National Charting Plan

A Strategy to Transform Nautical Charting

November 1, 2017

Office of Coast Survey
Marine Chart Division

CONTENTS

FOREWORD

A draft of the National Charting Plan was released in February 2017. Public comments were solicited and accepted through the end of July 2017. The final version presented here reflects the feedback received from professional mariners, recreational boaters, print-on-demand chart publishers, third-party data providers, software developers, and other users of NOAA charts.

Much of the content of the original draft remains unchanged, but several topics were added or clarified. These included the following:

- Provided a more nuanced discussion of future production of raster and paper nautical charts. NOAA has no current plans to stop the production of paper or raster nautical charts. However, raster charts may look a bit different in the future.
- Added an acknowledgement of the role played by third-party providers of information based on NOAA raster chart products.
- Added an acknowledgement of the growing amount of source data that is coming from non-traditional or "crowd-source" data providers.
- Coast survey received fewer than twenty comments regarding the possible conversion of depths from fathoms and feet to meters. These came from both recreational boaters and professional mariners. The majority of the comments favored retaining the standard U.S. units of fathoms and feet.
- Coast survey is proceeding to make ENCs more compatible with metric units (The international product specification for ENC mandates that depths must be encoded in meters). However, raster charts will continue to show depths in fathoms and feet.
- Coast Survey is prototyping some options that would allow users to create customized raster charts by selecting the chart size and scale, as well as the units used to display depths.
- In partnership with the U.S. Army Corps of Engineers, Coast Survey will continue to explore ways to improve the consistent, up-to-date provision of depth information in channels maintained by the Corps. This will likely change the way channel depths are portrayed on charts.
- Added a section describing Coast Survey's support to the U.S. Baseline Committee and the charting of important maritime boundaries.

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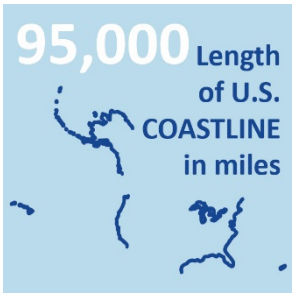
ERRATA

Page 18, Figure 12
Oct 11, 2018 - Changed "shoaler" to "deeper" and "30 ft" to "60 ft" in last sentence of the figure caption to read:

> Since no 10 m depth contour is available, ECDIS will portray the next deeper depth area (60 ft, 18.2m) as “unsafe water.”

INTRODUCTION



The U.S. Coast Survey was established in 1807 to provide nautical charts to help the young nation with safe shipping, national defense, and maritime boundaries. Two centuries later, Coast Survey – now an office within the National Oceanic and Atmospheric Administration (NOAA) – continues to provide navigational products and services that ensure safe navigation and efficient maritime commerce on America's ocean and coastal waters, and in the Great Lakes. This comprises an area of about 3.4 million square nautical miles and 95,000 miles of coastline.

Purpose and Organization of the National Charting Plan

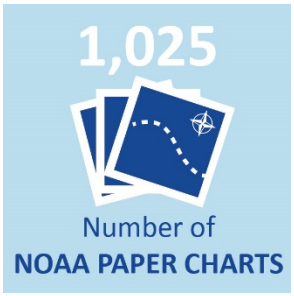
This plan describes a strategy to make comprehensive improvements across the entire suite of NOAA nautical chart products. Changes to individual charts are not a part of this plan. The evolving state of marine navigation and nautical chart production has provided NOAA with opportunities to improve the content and utility of its charts.

Some changes have already begun, such as improving the portrayal of wrecks on electronic navigational charts. Other changes, such as the possible conversion of charted depths from feet and fathoms to meters, are being evaluated. Users are encouraged to provide their thoughts about all the changes discussed in the plan using one of the feedback methods described on the next page.

Mariners, boaters, navigation system developers, value-added data providers, and other users will be interested in learning about the services and products that will be changed or discontinued, and the introduction of completely new products and services optimized for modern technology and techniques.

Part I describes the current set of NOAA nautical chart products and their distribution. Part II describes some of the steps we are taking to improve those products, including changes to chart formats, scales, data compilation, and symbology. At the end of Part II, some thoughts are presented about the long-term future of NOAA navigational products.

Rationale for Change



The first complete nautical chart published by the Coast Survey was of New York Harbor in 1844. The format, information, and intended uses of this chart were similar to the raster charts that NOAA makes today. Mariners continue to plot courses on paper charts in much the same way they did in the age of tall sailing ships.

Although NOAA still produces traditional raster nautical charts, a sea change in chart production methods and the art of navigation began in the mid-1990s when Global Positioning System (GPS) technology and vector, electronic navigational charts (ENCs) became available to the public.

Raster and Vector Charts

Raster charts are digital or paper images of traditional nautical charts. The image comprises rows of color pixels, or dots of ink, which form the symbols, lines, and tints that compose a chart. Vector charts are digital data that store features as pairs of latitude and longitude coordinates (as opposed to a matrix of pixels). Records associated with each feature further describe its color, shape, purpose, or other attributes.

NOAA raster chart products include paper nautical charts, raster navigational charts, and booklet charts. Electronic navigational charts are NOAA's only nautical vector product.

Since the introduction of ENCs thirty years ago, the size of commercial vessels has increased more than four-fold and modern navigational systems have become more sophisticated. There are over 15 million recreational boats in the U.S. and recreational boaters have joined professional mariners in using electronic chart displays to ply the nation's waters. Users of all types are expecting improved ease of access to more precise, higher resolution charts that deliver the most up to date information possible.

Coast Survey's Marine Chart Division has developed a number of strategies to meet this growing demand for greater performance in our products and services, which are presented in this plan. We are confident that the actions outlined here will deliver products that are more useful, up-to-date, and will enhance the safety of navigation.

PART I – Present State of Nautical Chart Production

MARITIME REGULATIONS AND NAUTICAL CHART SPECIFICATIONS

Coast Survey chart products meet strict chart production and updating requirements for charts that the International Maritime Organization (IMO) and the U.S. Coast Guard (USCG) require on large commercial vessels, such as tankers, bulk carriers, container and cruise ships, as well as smaller vessels, such as tugs, barges, and ferries. These products are said to meet "carriage requirements," that is, they meet the IMO and USCG requirements for charts that must be *carried* on many commercial vessels. Coast Survey has developed a Nautical Chart Manual, which serves as the raster chart product specification and ENC encoding guide for NOAA. Much of the chart manual is based on the International Hydrographic Organization's (IHO) standards and specifications for nautical charts and electronic navigational charts.

Carriage Requirements for SOLAS Vessels

Ships that must comply with the 1974 International Convention for the Safety of Life at Sea (SOLAS) include passenger ships, tankers and cargo ships on international voyages. In 2012, the IMO adopted regulations that will make use of sophisticated navigation equipment, called an Electronic Chart Display and Information System (ECDIS), mandatory on certain SOLAS class vessels by July 2018.[1] The schedule for transitioning to ECDIS by SOLAS ships of different types and gross tonnage (GT), which will be completed in July 2018, is shown in Figure 1.

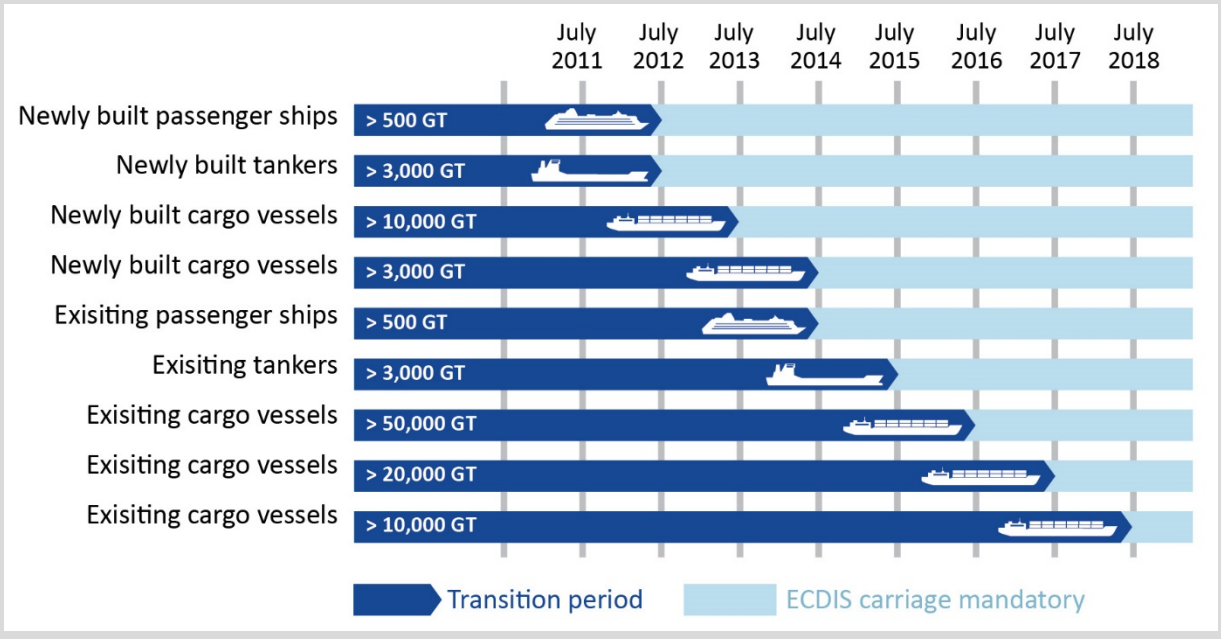


Figure 1 – ECDIS Implementation Schedule

[1] IMO amendment to Safety of Life at Sea (SOLAS) Chapter V regulation 19.2.

This means that all large SOLAS class ships will soon stop using paper charts as the primary means of navigation and start using an ECDIS to display the electronic navigational charts produced by NOAA in the United States and by other national charting agencies in other countries. ENCs and other raster chart products are described in Section 5, "NOAA Chart Products."

USCG Carriage Requirements for Inspected Vessels

Until recently, U.S. flagged vessels engaged in domestic voyages and subject to USCG inspections were required to navigate with paper charts. In February 2016, the USCG released requirements[2] for the use of electronic charts and publications. These requirements allow vessels subject to USCG inspections to use ENCs in lieu of paper charts if they are using an Electronic Chart System (ECS) that meets certain performance requirements.

Although not required, more and more commercial mariners and recreational boaters are choosing to forsake the use of paper charts, which they must update manually through hand-drafted corrections, and are navigating with an ECS or other "chart plotter." NOAA provides weekly updates of its ENC and RNC products used by these systems. Coast Survey has anticipated this shift from paper to digital charts and is working to improve ENC content and coverage so it will ultimately become the product of choice for all mariners and boaters. Many of these improvements, described in Part II of this plan, will also enhance raster charts.

International Hydrographic Organization (IHO) Specifications

The IHO is an intergovernmental consultative and technical organization that supports safety of navigation and the protection of the marine environment. One of its functions is to foster the greatest possible uniformity in nautical charts and documents produced throughout the world. Coast Survey has long held active roles in IHO activities to develop and maintain product specifications for the content and format of paper charts, ENCs, and RNCs. NOAA plays a significant role in the development and maintenance of many IHO standards and specifications. The ones most closely related to raster and vector nautical chart production include the following:

S-4 Regulations for International (INT) Charts and Chart Specifications of the IHO
S-52 Specifications for Chart Content and Display Aspects of ECDIS
S-57 IHO Transfer Standard for Digital Hydrographic Data ("S-57 ENC product specification")
S-61 Product Specification for Raster Navigational Charts (RNC)
S-100 IHO Universal Hydrographic Data Model
S-101 Electronic Navigational Chart Product Specification

[2] Navigation and Vessel Inspection Circular 01-16, which provided uniform requirements for the use of electronic charts and publications for U.S. Flagged Vessels engaged in domestic voyages.

NOAA Chart Customers

Paper nautical charts were originally created for an élite group of commercial and government users. In fact, nautical charts were considered state secrets during the age of exploration in the 15th Century. Similarly, the product specification for electronic navigational charts was developed for a select group of mariners, those sailing large commercial vessels on international voyages.

Now, nautical charts are available to anyone in a variety of paper and electronic formats that are used for many purposes. Coast Survey strives to support a growing group of customers, which includes the following:

- Professional mariners sailing aboard or supporting IMO regulated SOLAS vessels[3]
- Professional mariners sailing aboard or supporting USCG inspected vessels[4]
- U.S. Navy, U.S. Coast Guard, NOAA and other government vessels
- Pilots and port authorities
- Recreational boaters
- Manufacturers of navigational systems for commercial vessels and recreational boaters
- Third-party value-added data providers
- Federal, state and local government agencies
- Other users of nautical data and Geographic Information Systems (GIS)

NAUTICAL CHART PRODUCTS

Raster and Vector Chart Formats

Coast Survey's Marine Chart Division maintains over one thousand charts in two digital formats, raster and vector. Both formats depict the same information: shoreline, made-made features, depths, buoys and other aids to navigation, rocks, wrecks, and other dangers to navigation, anchorages, limits of regulated areas, vessel traffic separation schemes, and many other features.

The raster format is a digital picture of a chart that uses rows of color pixels to portray "traditional paper chart" symbology when rendered on a computer screen or printed on paper (see Figure 2.a). The chart information is compiled at a specific scale and the representation is fixed in place.

A chart in vector format is distributed as a database of points, lines and polygons, which may be displayed in a navigation system in a variety of symbology styles. Figure 2.b shows "simplified" symbology used in an ECDIS. Vector charts enable the display or suppression of specific types of features and querying of the vector database to obtain additional information about the features shown.

[3] Ships that must comply with the 1974 International Convention for the Safety of Life at Sea (SOLAS) include passenger ships engaged on international voyages and non-passenger ships of 500 gross tons or more engaged on international voyages.

[4] The U.S. Code of Federal Regulations (CFR) defines which vessels are regulated by the U.S. Coast Guard. These include, with some exceptions, self-propelled vessels of 1,600 or more gross tons and towing vessels of 12 meters or more in length operating in the navigable waters of the United States other than the St. Lawrence Seaway.

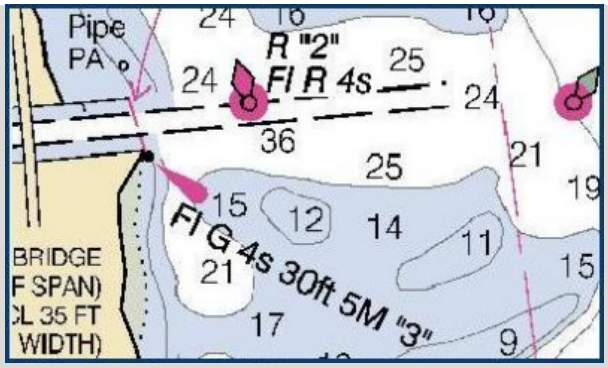


Figure 2.a – Raster Chart Image


Figure 2.b – Vector Chart Image

The Electronic Navigational Chart (ENC) is the Coast Survey's only vector navigational product. Several types of raster products are distributed in a variety of forms. The Coast Survey classifies all of its raster and vector products as either meeting or not meeting carriage requirements. All chart products and related online chart viewers are described below. Also, see Annex A for a Quick Usage Guide for NOAA charts.

Charts Meeting IMO and USCG Carriage Requirements

Coast Survey produces three products that meet the carriage requirements specified by the International Maritime Organization and the U.S. Coast Guard. These are the nine-volume set of the U.S. Coast Pilot® sailing directions, NOAA ENC® digital charts, and NOAA paper nautical charts (when printed by a NOAA certified chart agent). More information about the U.S. Coast pilot is available at www.nauticalcharts.noaa.gov/nsd/cpdownload.htm. ENCs and NOAA paper nautical charts are described below.

NOAA Electronic Navigational Chart or NOAA ENC®


Figure 3

NOAA ENCs are the official U.S. electronic chart used in ECDIS and ECS. They support real-time navigation, as well as the collision and grounding avoidance needs of the mariner. ENCs have several advantages over raster charts; different layers of data may be turned on or off as desired to simplify the chart display, and users may "query" individual features to get more information about them, such as the height of a landmark, characteristics of a light, or rules associated with regulated areas.

The IMO also allows Raster Navigational Charts (RNCs) to be used in ECDIS to meet carriage requirements, if adequate ENC coverage is not available. However, because there is complete ENC coverage of U.S. waters, NOAA RNCs cannot be used to meet carriage requirements. However, NOAA RNCs can be used in other systems and settings that are not required to meet IMO or USCG carriage requirements.

NOAA Paper Nautical Chart

Figure 4

The U. S. Government no longer prints paper copies of its raster nautical charts. However, NOAA provides digital images of its raster charts to NOAA certified chart agents, from whom the public may purchase NOAA paper nautical charts printed at the proper scale and quality to meet USCG carriage requirements. These charts include all critical corrections and other routine data compilations that have been made since the last new edition was released, up to the week that the chart is purchased. This means users will not have to bring a newly purchased chart up to date with penciled in hand-corrections from USCG notices to mariners.

General Use (non-carriage) Nautical Chart Products and Services

NOAA produces several other nautical chart products with the same information found on NOAA paper nautical charts, which *do not* meet carriage requirements for commercial ships.

NOAA Raster Navigational Chart (NOAA RNC®) and the RNC Tile Service

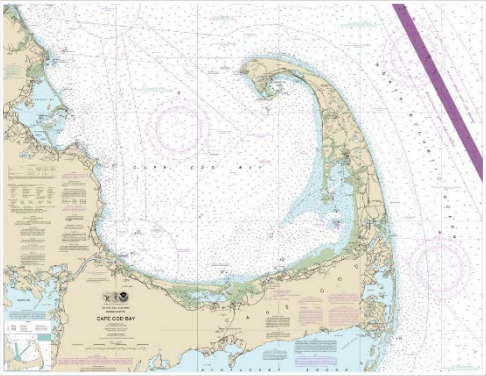


Figure 5

The same digital raster chart images used to print paper charts are used to produce the georeferenced **NOAA Raster Navigational Chart** or **NOAA RNC®** product (see Figure 5). RNCs can be used with GPS enabled ECS and other "chart plotter" systems to provide real-time vessel positioning.

The **NOAA RNC Tile Service** comprises 15 million individual chart tile images. Each full RNC is cut into thousands of smaller "tiles" that display much faster than full RNC images. The tile service provides geo-referenced, nautical chart tilesets for the public that comply with several web map and map tile standards. These may be ingested directly into several commercial electronic chart systems, mobile apps, and third party nautical data integration websites.

Full-Size Nautical Chart and Page-Size BookletChart™ PDF files

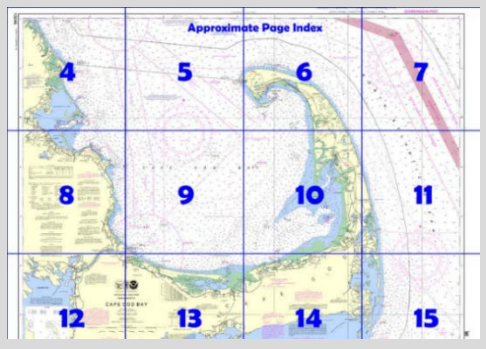


Figure 6

Full-size nautical charts and page-size BookletCharts can be downloaded in PDF format. The former is a single large chart image; the latter is a set of 8.5" x 11" pages that show different portions of a chart that can be printed at home and assembled into a booklet. Figure 6 shows the index of the 12 chart pages of a booklet chart. Other pages in the booklet provide information about the area, descriptions of navigational aids, and other safety related information.

Online Chart Viewers

Coast Survey also hosts three online viewers to display nautical chart data. The **ENC Viewer** (Figure 7.a) and **RNC Viewer** (Figure 7.b) provide seamless displays of the entire vector and raster chart suites, automatically progressing to the most appropriate scale chart as the user zooms in and out of the display. The **Nautical Chart Viewer** (Figure 8.) displays complete, single nautical chart images and allows users to easily pan and zoom over an entire chart, including notes and marginalia.

Figure 7.a – NOAA ENC® Viewer

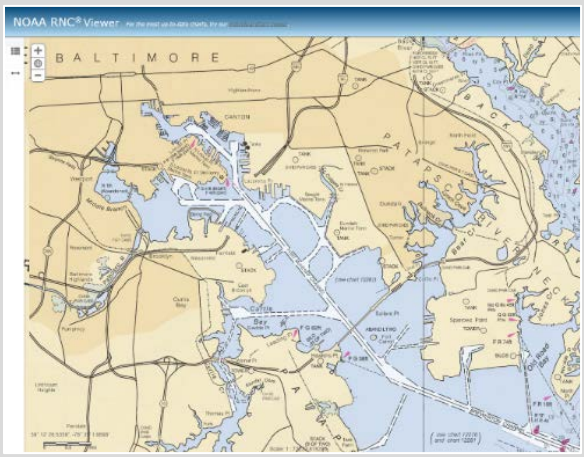


Figure 7.b – NOAA RNC® Viewer

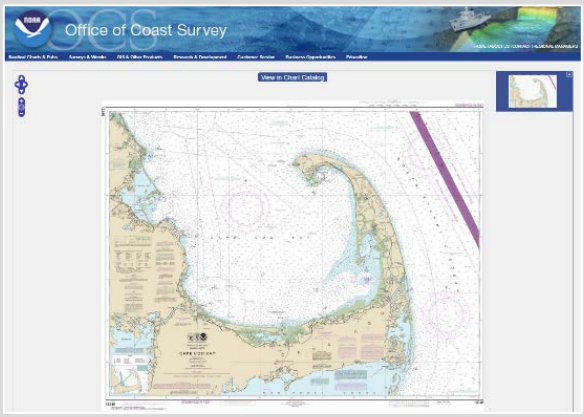


Figure 8 – NOAA Nautical Chart Viewer

Sources of Data used to Maintain Charts

The data used to compile and update nautical charts comes from a variety of sources. This section describes the principal sources used by NOAA.

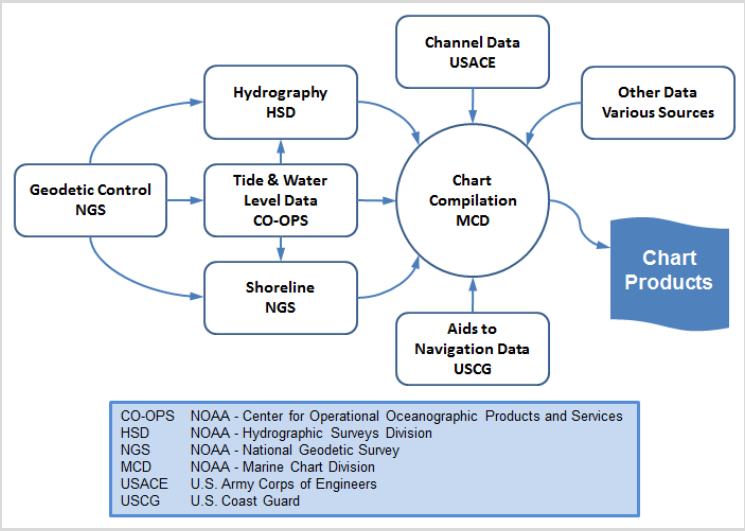


Figure 9 – Sources of NOAA Nautical Chart Data

NOAA's National Geodetic Survey (NGS) provides vertical and horizontal control data that are the foundation for their own photogrammetric and LIDAR shoreline surveys, as well as for hydrographic surveys. Coast Survey's Hydrographic Survey Division (HSD) measures water depths and locates hazards, such as wrecks, rocks, and shoals. Commercial survey companies and other government agencies also provide hydrographic survey data, which is processed by HSD. NOAA's Center for Operational Oceanographic Products and Services (CO-OPS) provides tide and other water level information that is used to help determine the position of the shoreline at the chart reference datum and to adjust depths to a chart's sounding datum. CO-OPS also provides information used in the predicted tide boxes that are published on NOAA charts. The U.S. Army Corps of Engineers (USACE) provides data on the depth and limits for over 1,500 federally maintained channels, as well as information about other harbor improvement projects, such as fish havens, dumping grounds, disposal areas, spoil areas, restricted areas, pipeline areas, and overhead cable clearances. The U.S. Coast Guard (USCG) publishes a Light List for each of its nine Coast Guard districts. These documents list the positions and characteristics of all USCG maintained buoys, beacons, and lights, as well as some private aids to navigation. NOAA uses this information and information from the USCG Local Notices to Mariners to update its charts, weekly. There is also a growing amount of information from crowd-sourced or non-traditional sources that Coast Survey is able to incorporate into its nautical products

CHART DISTRIBUTION

Free Download of all NOAA Chart Products

All formats of NOAA chart products (ENC, RNC, Full-size nautical charts, and Booklet Charts) can be downloaded free from the Coast Survey website at www.nauticalcharts.noaa.gov. The NOAA Chart Locator at www.charts.noaa.gov/InteractiveCatalog/nrnc.shtml helps users find and download individual charts.

NOAA Paper Nautical Charts

Paper copies of NOAA nautical charts may be purchased from one of the NOAA certified chart agents listed at www.nauticalcharts.noaa.gov/staff/print_agents.html. These are the only paper versions of NOAA charts that meet carriage requirements for commercial vessels. They contain all critical corrections published in notices to mariners since the last new edition of the chart was released, as well as any newly compiled routine changes (see the "Prioritization of New Chart Source Data" section below for a description of "critical" and "routine" updates).

ENC Distributors

ENCs are available free from the NOAA Coast Survey website at www.nauticalcharts.noaa.gov. They may also be obtained from a NOAA certified ENC distributor through NOAA's agreement with the International Center for Electronic Navigational Charts (IC-ENC), www.ic-enc.org, or from one of NOAA's other certified distributors listed at www.nauticalcharts.noaa.gov/staff/print_agents.html#mapTabs-5. Only ENCs that are obtained through NOAA-certified distributors, IC-ENC distributors, or directly from the NOAA website meet USCG carriage requirements.

NOAA RNC Tile Service

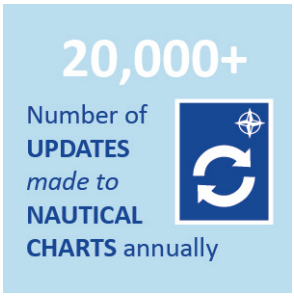
ECS vendors, third party data providers, and other users can also download free updated tiles from the **NOAA RNC Tile Service**. This eliminates the need for application developers to do the cumbersome process of transforming NOAA RNC files into tilesets for their customers. Tiles covering areas of charts that have changed are updated and replaced by NOAA weekly.

PART II – Transformation of Nautical Chart Production

NEW EDITION CHARTS AND CHART UPDATES

New editions of ENCs, RNCs, and NOAA paper nautical charts are issued every two to ten years or so depending on the chart. Smaller scale charts and areas with fewer changes usually have less frequent new editions. However, updates for all chart products are issued weekly. In the past, there were important differences between new editions and chart updates, but advancements in chart production, distribution methods, and navigation system technology are diminishing those differences. This section discusses the impact these changes will have on how customers use and update NOAA chart products.

Prioritization of New Chart Source Data



As Coast Survey receives new data for updating its charts, the information is prioritized as being either **Critical** or **Routine**. Critical data includes any changes that may pose a danger to navigation and that mariners should be informed of as soon as possible. This includes, but is not limited to changes to the position or characteristics of aids to navigation (buoys, beacons, and lights), newly discovered rocks, wrecks, shoals, or other dangerous obstructions, and changes to the position or minimum depths of federally maintained channels. All other data are categorized as routine. This includes ordinary hydrographic and shoreline surveys, which can be extensive, but have not identified any immediate dangers.

*In the past, **only chart updates** for ENC, RNC and paper nautical charts provided **Critical data corrections**. **New Routine data** were only provided in **New Editions**.*

New Editions of Paper Charts

Until the government stopped printing paper nautical charts in 2014, two primary drivers for publishing a new edition of a chart were, the number of pending corrections (both critical and routine) that would be compiled for a new edition, and the quantity of chart stock available in the warehouse for distribution. Typically, thousands of copies of each new edition were printed. Publishing a new edition of any given chart was a lower priority when the stock of its current edition was plentiful, especially if there were not many pending corrections.

This system was economical for the government, because it allowed for more efficient, large print runs. It also enabled mariners to extend the life of their chart through hand corrections until they were obliged[5] to purchase a new edition when it was eventually published. However, this system also made it impossible to supply the most recent hydrographic survey data and other routine updates to mariners in-between new editions. Depending on the chart, it could be years before the supply of charts got low enough, or the number of pending corrections got high enough to justify printing another new edition.

The introduction of a print-on-demand chart service relieved NOAA of the burden of managing a large inventory of charts, because NOAA certified chart agents print just a few copies of the latest updated chart as orders come in. Initially, NOAA continued to wait to update charts with routine (non-critical) data until a

[5] Once a new edition is issued, the previous edition is cancelled and it is no longer maintained through notices to mariners. Once cancelled, a previous edition chart does not meet carriage requirements and a new edition must be purchased.

new edition was produced. Many mariners waited for a new edition to come out before buying a new print-on-demand chart. This was the only way to get newly updated routine data, such as new hydrographic survey or shoreline survey updates. The recent integration of the chart production systems that once produced new editions and chart updates separately has enabled NOAA to provide critical *and routine data* on both new editions *and weekly chart updates*.

> *Chart updates are now issued with **both critical and routine data** on a weekly basis, without having to wait for a new edition.*

NOAA Chart Updates Viewer

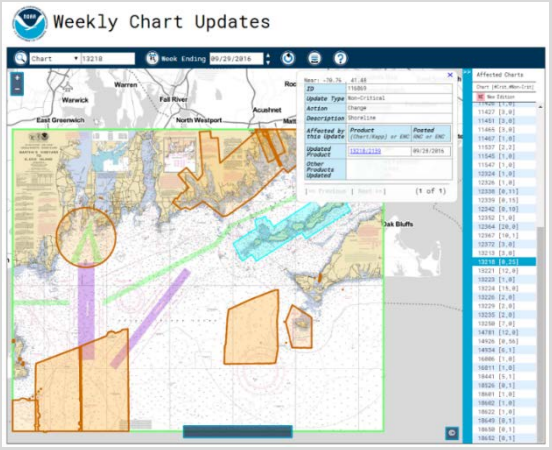


Figure 10

The new **NOAA Chart Updates** web page enables mariners to identify areas where new data (both critical and routine) have been applied to a chart. This will help them to decide between ordering a new paper nautical chart or to continue hand correcting the version that they already have. NOAA provides updated digital versions of its ENC and raster chart products weekly. By using the chart updates viewer and the print-on-demand paper chart service, the advent a new edition become less relevant. Essentially, the customer can decide when they want a "new edition" of a paper chart at any time.

ENC and RNC Chart Updates and New Editions

The difference between ENC new editions and ENC updates is purely technical. ENC updates, (called “revisions”) are issued by NOAA for all changes, as often as weekly. The revisions and the original ENC new edition are combined within an ECDIS to make a complete, updated ENC database. New editions are usually only issued after the 25th revision, or if the size of the revision files exceed 5 MB, whichever comes first.

For RNCs, the difference between new editions and updates is manifested only by a change in the edition number for new editions. Weekly “updates” for RNCs are issued as fully functional, complete RNC files that can be used directly in navigation or chart display systems.

Coast Survey now uses an algorithm for determining when to issue a new edition of a raster chart based on the magnitude and importance of new changes and other criteria that will be more meaningful to mariners. It is also possible that “new editions” may vanish altogether and versions of charts will only be tracked by their release date.

IMPROVING CHART CONTENT

Normalizing ENC Depth Contours

All but a handful of NOAA’s 1,000-plus raster nautical charts show depths in feet or fathoms; however, IHO ENC product specifications state that all depths must be encoded in meters. When NOAA digitized paper charts in the 1990s to create the first U.S. ENCs, depth values for soundings, depth curves, and other features with depths were converted from fathoms or feet into meters to populate the ENC database.

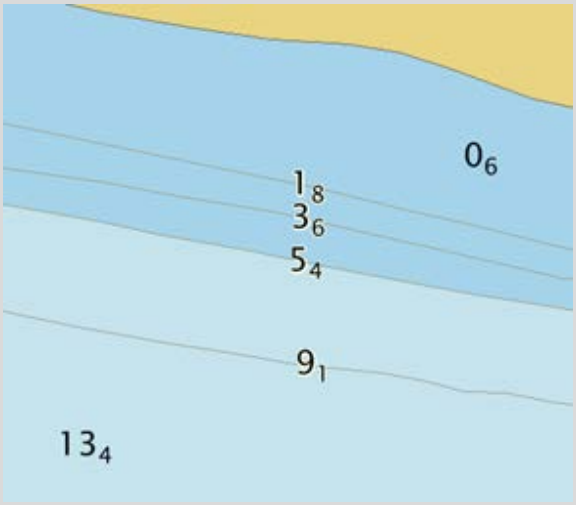


Figure 11 – Typical ENC depth contours.

As a result, soundings and depth areas currently in U.S. ENCs are compiled in fathoms and feet, but stored and displayed in ECDIS in decimal metric values, not whole (integer) metric values, as shown in Figure 11.

1 fm	6 ft	1.8M
2 fms	12 ft	3.6M
3 fms	18 ft	5.4M
5 fms	30 ft	9.1M

In addition to presenting mariners with a rather unwieldy set of depth contour values to decipher when viewed in an ECDIS, not using integer metric units diminishes the utility of NOAA ENCs for navigation in other significant ways.

Figure 12 – Safety contour is set at 10M. This causes an unnecessary alarm as a ship enters port. Since no 10 m depth contour is available, ECDIS will portray the next deeper depth area (60 ft, 18.2m) as “unsafe water.”

For example, on approach charts, 10 m and 20 m depth contours are common on international charts; on NOAA approach charts, 30-foot and 60-foot contours are usually used. In a NOAA ENC, these depth areas are stored as 9.1 meters and 18.2 meters respectively. Many mariners set a safety contour value of 10 meters in their ECDIS. This setting initiates an alarm in ECDIS if the vessel approaches the 10-meter contour. If the 10-meter contour is not present in the ENC, the next deeper contour will initiate an alarm. Figure 12 shows and example where there is no 10-meter contour. ECDIS symbolizes the next deeper depth area (18.2 meters) with a blue tint indicating that it is shoaler than the ship's draft. The system will also sound an alarm when the 18.2-meter contour is crossed as the ship enters harbor, even though the line would be 8.2 meters or nearly 27 feet deeper than the ship’s 10-meter safety contour setting.

Coast Survey will start compiling ENC depth contours in integer meter units in 2018.

Conversion of Depths from Fathoms and Feet to Meters on NOAA Raster Charts

The first international hydrographic conference (convened in London in 1919) set in motion the

establishment of the International Hydrographic Bureau.[6] The conference passed a resolution that, "strongly recommended that all countries, as soon as convenient, adopt the metric system for their nautical publications." Nearly a century later, almost all NOAA nautical charts still depict depths in fathoms and feet. The U.S. Omnibus Trade and Competitiveness Act of 1988 designated the metric system as the preferred system of weights and measures for United States[7] and the Coast Survey made one brief attempt to convert its nautical charts to meters in the early 1990s. However, the effort was abandoned after only a small number of charts were converted.

Coast Survey is reinvestigating the feasibility of converting all depth values into meters on its raster charts. This will be a considerable effort, but much less onerous than it was 25 years ago. Now, all chart data is in digital format and more efficient computer tools are available. Having all chart formats use the same international units for depths will make chart production more efficient and use of NOAA charts less confusing for U.S. and foreign mariners transiting in and out of U.S. waters. The decision to convert to meters is still under consideration; therefore, there is no timetable for when raster charts might be converted. Coast Survey is also starting to prototype a chart product-on-demand service in which a user may select feet and fathoms, or meters for the display of depths before the chart is rendered and printed.

Reducing Unwarranted ECDIS Alarms and Isolated Danger Symbolization

Coast Survey is committed to improving our data encoding practices to reduce the number of unwarranted ECDIS alarms and indications experienced by mariners using NOAA ENCs. ECDIS uses the "safety depth contour" setting – based on a ship's draft – to initiate alarms and other indications when a ship is heading toward a danger, such as a shoal, rock, or wreck. The ECDIS display also automatically changes to highlight certain features that are shoaler than the "safety depth contour" setting. This capability can sometimes cause clutter in the ECDIS display and initiate unnecessary alarms. The way Coast Survey has encoded some features in the past has contributed to this problem.

Non-dangerous wrecks of unknown depth

One example of this problem is when ECDIS replaces the traditional or "paper chart" "dangerous wreck, depth unknown" symbol, or the "non-dangerous wreck" symbol, with the unique ECDIS "isolated danger" symbol, . This occurs when these features are shoaler than the ship's "safety depth contour" setting or when no least depth has been encoded for the wreck. ECDIS does not take into account the classification of wrecks as “dangerous” or “non-dangerous” when symbolizing them. Thus, a wreck will be portrayed as an “isolated danger,” when in reality it is not, if no least depth is encoded for the feature. This is the case for the wrecks shown in Figure 13.a. Figure 13.b shows the usual depiction of the same features. Data for ENCs were initially collected from paper charts and the encoding was

Figure 13.a – ECDIS display of wrecks with the "isolated danger" symbol

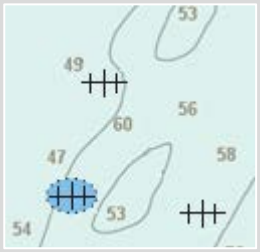


Figure 13.b – ECDIS display of one "dangerous" and two "non-dangerous" wrecks

[6] The International Hydrographic Bureau (IHB) was ultimately established in June of 1921 and subsequently reorganized as the International Hydrographic Organization (IHO) in 1967.

[7] National Institute for Science and Technology (NIST), The United States and the Metric System, a Capsule History, at https://www.nist.gov/sites/default/files/documents/pml/wmd/metric/1136a.pdf

often based only on the position of the wreck, which many times did not have an accompanying estimated safe clearance or least depth. Coast Survey is now undertaking an effort to estimate and populate "safe clearance" depth value for all wrecks deeper than 66 feet (11 fathoms). This will eliminate much of the unnecessary display clutter and many alarms.

Channel Tabulations

Coast Survey currently receives information on minimum channel depths from the U.S. Army Corps of Engineers (USACE), which is then added to nautical charts, often in the form of a table or "channel tab," listing the minimum depths along various sections of federally maintained navigational channels. These data are also made available to the public by USACE district offices on their websites.

The channel data published on NOAA raster charts and ENCs has often been out of sync with the data publicly available on USACE district websites. This discrepancy is because of varying USACE survey processes, field-to-office practices, and delivery methods to NOAA. The production requirements for the compilation of other chart data, the frequency and timing of the receipt of channel data from each Corps district, and other factors also affect the time it takes to update any given chart. Even more challenging is harbor pilot access of USACE data prior to its application to the nautical chart. This can cause disagreement between a pilot guiding a ship in from the sea buoy (using more recent USACE data) and the vessel's captain (looking at older USACE channel data on the NOAA chart). The need for consistent data and availability has led USACE to implement an enterprise-wide channel data reporting process known as eHydro, in which data is available from all districts and navigation projects through a single portal.

USACE maintained channels are depicted in many different ways on NOAA raster charts. Coast Survey believes that standardizing the presentation of channel data will improve data consistency and safety. Coast Survey is investigating a number of steps that will improve the government's ability to provide the most timely and accurate channel depth information to the public, some of which are described below.

Provide a reference to USACE websites providing the latest depth information

The current set of channel tabulations showing the most recently received minimum channel depths, as shown in Figure 14.a, will be replaced with a smaller table showing only the USACE "project dimensions" for each channel section, as shown in Figure 14.b. Project dimensions describe the shape of a channel's original design, which is maintained by periodic dredging operations.

BALTIMORE HARBOR CHANNEL DEPTHS

TABULATED FROM SURVEYS BY THE CORPS OF ENGINEERS - SURVEYS TO SEP 2015

NAME OF CHANNEL	CONTROLLING DEPTHS FROM SEAWARD IN FEET AT MEAN LOWER LOW WATER (MLLW) *					PROJECT DIMENSIONS		
	LEFT OUTSIDE QUARTER	LEFT INSIDE QUARTER	RIGHT INSIDE QUARTER	RIGHT OUTSIDE QUARTER	DATE OF SURVEY	WIDTH (FEET)	LENGTH (MILES)	DEPTH MLLW (FEET)
BREWERTON CHANNEL	49.0	51.0	51.0	49.0	9-15	700	3.50	50
BREWERTON ANGLE	47.0	48.0	49.0	48.0	3-15	700-1460	1.10	50
FORT MCHENRY CHANNEL	45.0	49.0	49.0	47.0	2-15	700	4.22	50
FERRY BAR CHANNEL	38.0	42.0	41.0	37.0	2-15	600	1.50	42
CURTIS BAY CHANNEL	47.0	47.0	47.0	45.0	3-15	400-1275	2.25	50
NORTHWEST HARBOR								
EAST CHANNEL	40.0	44.0	47.0	43.0	1-15	600-950	1.52	49
WEST CHANNEL	38.0	39.0	38.0	36.0	1-15	600-1068	1.38	40

* ALL DEPTHS REPORTED TO NEAREST FOOT
NOTE - CONSULT THE CORPS OF ENGINEERS FOR CHANGES SUBSEQUENT TO THE ABOVE INFORMATION

Figure 14.a – Example of Current Channel Tabulation

BALTIMORE HARBOR CHANNEL

Go to http://www.nab.usace.army.mil/Missions/Civil-Works/Nav-Maps for the latest minimun depth information

NAME OF CHANNEL	PROJECT DIMENSIONS		
	WIDTH (FEET)	LENGTH (MILES)	DEPTH MLLW (FEET)
BREWERTON CHANNEL	700	3.50	50
BREWERTON ANGLE	700-1460	1.10	50
FORT MCHENRY CHANNEL	700	4.22	50
FERRY BAR CHANNEL	600	1.50	42
CURTIS BAY CHANNEL	400-1275	2.25	50
NORTHWEST HARBOR			
EAST CHANNEL	600-950	1.52	49
WEST CHANNEL	600-1068	1.38	40

Figure 14.b – New Channel Tab Format

This approach provides mariners with the designed channel project dimensions and depths on the raster chart, while pointing mariners to a website closely coordinated between USACE and NOAA, which shows the controlling (minimum) depths from the Corps' latest hydrographic survey of the channel. Controlling

depths will continue to be encoded in ENCs, which can more easily be updated and provided to mariners in weekly digital ENC revisions.

Depicting Bathymetry within Charted Channels

Generally, depth values are not shown within charted channels. However, there are a few exceptions, most notably in the Boston and New York areas. Given the other changes in how Coast Survey will be portraying channel data, soundings and depth contours within channels on raster charts may be removed in order to re-align these charts with standard NOAA charting practices. Mariners who need up-to-date Army Corps channel information will be encouraged to use ENCs.

To provide mariners with a better indication of the quality of the USACE bathymetric data depicted within channels, NOAA has started including dredged channels in its raster chart zone-of-confidence diagrams (previously called source diagrams). Channel depths are often collected by the USACE with lower resolution single beam sonar technology, this data will usually be classified as category B, “Full seafloor coverage not achieved; uncharted features, hazardous to surface navigation are not expected, but may exist.”

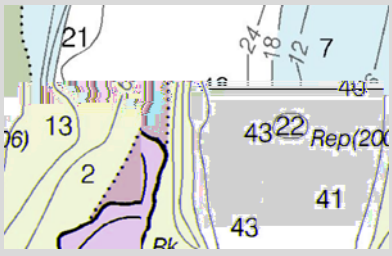
Distributing NOAA and USACE Data Simultaneously

NOAA and USACE seek to get the best available data to the mariner in a timely and consistent manner. Some new approaches to data coordination between the two agencies are being implemented or considered. The previously mentioned eHydro Program in USACE will standardize the format, content, and availability of navigation channel data, and eliminate the inconsistency of channel condition products published by USACE districts and data provided to NOAA.

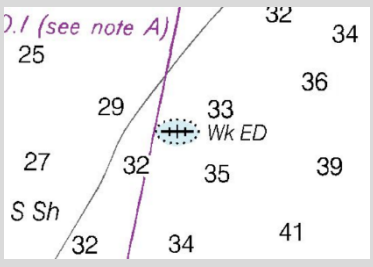
Another possibility is the USACE publication of surveys in an ENC compatible format on a multi-agency website. Whether better data transfer between agencies or publication of similar formats, both agencies seek to allow pilots and ship captains to have access to the same data simultaneously.

Reported, Existence Doubtful, and Position Approximate Dangers

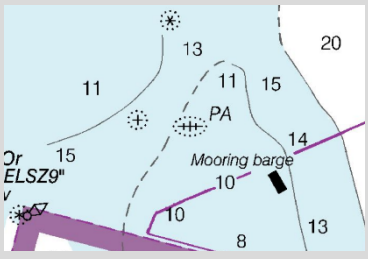
The majority of the wrecks, rocks, obstructions, shoals, and other dangers to navigation shown on NOAA charts have been precisely surveyed and positioned. However, thousands of unverified or imprecisely positioned dangers remain charted as "reported," "existence doubtful," or "position approximate." These are labeled as *Rep*, *ED,* and *PA*, respectively on NOAA raster charts, as shown in Figure 15.



Shoal sounding reported on Chart 13285



Wreck, existence doubtful on Chart 18704



Submerged wreck, position approximate on Chart 12335

Number of ENC features attributed as reported, existence doubtful and approximate in December 2016:		
Rep, not confirmed or Rep, not surveyed: 2,253	Existence doubtful: 765	Position approximate or Position doubtful: 17,930

Figure 15

Although there has been an ongoing effort to investigate these features, many of these have lingered on charts for decades, even in the midst of busy harbors. A renewed effort is now underway to deploy resources to investigate and resolve these uncertainties with high traffic areas as the priority.

Maritime Boundaries

The U.S. Baseline Committee, created in 1970, precisely defines the location and nature of the U.S. coastline. The Mean Lower Low Water (MLLW) line on NOAA charts is used by the Committee to establish the baseline from which other U.S. maritime boundaries are based. NOAA is responsible for depicting the following three maritime boundaries on its nautical charts:

Territorial Sea

A maritime zone over which the United States exercises sovereignty. Sovereignty extends to the airspace above and to the seabed below the territorial sea. The U.S. territorial sea extends 12 nautical miles from the baseline.

Contiguous zone

A zone contiguous to the territorial sea, in which the U.S. may exercise the control necessary to prevent and punish infringement of its customs, fiscal, immigration, cultural heritage, or sanitary laws and regulations within its territory or territorial sea. The U.S. contiguous zone is measured 24 nautical miles from the baseline.

Exclusive Economic Zone (EEZ)

The exclusive economic zone (EEZ) of the U.S. extends 200 nautical miles from the territorial sea baseline and is adjacent to the 12 nm territorial sea of the U.S., overlapping the 12-24nm contiguous zone. Within the EEZ, the U.S. has:

- Sovereign rights for the purpose of exploring, exploiting, conserving, and managing natural resources, whether living and nonliving, of the seabed and subsoil and the superjacent waters and with regard to other activities for the economic exploitation and exploration of the zone, such as the production of energy from the water, currents, and winds.
- Jurisdiction as provided for in international and domestic laws with regard to the establishment and use of artificial islands, installations, and structures, marine scientific research, and the protection and preservation of the marine environment.
- Other rights and duties provided for under international and domestic laws.

Baselines are subject to change as coastlines accrete and erode. Based on efficiencies that Coast Survey hopes to achieve in its chart production system from the changes described elsewhere in this plan, we hope to improve the timeliness of charting maritime boundaries and our support of the U.S. Baseline Committee.

IMPROVING CHARTS SCHEMES

In the early 1990s, NOAA began digitizing data from its paper nautical charts to create content for the first NOAA ENCs. The limits of each ENC were inherited directly from its corresponding paper chart. The resulting ENC product suite now consists of 1,226 irregularly shaped cells compiled at 131 different scales. Current ENC harbor usage-band coverage in western Long Island is shown in Figure 16. Annex B shows additional information about scales and usage bands.

Figure 16 – Current ENC Footprints for Harbor Usage-band in Western Long Island

Rescheming ENCs

ENCs do not need to follow traditional raster chart limits and are solely limited by the 5 MB ENC file size restriction. Coast Survey plans to create a gridded system with standardized scales and cell sizes. Cell boundaries will follow lines of longitude and latitude. Cells in progressively larger scale usage bands will nest within the (larger size) cells of smaller scale usage bands.

The goal is to create ENC cell footprints in a standardized, consistent gridded framework that can easily be segmented or extended, based on geographic location, available data, and scale, as shown in Figure 17.

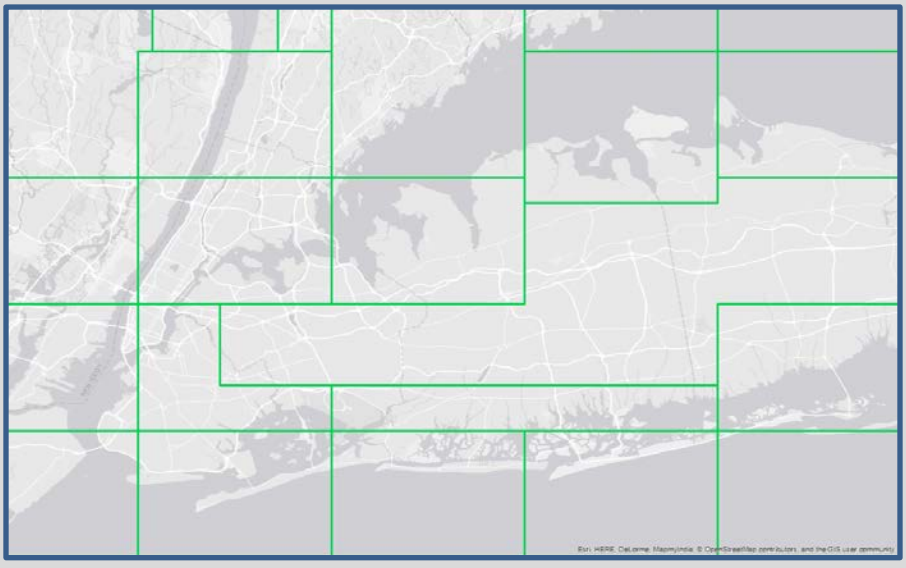


Figure 17 – Possible New ENC Scheme for Harbor Usage-band in Western Long Island

In the past, each ENC cell was maintained within its own individual database, which made rescheming ENCs difficult. However, all ENC data now resides within a single, seamless database called the Nautical Information System (NIS). Coast Survey will release an ENC rescheming plan for public review in 2018.

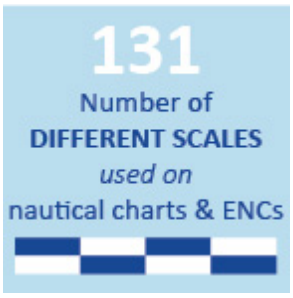
The NIS database will simplify several other ENC enhancements, such as the edge matching of data on adjacent cells of the same or similar scales, and increasing the conformity of feature compilations on different scale ENCs. Figure 18 shows an example of adjacent ENCs that do not match.

Figure 18 – This image shows three ENC cells.
The extent of the 60 ft (18.2m) depth area in the ENCs on the left and center does not match. The ENC on the right does not show this depth area at all.

Standardizing Scales

A note about scale

Cartographic products are designed to be used at a specific scale. For example, on a map with a scale of 1:63,360, one inch on the map represents one mile in the real world. Large-scale charts show more detail, such as a marina's individual berthing slips. Most chart insets are large-scale. Small-scale charts show less detail over a larger area. The same marina shown in a large-scale inset would not even be depicted on a small-scale chart that portrays the entire West Coast.



Paper is the ultimate control of scale. A mariner cannot "over zoom" into a paper chart. However, digital charts enable users to magnify the display of a chart beyond its intended scale. ECDIS warns mariners that they have "over zoomed" by overlaying vertical bars on any chart that is shown at a scale larger than its intended display scale. However, many computer or mobile phone apps ignore over zooming. This can provide users with a false sense of precision for data compilations that have been generalized for a smaller scale. This is the cause of many inquiries to Coast Survey by users who expect to see features on a chart that, if viewed at its intended scale, would not be meaningful.

Standardizing ENC Display Scales

NOAA raster charts and ENCs are now compiled at 131 different scales. This will be reduced to 20 or fewer standardized scales during the re-scheming process. The standardized scales will conform to the ENC scales recommended by the IHO in the S-57 and S-101 ENC product specifications (see Annex B).

Standardizing Raster Chart Scales

As different sections of ENC coverage are reschemed, Coast Survey will investigate rescheming and standardizing scales for raster charts as well. This will enable more efficient chart production, greater consistency, and improve synchronization between vector and raster chart products. One significant difference in the new schemes for ENCs and paper nautical charts will be that while ENC cells cannot overlap, nautical charts do, to facilitate transitioning from one chart to another.

ENC-Only Charts

NOAA raster charts were the source material used to create the original suite of NOAA ENCs. Therefore, every ENC had a corresponding raster chart. (However, not every raster chart has a corresponding ENC, because a few types, such as canoe charts in Minnesota, were not converted.) In the past few years, Coast Survey has created a handful of "ENC-only" charts from original (non-raster chart) source materials. For some of these, the compiled data were subsequently used to create new raster charts. However, for some large-scale products, Coast Survey has decided not to create corresponding raster charts. This saves the additional effort needed to maintain the raster equivalents and resources may be put to better use carrying out other parts of Coast Survey's mission. As the mandate for all large SOLAS class vessels to use ECDIS comes into full effect in 2018, Coast Survey may decide to cancel a select number of existing raster charts that are likewise being used primarily by SOLAS class vessels. Monitoring statistics for the sales of paper charts and downloads of ENCs and RNCs will help guide these decisions.

Improving Chart Coverage for Small Craft

The first U.S. small craft charts were created in the middle of the Twentieth Century. While these charts were useful and popular with recreational boaters for decades, there are now Twenty-First Century NOAA products that are easier and safer for recreational boaters to use in an ECS or mobile app. Some NOAA small craft charts have two dozen chart panels, often with several that are skewed, sometimes by more than 90° from the conventional “north up” orientation. This makes it more difficult for mariners to form a mental image of how the various panels fit together, requiring either physically rotating the paper chart or turning the chart image in their own head. Another disadvantage is that an ECS will automatically display a skewed RNC panel in the north-up orientation, but it cannot rotate the symbology and text that is in a fixed position on the raster image. This means that the accompanying text and symbology will be displayed sideways. Figure 19 shows the various orientations of the 15 panels of the now cancelled small craft chart 18445.

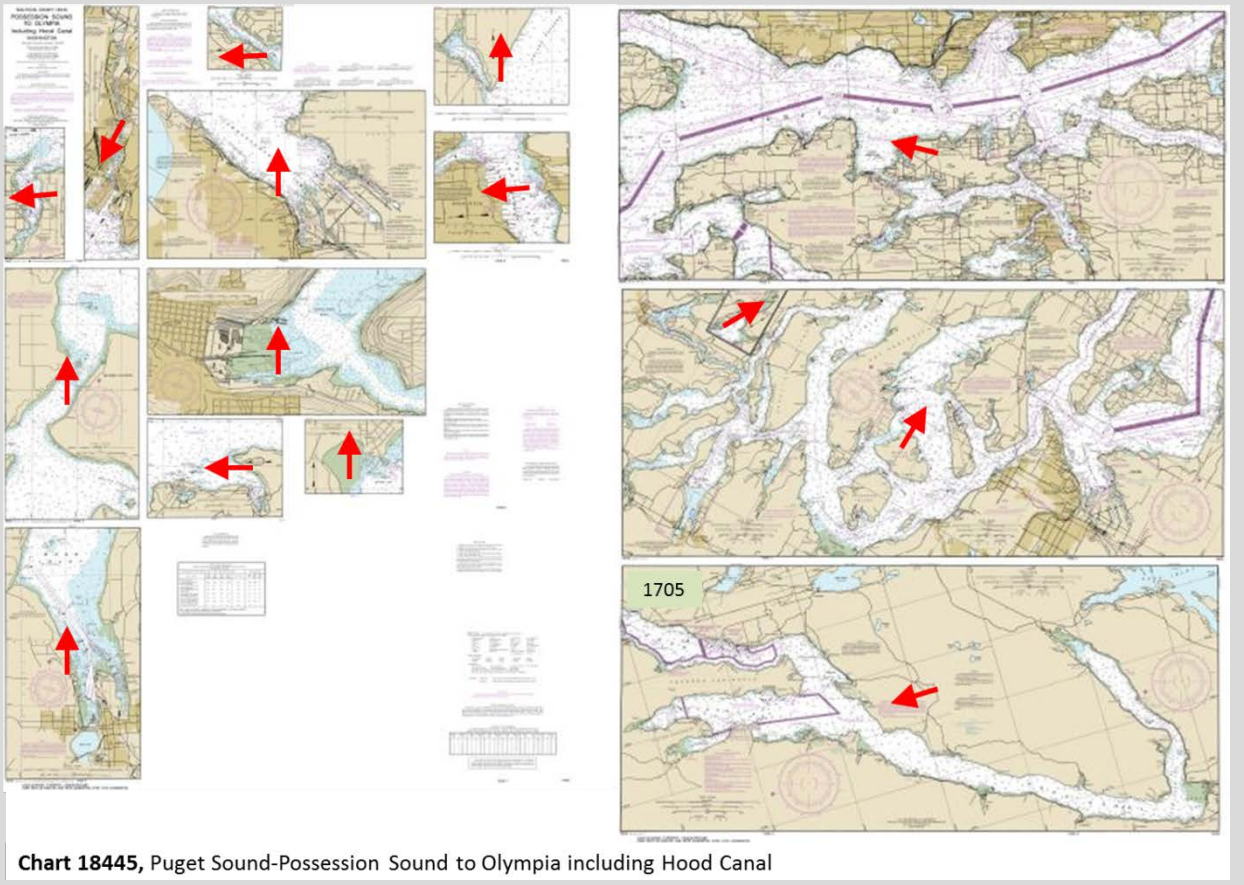


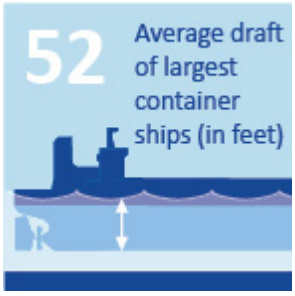
Figure 19 – The red arrow in each chart panel indicates the direction of north

Coast Survey is now exploring how to move the current small craft chart coverage onto existing or new standard nautical charts of the same or larger scale. This will provide consistent "north-up" orientation of all raster charts. The isolated depiction of the many small insets found on small craft charts will usually be moved and presented within the extent of larger chart coverage. This will enable easier orientation and transition from one chart to another while underway.

Partnering with Industry

NOAA works with a variety of partners to ensure that our products can be used in a range of applications. The market includes ECDIS, ECS, and Portable Pilot Units, to data used in apps developed for smartphones. In order to reach a wide variety of users, NOAA participates in a wide variety of fora to engage both end users (mariners and boaters) and equipment manufacturers. For example, NOAA engages with the ECDIS community through our involvement in the development of ENC and ECDIS related standards within the IHO and IMO. Another avenue is our participation in the development of ECS related standards within the Radio Technical Commission for Maritime Services, which develops industry standards that are used by the USCG for the carriage of ENCs by vessels subject to inspection. NOAA also engages with industry by holding "industry days" in conjunction with boat shows to showcase its products, meet with chart users, and to coordinate with developers of recreational navigation systems. Coast Survey also recognizes that several third-party data providers depend on NOAA RNC or RNC Tile Service data to create their products for recreational boaters.

IMPROVING CHART PRODUCTION EFFICIENCY



Army Corps of Engineers (USACE) Data for Ship Channels

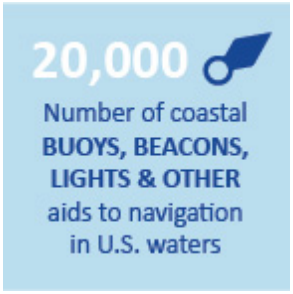
The USACE provides hydrographic survey and minimum depth information to NOAA for over 1,500 federally maintained channels. Each channel has its own authorization and funding, and USACE maintenance is closely coordinated with the needs and demands of local navigation interests. Channel condition data from 23 USACE districts can therefore have different formats and be delivered by different methods and on different schedules.

The USACE recently implemented the eHydro program to make standardized channel data available to other users, including NOAA, through an enterprise approach. Ultimately, timely, accurate, and authoritative data for all USACE channels will be available through a single portal. This will save NOAA a significant amount of the extra time that was required to process the different data formats provided in the past. NOAA will take advantage of the new format as each district is fully functional in eHydro. This will enable Coast Survey to obtain timely channel data from a single online location in one standardized format, as needed.

Coast Survey also hopes to explore the possibility of USACE data (surveys) distributed seamlessly and simultaneously with NOAA ENCs to end users. This practice could further help eliminate conflicting data to customers from the two agencies. USACE has agreed to explore the possibility while still satisfying data needs and demands from local customers.

We envision a time when digital channel bathymetry products from USACE hydrographic surveys are available in the form of ENC data or a compatible digital data layer that could be displayed and used directly within a mariner's ECDIS or ECS. Such products could be produced by USACE or by NOAA with a timely and carefully coordinated data exchange process. Most importantly, we will work with the USACE to provide the best available channel data, in conjunction with the ENC, to all customers at the same time.

U.S. Coast Guard Aids to Navigation Data



U.S. Coast Guard maintains over 20,000 floating and fixed aids to navigation (buoys, beacons, and lights) in U.S. coastal waters. Currently, Coast Survey is made aware of changes to existing aids and the addition or removal of aids through USCG issued local notices to mariners. These changes must then be applied individually to the chart production database. Recently, the USCG and Coast Survey have started working together to develop a process for extracting the entire set of aids to navigation changes from a USCG database. This XML formatted file could then be ingested directly into Coast Survey's chart production database weekly to refresh the positions and other characteristics of any aid that changed. This not only would save a significant amount of time, but would also preclude any chance of data being entered incorrectly by hand.

OPEN DATA AND MARINE SPATIAL DATA INFRASTRUCTURE

Open Data and Marine Spatial Data Infrastructure

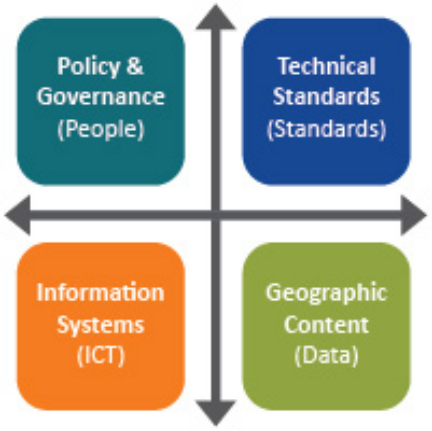
Coast Survey will continue to practice an open data policy. Newly generated data will be made freely available in machine-readable formats where privacy, security, and safety needs allow. Our practices are consistent with existing international standards, the Digital Accountability and Transparency Act of 2014

(DATA Act) and any other applicable Federal policies. This includes leveraging data tools and resources when available to include data catalogs, converter tools, and development platforms. Eligible datasets are discoverable on the data catalogs, https://data.noaa.gov and https://www.data.gov.

A basic tenet of data management at NOAA is full and open data access. Greater access to marine data and information helps support economic growth in commercial markets and industries, such as commercial fishing, maritime transportation, aquaculture, and offshore energy. This improves the ability of tribal, state, local, regional, and federal agencies to make policy decisions.

NOAA nautical chart products are available in several formats, as described in the Nautical Chart Products section above. Additionally, the ENC Direct to GIS web service allows users to display, query, and download all available base editions of NOAA ENC® data in a variety of GIS/CAD formats. Access to nautical chart source data, such as hydrographic and topographic surveys are also available online.

Marine Spatial Data Infrastructure



A Marine Spatial Data Infrastructure (MSDI) is a framework for policy and governance, standards, Information Content Technology (ICT), and geographic content. It enables spatial discovery, evaluation, retrieval, and application of marine spatial data for users and providers in the public and within all levels of government, the commercial sector, the nonprofit sector, academia, and by citizens in general.

MSDIs typically comprise a variety of content, such as marine boundaries and limits, conservation and preservation areas, marine habitats, oceanography, bathymetry, hydrography, geology, marine infrastructure, wrecks, offshore installations, pipelines, and cables. This data are organized into themes, examples of which are listed below.

- Horizontal and Vertical Datum
- Offshore Cadastre
- Land Ownership
- Shoreline
- Climate
- Flood Hazards
- Marine Boundaries
- Oceanographic Features
- Bathymetric Elevation
- Seabed Character
- Offshore Minerals

Although the primary use of NOAA nautical charts is the safety of navigation, they can serve many other purposes when included in a SDI, such as:

- Conservation assessment and designation
- Site selection (e.g., renewable energy, oil and gas extraction)
- Coastal protection and shoreline management
- Habitat mapping and heritage assessment
- Emergency planning and management
- Vessel location and disposal monitoring
- Survey planning and execution
- Licensing and consent evaluation
- Fisheries regulation
- Route optimization
- Aggregates extraction
- Homeland security and defense

Coast Survey is committed to providing its data in an MSDI. The process of building a robust MSDI will take years, but some steps, such as providing the ENC Direct to GIS service, have already been completed. We plan to expand our offerings to include base level hydrographic survey data from a bathymetric database and authoritative theme layers extracted from nautical charts.

NAUTICAL CHARTS IN THE FUTURE

Providing for the Needs of Commercial Mariners and Recreational Boaters

NOAA will continue making nautical charts in both raster (paper, RNC and PDF) and vector (ENC) formats. As noted in this plan, we are undertaking several initiatives to make our existing products even more accurate and easier to use. Chart producing nations around the world, including NOAA are also exploring the development of new nautical chart forms that will provide greater safety of navigation and convenience for commercial mariners and recreational boaters. However, the limited resources available to any chart-producing agency necessitate that the compilation, updating, and distribution of new and existing products be as efficient and cost effective as possible.

The Declining use of Paper Charts

After July 2018, the International Maritime Organization (IMO) will require all large commercial vessels on international voyages to navigate with ENCs using an Electronic Chart Display and Information System (ECDIS). In Feb 2016, the US Coast Guard approved changes to chart carriage requirements for commercial vessels on domestic voyages within US waters. These vessels now have the option of using ENCs with an Electronic Chart System (ECS) in lieu of paper charts.

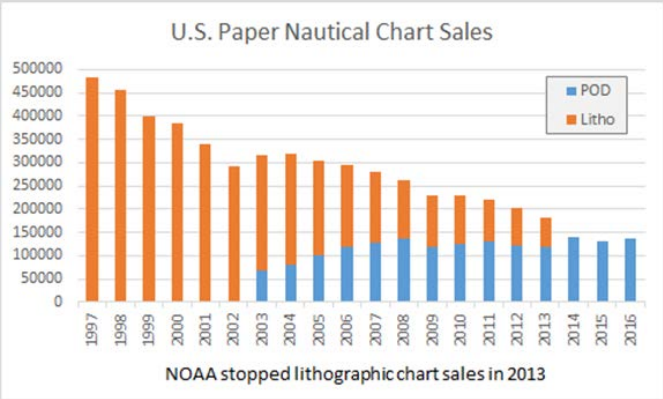


Figure 20

Eliminating the requirement for commercial vessels to carry paper charts is expected to sustain, if not accelerate, declining sales of lithographic and print-on-demand paper nautical charts. This trend started over two decades ago, as shown in Figure 20.

The IMO and USCG both require vessels to have a back-up to their primary navigation system and use of paper charts is allowed as a back-up. However, the additional cost of maintaining portfolios of both ENCs and paper charts may compel some shipping companies to consider the additional cost of purchasing a second, independent ECDIS of ECS versus the cost of purchasing, storing, and hand correcting a portfolio of paper charts."

Taking the Best Advantage of Agency Resources

If the use of paper nautical charts continue to fall, there will be a point when NOAA will re-evaluate the paper chart suite to make it better suited for paper chart back up, recreational navigation, or small scale situational awareness. In any event, Coast Survey is always exploring options that will put resources to the best use updating the products that will have the greatest

impact supporting safety of navigation for mariners and recreational boaters. Some of the developments that are being evaluated are discussed below.

Continuing Availability of Paper Nautical Charts

Even as use of paper charts decreases, there will still be some commercial mariners and recreational boaters who either prefer to use paper charts as a primary means of navigation or as a back-up. Coast Survey is reviewing a few different approaches for making paper charts more efficiently in the future. One way is to generate symbolized raster charts directly from vector ENC data. This rule-based, semi-automated process would save a substantial amount of compilation time required to produce raster chart and ENC products separately. This could also be an economical way to provide paper back-ups for mariners and recreational boaters navigating with ENCs.

“Chart product on demand” is another promising capability that Coast Survey is exploring. This enables users to create their own customized chart online by selecting its scale, center-point, and paper size.

Both of these processes will produce a slightly different looking nautical chart product that will have notes, scales, and other chart elements positioned at the bottom of the chart. Rescheming ENCs and reducing the number of compilation scales, as discussed elsewhere in this plan, will be required to enable rasterizing ENCs or a chart product-on-demand capability.

ANNEX A – QUICK USAGE GUIDE FOR NOAA CHARTS

Quick Usage Guide for NOAA Charts

Check marks show the charts typically used by the vessel types indicated

	Chart Type		Vessel Type		
			Commercial		
	Vector	Raster	ECDIS Required	ECDIS Not Required	Recreational
Meet Carriage Requirements	NOAA ENC® 		✓	✓	✓
Meet Carriage Requirements		NOAA Paper Nautical Chart 	✓ ① ②	✓ ①	✓
Do Not Meet Carriage Requirements		NOAA RNC® 	③		✓
Do Not Meet Carriage Requirements		NOAA Full-size Nautical Chart 			✓
Do Not Meet Carriage Requirements		NOAA Booklet Chart™ 			✓
Do Not Meet Carriage Requirements		NOAA RNC Tile Service 			✓

① NOAA paper nautical charts only meet carriage requirements if they are purchased from a NOAA Certified Chart Agent and kept up-to-date with notice to mariners corrections.

② Some older ECDIS mandated cargo ships may navigate with paper charts until July 2018.

③ RNCs are approved for use by ECDIS mandated vessels only if adequate ENC data is not available. Complete ENC coverage is available in all U.S. waters, so NOAA RNC® data may not be used in ECDIS.

ANNEX B – Current Raster Chart Scales Allocated to NIS Compilation Scales – ENC Navigational Usage Bands

NIS Comp Scale	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
	2,500	**5,000**	**10,000**	**15,000**	**20,000**	**25,000**	**30,000**	**40,000**	**50,000**	**60,000**	**80,000**	**100,000**	**120,000**	**200,000**	**300,000**	**400,000**	**500,000**	**700,000**	**1,200,000**	**1,500,000**	**3,500,000**	**10,000,000**
Current Raster Chart Product Scales	3,500	6,000	12,000		24,000	25,475	32,500	41,275	50,204	72,962	80,660	106,600	135,000	207,840	326,856	419,706	600,000	736,560	1,444,000	1,534,076	4,860,700	
		6,500	12,500			26,420	36,481	42,240	50,615	75,000	80,728		150,000	209,978	350,000	432,720	642,271	811,980		1,587,870		
		7,500					38,730	45,602	50,819	77,072	80,905		160,000	210,668	378,838	449,659	653,219	868,003		1,650,000		
		8,000						47,750	51,024	77,477	81,326		170,000	216,116		456,394	663,392	875,000		2,100,000		
								47,943	51,639	77,812	81,436		175,000	217,828		458,596	675,000	931,650		2,160,000		
								48,000	52,150	78,000	81,529		176,253	220,000		460,732		969,756		3,121,170		
								48,149		78,900	81,847		180,000	229,376		466,940		969,761				
								48,767		78,291	82,662		180,789	232,188		470,940		1,023,188				
								48,973		79,334	83,074		185,238	234,270		495,362		1,058,400				
								49,177					191,730	240,000				1,126,321				
								49,590					194,154	247,482								
								49,794					196,948	250,000								

ENC Usage Bands

	Radar	S-101	S-57		Current NOAA ENCs	
Navigational Purpose	Standard Ranges	Display Scale Ranges	Larger Scale Limit	Smaller Scale Limit	Larger Scale Limit	Smaller Scale Limit
1. Overview	3 000 000 1 500 000	10 000 000 1 500 000	1 500 000		1 500 001	
2. General	1 500 000 700 000 350 000	1 500 000 700 000 350 000	350 000	1 499 999	600 001	1 500 000
3. Coastal	350 000 180 000 90 000	350 000 180 000 90 000	90 000	349 999	150 001	600 000
4. Approach	90 000 45 000 22 000	90 000 45 000 22 000	22 000	89 999	50 001	150 000
5. Harbor	22 000 12 000 8 000 4 000	22 000 12 000 8 000 4 000	4 000	21 999	5 001	50 000
6. Berthing	4 000	4 000 3 000 2 000 1 000		3 999		5 000

NOTES