



INTERNATIONAL HYDROGRAPHIC ORGANIZATION

NATIONAL REPORT FROM THE UNITED STATES OF AMERICA

ARHC-13

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.navmetocom.navy.mil/>

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1. HYDROGRAPHIC OFFICE/SERVICE

This U.S. 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) establishes the U.S. geodetic reference framework, conducts hydrographic surveys conducts tides and water levels observations, and produces nautical charts and related hydrographic information within the nation's Economic Exclusion Zone (EEZ).

1.1.2 National Geospatial-Intelligence Agency (NGA), Source Operations and Management Directorate, provides the global WGS84 geodetic framework, the World Magnetic Model, the Gravity Model and a suite of nautical charts and related hydrographic information. Geospatial data products and services are made releasable where possible either publicly or through data sharing arrangements with other nations.

1.1.3 The U.S. Navy, primarily the Commander, Naval Meteorology and Oceanography Command (COMNAVMETOCOM), serving as Hydrographer of the Navy, conducts oceanographic, bathymetric, and hydrographic surveys worldwide to satisfy Department of Defense (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 Mariners for hazard avoidance, search and rescue, security, and ice operations in the Arctic. [Coast Guard District 17](#) serves the US 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 (US EEZ) and along its 95,000 miles of shoreline.

In 2021 and 2022, NOAA surveyed approximately 4300 square nautical miles (SNM) of Arctic seafloor across six separate projects. In 2023, three Arctic hydrographic surveys are planned to provide updated bathymetry in over 4200 SNM of Arctic waters.

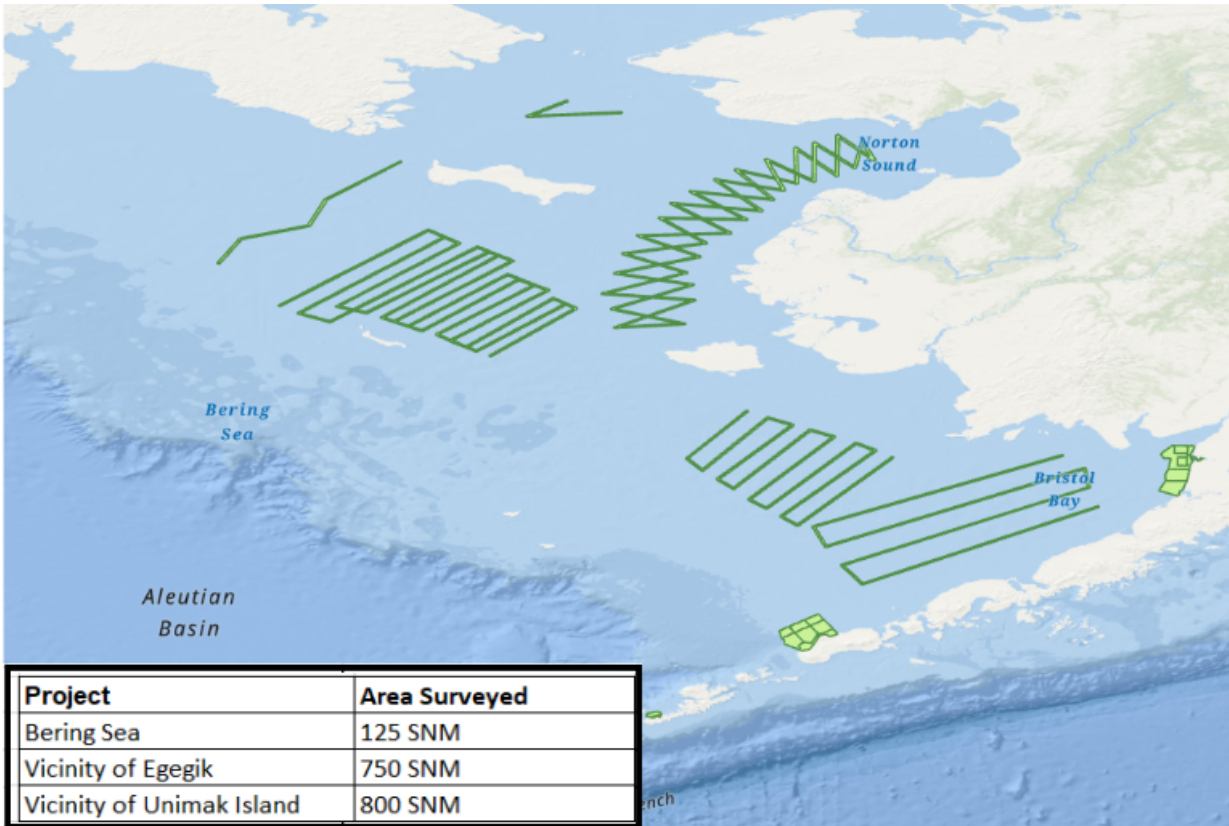


Figure 1. 2021 NOAA Arctic Hydrographic Surveys

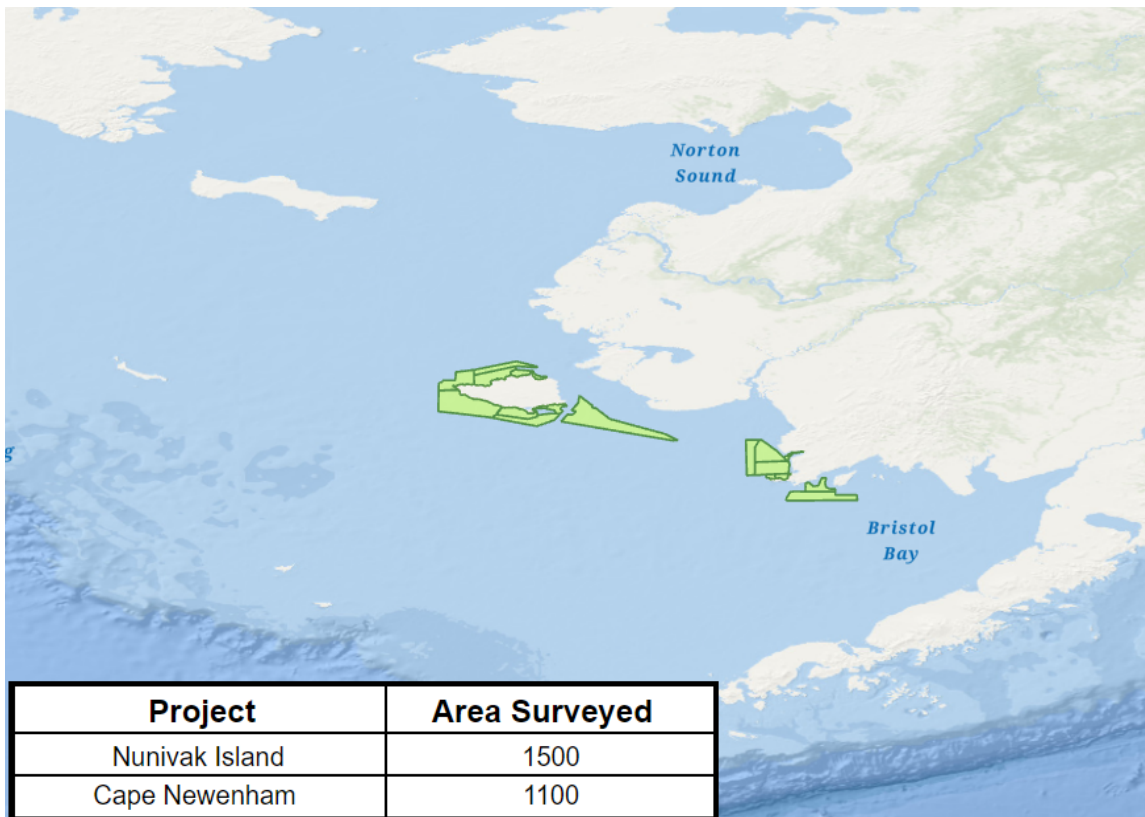


Figure 2. 2022 NOAA Arctic Hydrographic Surveys

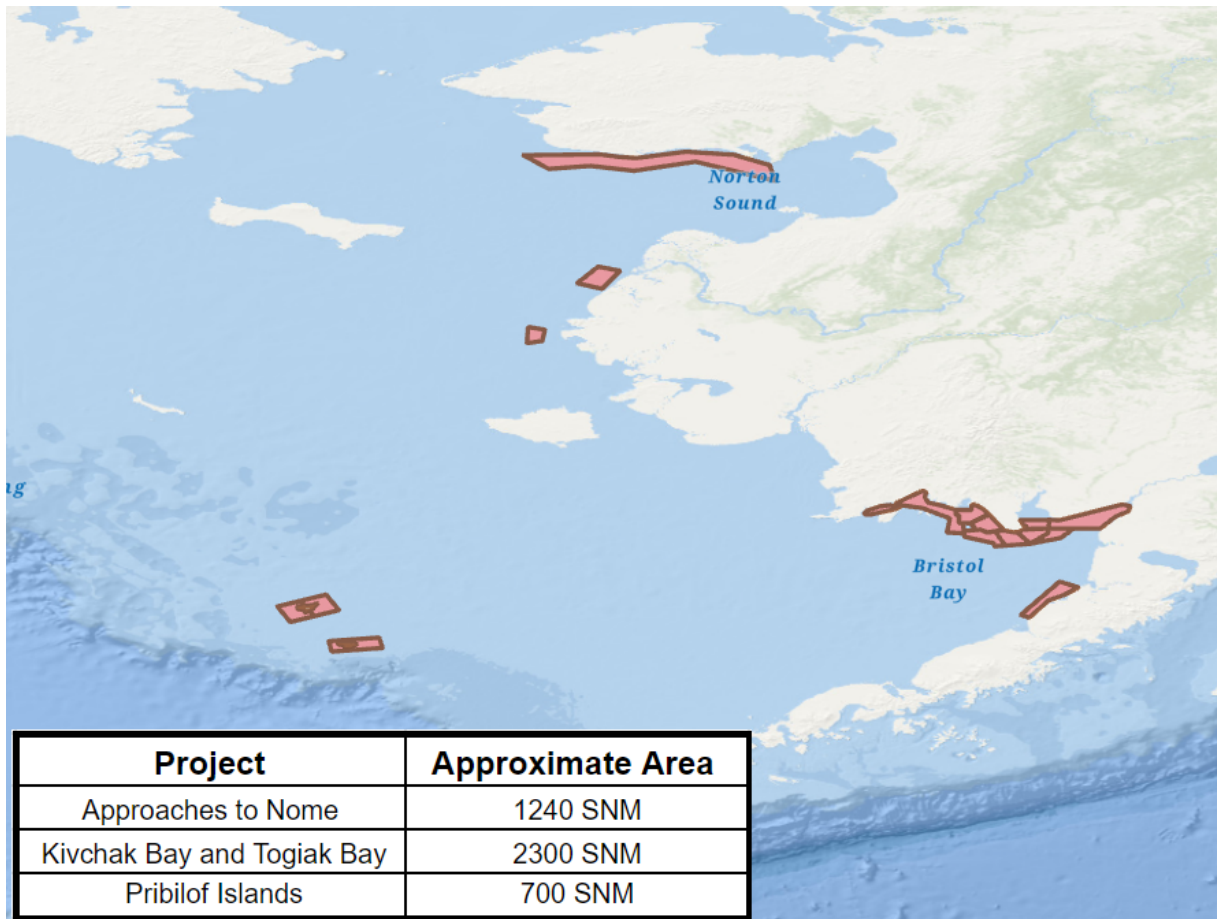


Figure 3. Planned 2023 NOAA Arctic Hydrographic Surveys

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 (COMNAVMETOPCOM) Instruction 5510.1A, “Disclosure of Information to Foreign Governments”, 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 a 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 (OHS�). The testing and evaluation of OHS� 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.

Marine Advanced Robotics' Wave Adaptive Modular Vessel (WAM-V) was employed to survey in the vicinity of Cape Newenham, AK during the 2022 field season and Norton Sound in 2023. This stable autonomous watercraft has a small footprint and shallow draft which allows it to operate in a wide-range of environments from the open ocean to very nearshore environments.

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. These vehicles have completed multiple missions along the Aleutian Chain, the North Slope of Alaska and within the Bering Sea.

The Naval Oceanographic Office (NAVOCEANO), a subordinate command of COMNAVMETOPCOM, currently employs six Pathfinder Class 100-meter multipurpose survey ships to conduct oceanographic, bathymetric, and hydrographic surveys in deep-ocean and coastal waters. These ships have the option to carry two 10-meter hydrographic survey launches (HSLs). NAVOCEANO also maintains a limited Airborne LIDAR Hydrography (ALH) capability with the Optech, Inc., "Coastal Zone Mapping and Imaging" LIDAR (CZMIL) system. NAVOCEANO and the Naval Oceanography Mine Warfare Center (NOMWC) have the ability to conduct limited littoral hydrographic surveys using a variety of deployable survey assets, including: portable multi-beam kits to support boat of opportunity (BOO) surveys; Unmanned Surface Vessels (USV) equipped with multi-beam sonar; and Iver3 580 Unmanned Underwater Vehicles equipped with Bathymetric Interferometric Side Scan Sonar.

2.3 New ships

NOAA has awarded a contract for design and construction of two new surveying and mapping ships. These ships will focus on surveying requirements in the Pacific (including Alaska). When delivered in 2027 and 2028 respectively, they will replace NOAA Ships Rainier and Fairweather, which will each be over sixty years old. 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

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.

The NGA Satellite Computed Bathymetry Assessment (SCuBA) program applies optical correction and photon classification algorithms to submarine returns from the Advanced Topographic Laser Altimeter System suite on NASA's ICESat-2 satellite. NGA established the SCuBA to complement emerging non-traditional hydrographic sources of data coverage in areas that are challenging or cost prohibitive to survey using traditional methods. SCuBA is currently being evaluated for use in enhancing other forms of satellite derived bathymetry and as a primary source for some safety of navigation products.

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.

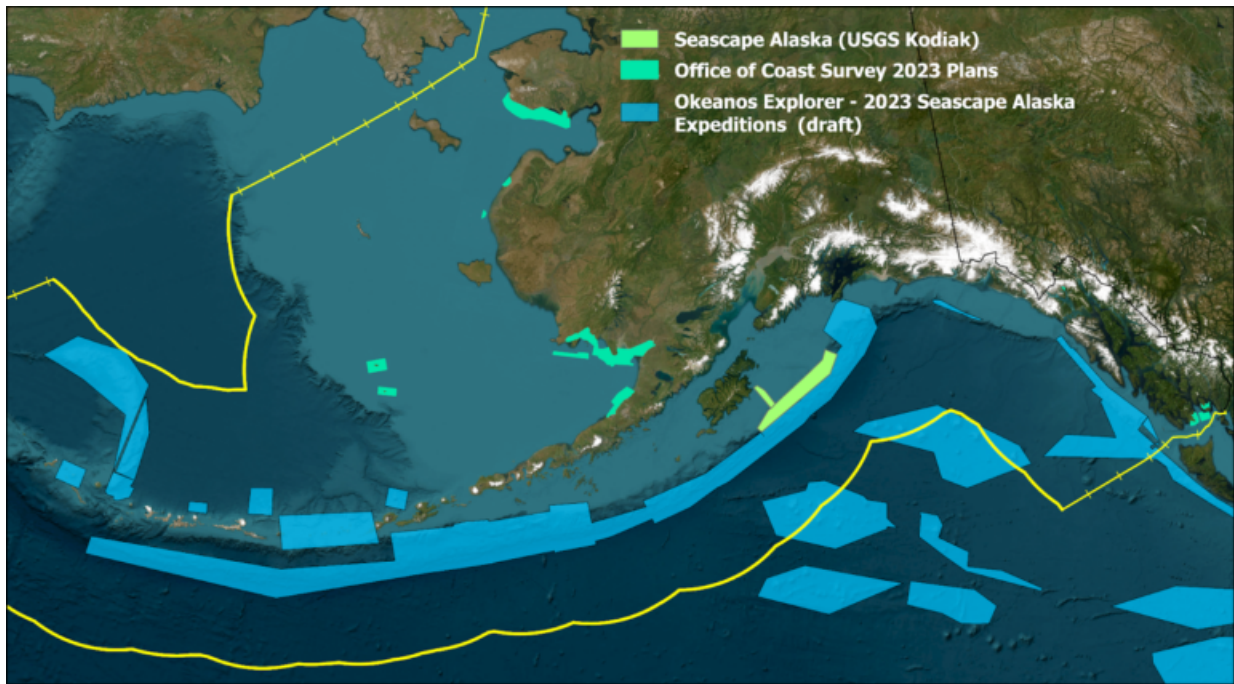
2.6 United Nations Ocean Decade endorses Seascope Alaska

The Intergovernmental Oceanographic Commission of the United Nations Educational, Scientific and Cultural Organization recently endorsed this important regional mapping campaign as part of the UN Decade of Ocean Science for Sustainable Development 2021-2030 (Ocean Decade), in part for its contributions to The Nippon Foundation-GEBCO Seabed 2030 Project.

Seascope Alaska began in 2021 in response to the 2020 National Strategy for Mapping, Exploring, and Characterizing the United States Exclusive Economic Zone and the Alaska Coastal Mapping Strategy. With Alaska's coastal and ocean waters at just over 1 million square nautical miles in size and 66% unmapped, the campaign seeks to fully map U.S. waters deeper than 40 meters by 2030 and coastal waters by 2040 through collaborative efforts among federal, tribal, state, and non-governmental partners with a wide range of interests and dependencies on mapping data. This campaign brings the Interagency Working Group on Ocean and Coastal Mapping and the Interagency Working Group on Ocean Exploration and Characterization federal members together with state, tribal, academic, private and other non-government sectors to share mapping plans and advance technical innovations to more efficiently map and characterize the area.

From May through September 2023, the National Oceanic and Atmospheric Administration (NOAA) will lead a series of Seascope Alaska expeditions on NOAA Ship *Okeanos Explorer*, with a particular focus on the Aleutian Islands, Gulf of Alaska, and Aleutian Trench. This work will be done in collaboration with numerous partners, including scientists and managers from across NOAA, management agencies in the region, and the global ocean science community, including the AleutBio team—another Ocean Decade endorsed project—which shifted its research in 2022 from the western to the eastern U.S. part of the Aleutian Trench.

From July to September 2023, NOAA and the U.S. Geological Survey (USGS) will also conduct a Seascope Alaska (USGS Kodiak) project on NOAA Ship *Fairweather* across a large portion of the Southern Alaskan continental margin, offshore of the Alaska/Kenai Peninsulas, between 200- to 1500-meter water depth. Project results will improve USGS' earthquake, tsunami, and landslide hazard assessments and forecasting, and NOAA Fisheries' delineation of trawlable and untrawlable seabeds for sustainable management of Gulf of Alaska fish stocks. In addition, hydrographic data collection operations in Alaska by NOAA's Office of Coast Survey and its contracting partners using uncrewed systems will be significant this year.



A map showing the geographic distribution of Seascopes Alaska mapping, exploration, and characterization plans for FY23

3. NEW CHARTS AND UPDATES

3.1 ENC coverage, gaps and overlaps

NOAA achieved complete ENC coverage of all US waters several years ago. There are no gaps in coverage. A major program to transition the suite of NOAA ENCs to a regular grid is underway and is detailed in the new [NOAA Nautical Charting Plan](#) released in August 2023. This transition will also include the recompilation of ENC depth curves from feet and fathoms into meters, and other improvements to deliver authoritative, fit-for-purpose navigation products to users in a timely fashion. Once complete, about 7230, often larger scale, ENC cells in 11 standard scales will be created. About 1400 of these new ENCs will be in Alaskan waters. Some minor overlaps exist with some Russian and Canadian ENCs. These are being 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 and NGA provide 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 ENC Charts: <https://nauticalcharts.noaa.gov/charts/noaa-enc.html>

For access to RNC Charts: <https://nauticalcharts.noaa.gov/charts/noaa-raster-charts.html>

Both ENCs and RNCs may also be downloaded through the [NOAA Chart Locator](#)

For access to the Coast Pilot: <https://nauticalcharts.noaa.gov/publications/coast-pilot/index.html>

NOAA maintains 74 RNCs and 510 ENCs over Alaskan waters. All charts are updated weekly with the latest Notice to Mariners and new dangers to navigation information.

US ENCs from NOAA and NGA are available as free downloads from the Internet at www.nauticalcharts.noaa.gov. Mariners operating regulated vessels may also fulfill ENC chart carriage requirements through International Center for ENC’s (IC-ENC) distributors, <http://www.icenc.org/Distribution.html>.

3.3 RNCs

No additional RNCs have been produced. All existing US RNCs will be canceled by January 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. Current plans call for all existing US INT Charts to be canceled by January 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 Paper nautical charts

In a November 2019 notice in the U.S. Federal Register, NOAA announced the cancellation of its traditional paper and raster nautical chart products. Cancellation of individual charts started in 2021 and will be completed by January 2025. About 30 charts per month are currently being canceled. 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 2800 ENCs maintained in 2023 to about 7230, 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.

NGA produces the Certified Printed ENC (CPENC -see section 3.5 for details) for customers where NOAA has canceled paper nautical charts in order to meet SOLAS or other regulatory requirement for specific customers. As the U.S. DoD will require some paper nautical charts for mission requirements, NGA will make these available to the public and partner nations where releasable.

3.5 Other charts, e.g. for pleasure craft

All existing US 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. NOAA released a major update to the Custom Chart application in February 2023. More information is on NOAA Coast Survey's [NOAA Custom Chart](#) web page.

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 takes out a product-dependent category and becomes 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 (15th edition 2022).
- 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, is intended to provide a convenient means of locating maritime ports and shipping terminals worldwide. It acts as a compendium to the Sailing Directions, as such, the principal sources of information within the publication comes from the Sailing Directions.

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 Rules¹ - 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.

For further reference, please see

<https://www.navcen.uscg.gov/navigation-rules-amalgamated>
<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.

¹ Note: this as a non-authoritative version. The USCG states “we make no claims or guarantees of such and expressly disclaim liability for its use.” USCG does recognize this (and other versions) as meeting Rule 1(g)/33 CFR 83.01(g) as meeting inland carriage, but not international.

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 web site: <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>

For access to Sailing Directions Planning Guides: <https://msi.nga.mil/Publications/SDPGuides>

For access to Sailing Directions Enroute Guides: <https://msi.nga.mil/Publications/SDEnroute>

World Port Index—The authoritative version of the World Port Index can be downloaded from the NGA Maritime Safety Information website: <https://msi.nga.mil/Publications>.

Up-to-date World Port Index data can be obtained from the same web site or downloaded directly from the Geospatial Viewer application: <https://fgmod.nga.mil/apps/WPI-Viewer/>.

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 most NGA publications is the pdf. However, The exception is the World Port Index (Pub 150) which now exists 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 Enterprise online platform and updated weekly. The authoritative version of the World Port Index is a .csv file containing the complete set of data. It is updated monthly and posted on NGA's Maritime Safety Information website, additionally it can be downloaded directly through the Viewer application as a .csv, file geodatabase, shapefile, JSON, or GEOPackage.

To access the World Port Index Geospatial Viewer: <https://fgmod.nga.mil/apps/WPI-Viewer/>

To add a port to the World Port Index: <https://fgmod.nga.mil/apps/WPI-Geoform/>

To request permission to become a crowd-sourcing contributor:

1. Create a free account on NGA's ArcGIS Enterprise: <https://fgmod.nga.mil/portal1/home/>
2. Fill out the World Port Index Editor Access Request Application: <https://fgmod.nga.mil/apps/WPI-AccessRequest/>
3. NGA will view the request and grant permission to the World Port Index with Editing Capability Application: <https://fgmod.nga.mil/apps/WPI-Editor>

In early calendar year 2022, NGA released a beta version of Radio Navigation Aids (Pub 117) available as a web application. The public-released version will be towards the end of calendar year 2023

These web applications allow users to interact directly with the data, querying and searching through entries to find applicable attributes. The ability to download customized sets of data is

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).

6. C-55

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. 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, 49 students graduated from the program, including one foreign national student from the Nigerian Navy. This cohort is made up of about 60% cartographers in NOAA's Marine Chart Division, but also hydrographers, physical scientists, geodetic surveyors, NOAA Corps officers, computer programmers, contractors, and personnel from other national charting agencies. In 2023, NOAA decided to pause this program to focus on other training required for the upcoming transition to S-101 ENC production and other needs.

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 COMNAVMETOCOM and the Information Warfare Training Group in Gulfport, Mississippi. This training is available to both uniformed and civilian government personnel.

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.

8. Oceanographic Activities

8.1 General

Crowdsourced Bathymetry

The IHO currently defines crowdsourced bathymetry data as “the collection and sharing of depth measurements from vessels, using standard navigation instruments, while engaged in routine maritime operations.” This 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 is 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 data from mariners around the world.

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

The U.S. is 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 US 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 3.0.0 of B-12 IHO Guidance on Crowdsourced Bathymetry has now been in circulation for a year 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. Following the publication of B-12 Ed. 3.0.0, CSBWG undertook several strategic planning sessions in the most recent annual meeting, to take stock of the current status quo, review what has worked well and what has not, identify barriers to scaling CSB and build an evidence base to inform future decision making. In doing so, the CSBWG were able to explore potential solutions to overcome these barriers and identify a few high-level priority work areas which were used as the basis to develop a new Work Plan.

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](#) (NOMECS) 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 NOMECS 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 NOMECS goals. In July 2021, *Seascape Alaska*, a regional mapping campaign supporting the NOMECS strategy, was born. The group has assessed that 66 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 2023](#)), a decrease from 69 percent in 2022. A plan of action to fill those gaps is underway. An Alaska Coastal and Ocean Mapping Summit occurred from November 16-17, 2022 ([see report here](#)). The next summit is planned for late 2023.

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.

9.3 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)

The Interagency Arctic Research Policy Committee (IARPC) released a new 5-year plan, which includes an objective to encourage and implement FAIR (Findability, Accessibility, Interoperability, and Reuse) and CARE (Collective benefit, Authority to control, Responsibility, and Ethics) data management principles in the Arctic.

<https://www.iarpcollaborations.org/plan/index.html>

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., “MarineCadastr.gov is an integrated marine information system that provides data, tools, and technical support for ocean and Great Lakes planning.” The team for MarineCadastr.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.” MarineCadastr.gov supports complementary efforts: Digital Coast, Data.gov, and Geoplatform.gov (a FGDC initiative). For more information visit: <https://marinecadastr.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

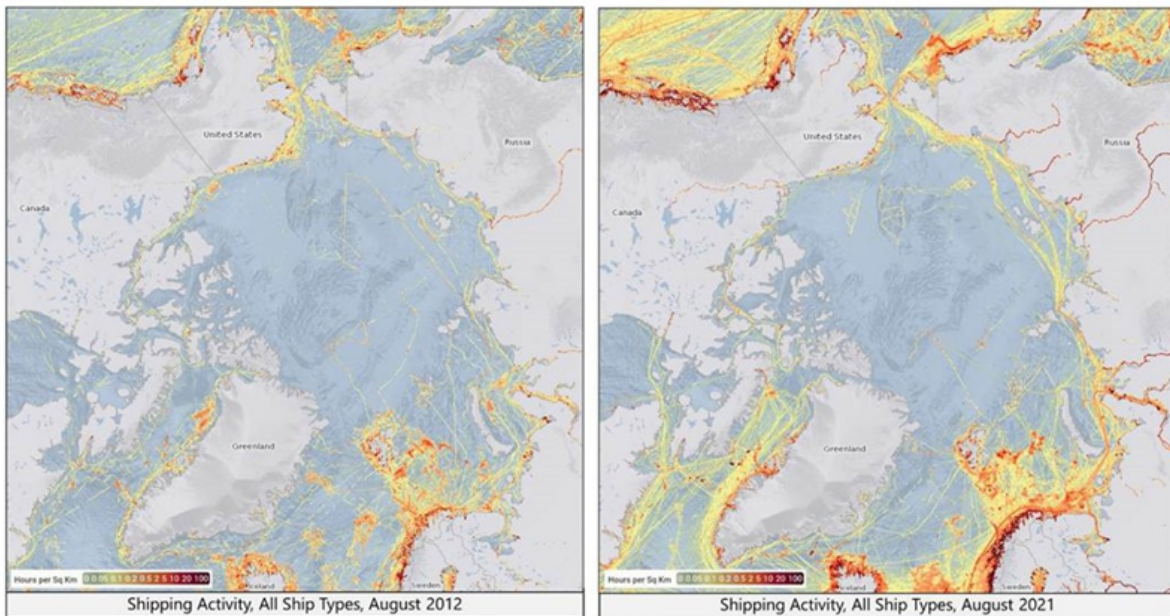
9.7 Challenges and achievements

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. U.S. hydrographic agencies are evaluating the GMTDS for use in chart adequacy assessments.

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.

Circumpolar Shipping, All Ship Types, August 2012 & August 2021



Map visualization depicts total ship hours (ShHr) of activity per square kilometer (km^2), not absolute ship numbers or counts. The increase in ShHr/km^2 , as well as geographic distribution of ship activity, is clearly identifiable between the circumpolar map from August 2012 compared to August 2021.

Figure 4. [Global Maritime Traffic Density Service](#)

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.

NOAA also released its Marinenavigation.noaa.gov website that provides a common gateway for all navigation related information under the NOAA umbrella.

NOAA recently released prototype high resolution data for use by navigation systems for the Ports of New York/New Jersey and Los Angeles/Long Beach. This data is meant for testing purposes and should not be used for navigation operations. The bathymetry represented in the prototype data is not necessarily representative of the current condition of the channels.

The prototype data leverages the International Hydrographic Organizations S-102 Bathymetric Surface Product Specification – Edition 2.1.0. This specification has been optimized for use in navigation systems and is a digital elevation model which represents the seafloor in a regular grid structure. In addition to creating product files, these datasets also maintain compliant discovery metadata that allows for machine to machine discovery and dissemination. The discovery metadata accompanies each data product and is an XML catalog file that contains all the relevant information about the data products, including product boundaries and latest edition. At this time the discovery metadata conforms with Edition 4.0.0 of S-100 and sometime in late 2023 NOAA will be transitioning the discovery metadata over to Edition 5.0.0 of S-100.

The S-102 prototype data for these two ports are generated from Coast Survey’s National Bathymetric Source (NBS), a continuously updated compilation of the best available bathymetry. As NBS continues to expand its operational area, NOAA will release additional S-102 prototype data for ports within that region.

As the S-102 standard continues to evolve towards the operational edition (3.0.0), NOAA will continue to develop prototype products and services for testing and evaluation until it can release operational products for navigation.

As well as the S-102 prototype data, NOAA has also released S-111 Surface Current Data. The data can be accessed in the following ways:

- Via the [Marine Navigation](#) websites [Data Gateway Viewer](#)
- Directly via the [Precision Navigation Cloud Servers](#)

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 (US EEZ) and along its 95,000 miles of shoreline. To help prioritize out-year hydrographic survey efforts, NOAA uses 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.

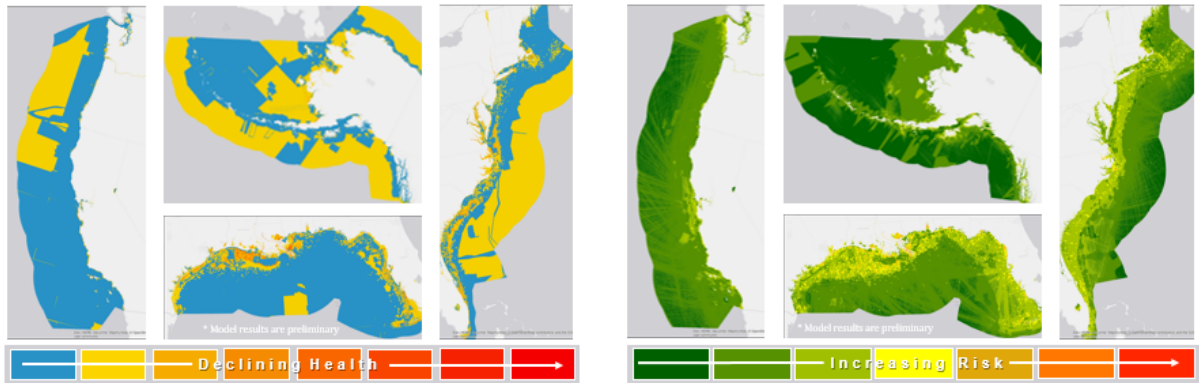


Figure 5. Hydrographic Health and Hydrographic Risk

11. OTHER ACTIVITIES

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. On 20 July 2023, NGA, National Reconnaissance Office, and the National Science Foundation announced the continued public access to historical and new Digital Elevation Models created using commercial imagery collected of the Polar Regions. The DEMs are publicly available on NGA's website through ESRI's ArcGIS platform

11.5 Engagement with Maritime Administration

The Committee on Marine Transportation System (CMTS) issued a U.S. Arctic Marine Transportation System Infrastructure Risk Resource Compendium. <https://rosap.ntl.bts.gov/view/dot/6231>

12. ANNEX

12.1 Annex A: NOAA ENC CATZOC Review in the ARHC

NOAA ENC CATZOC Review in the ARHC

Julio Castillo, Julio.Castillo@noaa.gov, NOAA Office of Coast Survey, August 2023

Purpose: To provide a baseline analysis of NOAA ENC CATZOC in IHO Region N (ARHC). This data could potentially be used in annual reports to quantify gridding, charting, and surveying progress in the region.

How "Adequacy" is defined: For the purposes of this exercise, "adequacy" is defined as currently charted M_QUAL objects with a CATZOC attribute of 1/A1, 2/A2, or 3/B. It is understood that "adequacy" is defined differently on different platforms and by different States. Limitations of using currently charted M_QUAL CATZOC attribution include and are not limited to not taking depth, time since hydrographic surveys have been made, and newer hydrographic surveys that have not been charted yet into account.

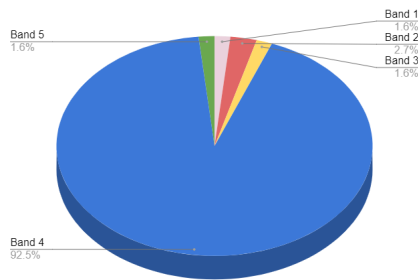
Procedure: [NOAA ENCs in ARHC Procedure](#)

Results:

1. Number of ENC's in Region N based on Usage Band

NOAA ENC's in Region N		
Usage Band	ENC Count	Percentage
1	2	1.08%
2	5	2.70%
3	3	1.62%
4	172	92.97%
5	3	1.62%
Total:	185	100.00%

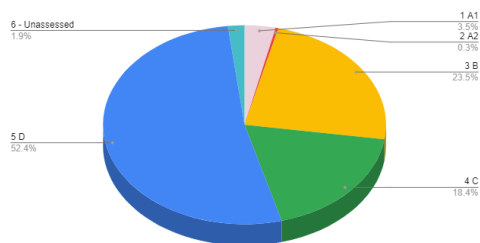
NOAA ENC Count in the ARHC



2. Adequacy within Band 4 ENC's

NOAA Band 4 ENC M_QUAL CATZOC in Region N (ARHC)		
M_QUAL CATZOC	Area (Sq Km)	Percentages
1 A1	4,789.48	3.54%
2 A2	409.08	0.30%
3 B	31,756.61	23.49%
4 C	24,917.88	18.43%
5 D	70,767.65	52.35%
6 - Unassessed	2,534.51	1.87%
Total Area =	135,175.21	
Adequate Area =	36,955.17	27.34%

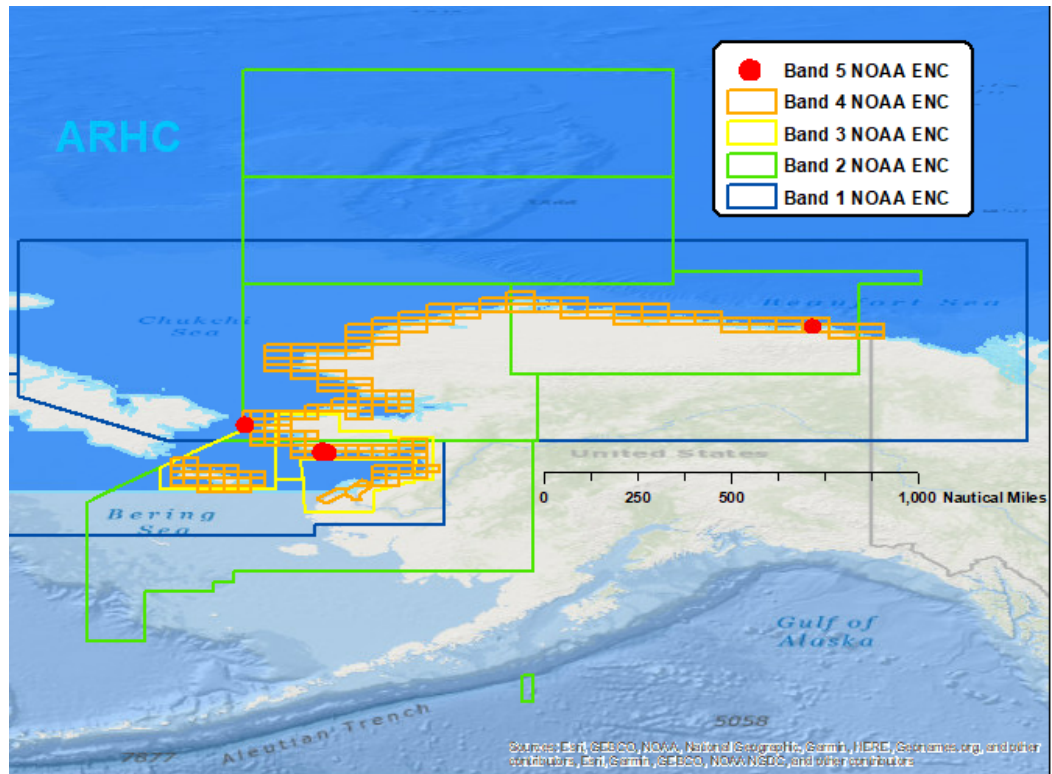
NOAA Band 4 ENC M_QUAL Area in Region N by CATZOC (Sq Km)



Conclusions: The vast majority (>92%) of NOAA ENC's in Region N are usage band 4 gridded ENC's. In the band 4 NOAA ENC's in Region N, there is approximately 135,175 sq km of M_QUAL coverage representing charted navigable waters, **36,955 (>27%) sq km of which are considered adequately surveyed** by this exercise.

Additional Images:

Total ENC count in ARHC waters: 185



Individually by Usage Band:

