafloor changes over time. Seafloor changeability takes into account the frequency of storms, current speed, and accumulation of marine debris, where the quality of data in highly changeable areas decreases faster than the quality of data in less changeable areas. Using historic knowledge of seafloor changeability, the model can also approximate the future quality of survey data and assess how often an area needs resurveying.

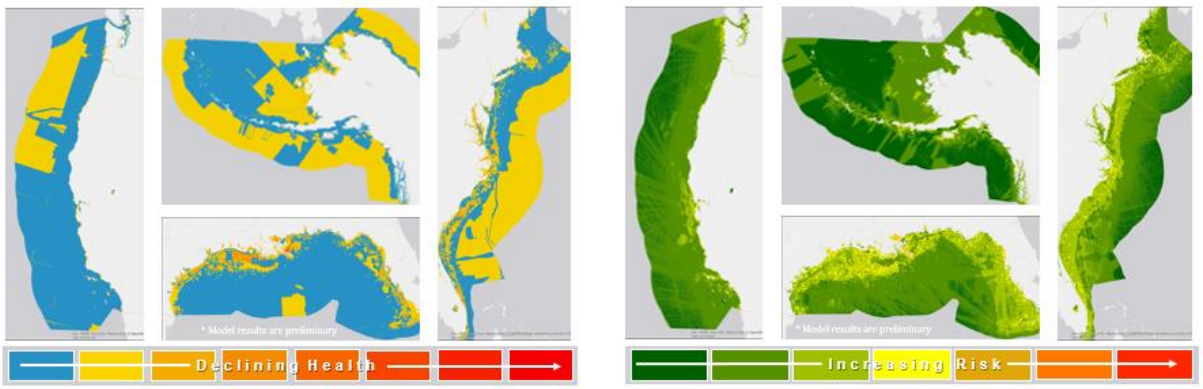

Figure 5. Hydrographic Health and Hydrographic Risk

10.3 Policy matters

11.OTHER ACTIVITIES

11.1 Participation in IHO meetings
11.2 Meteorological data collection
11.3 Geospatial studies

11.4 Preparation for responses to disasters

Interest in the Arctic is growing as diminishing sea ice opens the region to economic opportunity. In response to increasing human activity, the National Geospatial-Intelligence Agency (NGA) is contributing to publicly-accessible geospatial intelligence (GEOINT) of the region. Arctic GEOINT includes foundational data needed to develop decision support such as high spatial resolution elevation and projected sea ice extents, along with relevant natural resources, administrative boundaries, and maritime safety activities. NGA's Arctic GEOINT provides a window into regional changes that are attracting human activity, which are warranting the agency's efforts to contribute to decision support. The transforming Arctic region presents unique operational and policy challenges and opportunities that will require GEOINT to support strategic responses. This site can be found at NGA ArcGIS website.

11.5 Environmental protection

11.6 Engagement with Maritime Administration
The U.S. updated its Arctic Marine Transportation System (MTS) Infrastructure Table for the first time in ten years. This table highlights aspects of the MTS reported by maritime agencies. https://www.cmts.gov/topics/arctic

11.7 Aids to Navigation matters
11.8 Magnetic and gravity surveys
11.9 International engagements