



HydrOffice CA Tools Manual

Release 2.4.4

2023, CCOM/JHC, UNH

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IN BRIEF



CA Tools assist in the assessment of the adequacy of nautical charts.

Accepted data inputs are ENC's, bathymetric grids, and sounding selections. The output is GIS-layers that alert to the user various parts of their data that might require more attention. Summary reports are also printed for the record and review.

The objectives are to improve data accuracy, while also reducing the overall time required for ping-to-public.

2.1 Installation

Note: If you download the frozen application ([from the download page](#)), you don't need to care about installation and dependencies (so you may just skip this section).

2.1.1 Installation using the Pydro distribution

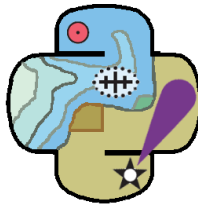


Fig. 2.1: The Pydro logo.

If you are on Windows, you can easily install QC Tools 2 as part of the [NOAA Office of Coast Survey Pydro](#) distribution.

Pydro is a suite of software tools used to support hydrography. It is (almost exclusively) built from open source components as well as public domain custom developed software. Pydro is maintained by Hydrographic Systems and Technology Branch (HSTB) to support NOAA operations (aiding Office of Coast Survey fleet) and is made available for public use.

You can download the latest Pydro installer from [here](#).

2.2 ENC Adequacy

2.2.1 Overview

The **ENC Adequacy** tab will:

- Ingest an ENC and survey soundings (see [Data inputs](#)).
- Identify survey's selected soundings with discrepancy as compared to the current chart (see [Chart Comparison](#)).

2.2.2 Data inputs

Ingest an ENC (.000), a survey soundings selection (.000), and a DTM (single resolution BAG and geotiff files are supported).

- Select the **ENC Adequacy** tab on top of the CA Tools interface.

In Data inputs:

- Drag-and-drop a survey sounding selection (.000 only) onto the **Survey Soundings** field. The "+" browse button may also be used (If you do not have a Survey Soundings file you may make one in the Sounding Selection tab).
- Drag-and-drop an ENC (.000) onto the **Current ENCs** field. The "+" browse button may also be used.
- Drag-and-drop a DTM (.bag, .tif or .tiff) onto the **Survey DTMs** field. The "+" browse button may also be used. Note: CA Tools does not support variable resolution surfaces.
- The directory and filename of loaded data will populate in the respective field of **Data inputs**.
- With the addition of a DTM, the **Sounding Selection** tab on the bottom of the interface will become available (Fig. 2.2).
- With the addition of a ENC and sounding selection, the **SS vs. Chart** tab on the bottom of the interface will become available (Fig. 2.2).
- The **Clear data** button may be used to remove all data inputs.

In Data outputs:

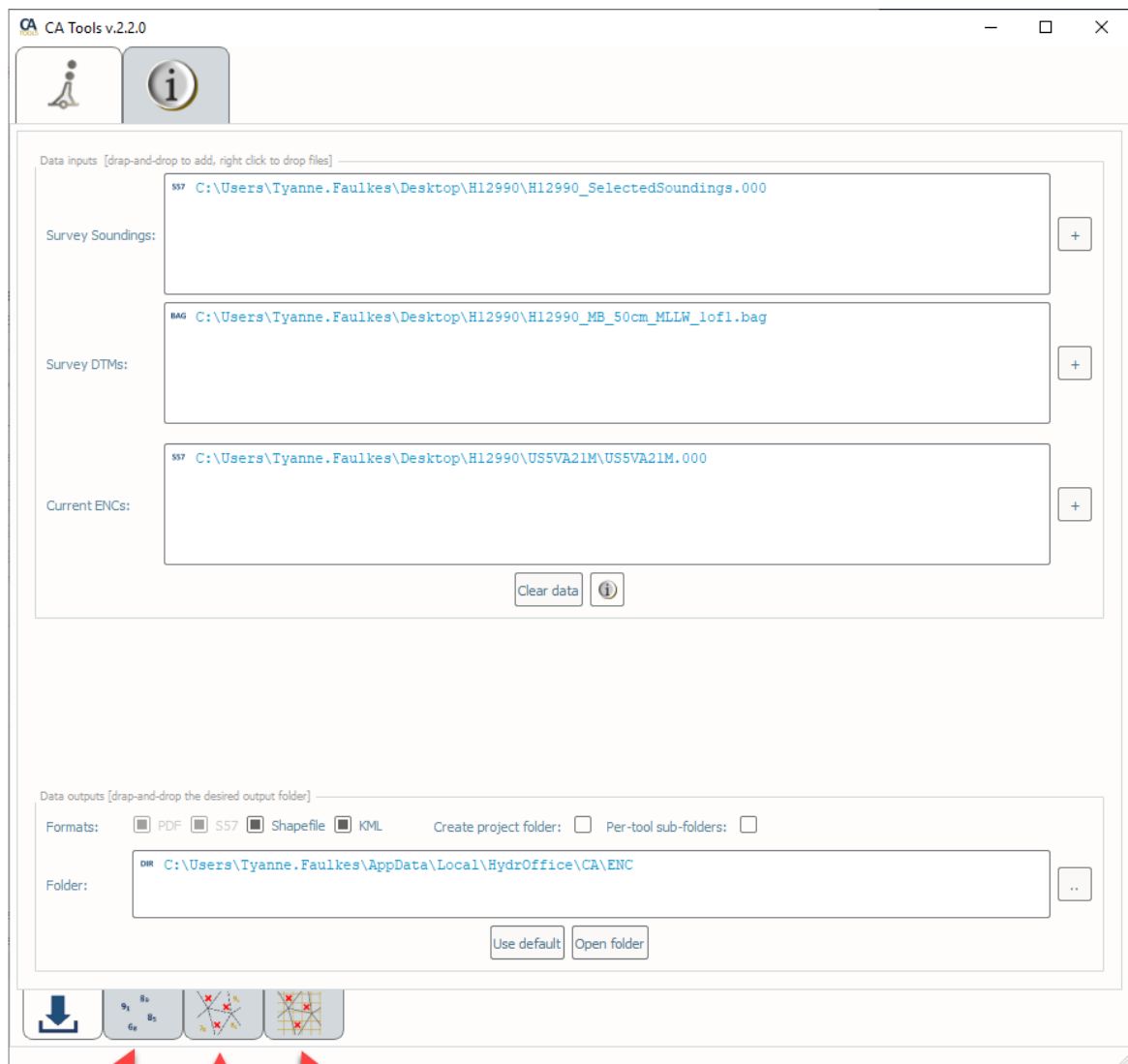
- The output **Formats** may be customized. The user has the option to suppress **Shapefile** and **KML** output.
- Output files location is controlled by the **Create project folder** and **Per-tool sub-folder** flags. The four available combinations are:
 - No flags set (see Fig. 2.3, pane A). The outputs are stored directly under the default or user-defined location.
 - Only the **Per-tool sub-folders** flag set (see Fig. 2.3, pane B). The outputs are stored in a tool-specific sub-folder (in the default or user defined-location).
 - Only the **Create project folder** flag set (see Fig. 2.3, pane C). The outputs are stored in a survey folder (in the default or user defined-location). *This is the default setting.*
 - Both flags set (see Fig. 2.3, pane D). The outputs are stored in tool-specific sub-folders in a survey folder (in the default or user defined-location).
- The default output **Folder** location is listed; however, this may be modified via drag-and-drop (or browse to) a user-specified output folder. To return to the default output folder location, click **Use default**.
- The ensuing functions will open the output folder automatically upon execution; however, if needed, the specified output folder may be accessed by clicking the **Open folder** button.

2.2.3 Sounding Selection

How To Use?

Sounding Selection allows the user to create a selected sounding selection from a DTM from survey data. This sounding selection layer will be used to compare the survey data to the chart.

- Select the either **Point-Additive v2** or **Moving Window v2** from the **Algorithm** drop down that you would like to use to perform your sounding selection. See the **How It Works** section for more information on the differences between these algorithms.
- Select the **Grid xyz** tab on the bottom of the QC Tools interface.



**Sounding
Selection**

**SS vs
Chart**

**DTM vs
Chart**

Fig. 2.2: ENC Adequacy tab.

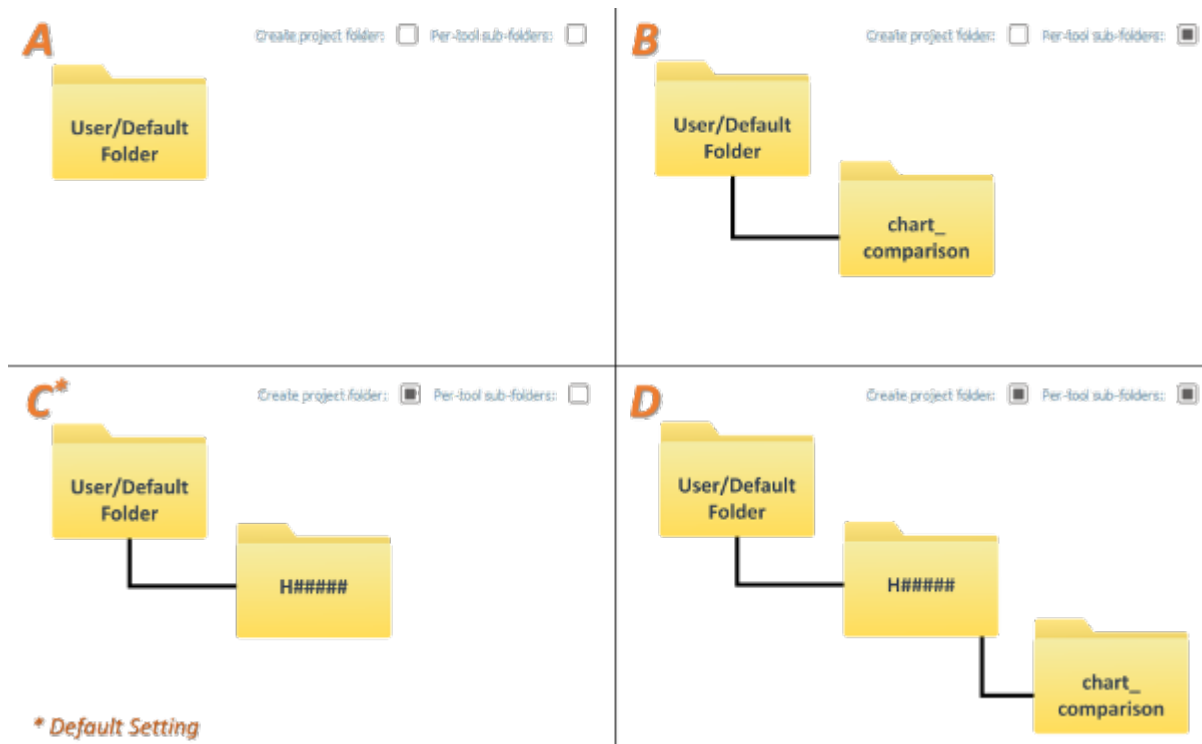


Fig. 2.3: The resulting folder structure based on the four available combinations of output flags.

Advanced:

- Choose between a **Shoal Bias** or a **Deep Bias** selection method.
- The user may define the **Search Radius**:
 - **Distance In Meters** allows the user to select a search radius in meters.
 - **1 cm at Scale** allows the user to create sounding selection at 1 cm at either the compilation scale of the ENC (this requires an ENC to be loaded in the **Data Inputs** tab) or the user can select a compilation scale of choice.
- Optionally you may decide to have a completed plot after the sounding selection is complete. If so, select the **Plot soundings** option.
- In **Execution** (Fig. 2.4), click **Sounding Selection v2**.
- After computing, the output window opens automatically, and the results are shown (Fig. 2.5). These results tell the user the number of nodes in the surface and the number of selected soundings.
- **The output file names adopt the following convention:**
 - [grid filename].[selection algorithm].soundings.[window size (w) or radius (r)][size]_[shoal biased or deep biased]

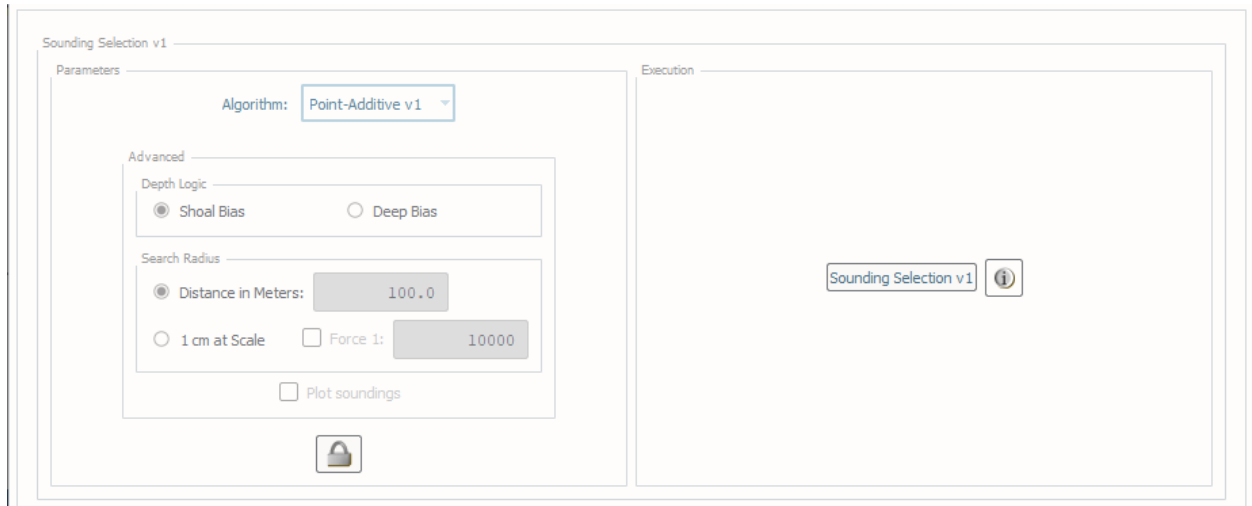
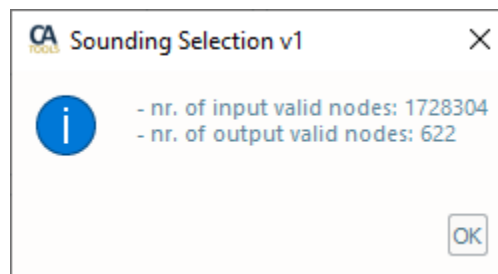


Fig. 2.4: Sounding Selection's Interface.

Fig. 2.5: The output message at the end of **Sounding Selection** execution.

How Does It Work?

At a minimum, a DTM is required for the sounding selection. Behind the scenes, the Sounding Selection tool will break down the DTM into readable chunks.

There are two different **sounding selection algorithms** to choose from for the Sounding Selection Tool:

Point Additive * First, the radius is translated from meters into nodes by dividing the radius by the resolution.

- Sounding selection selects the shallowest point in the chunk and then removes all data within the radius of the selected sounding.
- Next, the algorithm moves onto the shallowest remaining sounding and continues until there are no remaining data points.

Below is an example (Fig. 2.6) of a 1-meter surface with a radius of 4 meters. First the shallowest sounding is selected and the radius of soundings are removed (A), the next shallowest sounding is then selected and radius removes neighboring soundings (B), and the process continues until all soundings are accounted for (C).

Moving Window sounding selection doubles the search radius and divides by the resolution of the surface. The surface is then divided into super cells and the shallowest point is then selected within that super cell. This sounding selection algorithm works quickly but soundings along cell boundaries may be selected very close together.

Taking the same example area as before and using search radius of 4-meters, the super cells are created (A) and the shallowest node in each super cell is selected (B)(Fig. 2.7).

The user may choose different depth logic. **Shoal Bias** logic will choose the shallowest nodes while **Deep Bias** chooses the deepest soundings.

The user may choose different ways to define the search radius for their survey:

- **Distance in Meters** sets the search radius at a specified distance in meters.
- **1 cm at Scale** requires an ENC to be loaded in the inputs tab. The “Compilation Scale” of the ENC is used to set the search radius. For example, if you have a 1:40,000 scale chart, the radius will be set to 400 meters.
- The user can force the compilation scale by checking the box next to **Force 1:** and enter a scale. For example, if the user enters 40,000 in this input the search radius will be set to 400 meters.

Lastly **Plot soundings** allows a plot to be produced which may be helpful for visual quality control purposes (Fig. 2.8).

2.2.4 Chart Comparison

Survey Soundings vs. Chart

How To Use?

Identify survey soundings with a shoal discrepancy as compared to the chart, evaluated via “triangle rule”.

- Select the **SS vs Chart** tab on the bottom of the CA Tools interface.
- In **Parameters** (Fig. 2.9, left side):
 - Check the **Detect deeps** checkbox if you want that the deep discrepancies are also evaluated. The **Discrepancy threshold** values also apply to deep discrepancies.
 - Check the **Point-in-Polygon tests** to check for features that fall in flat triangles such as dredge areas and depth contours with equal values On all sides
- For custom analysis:
 - Click the **Unlock** button, and click **OK** to the dialogue.

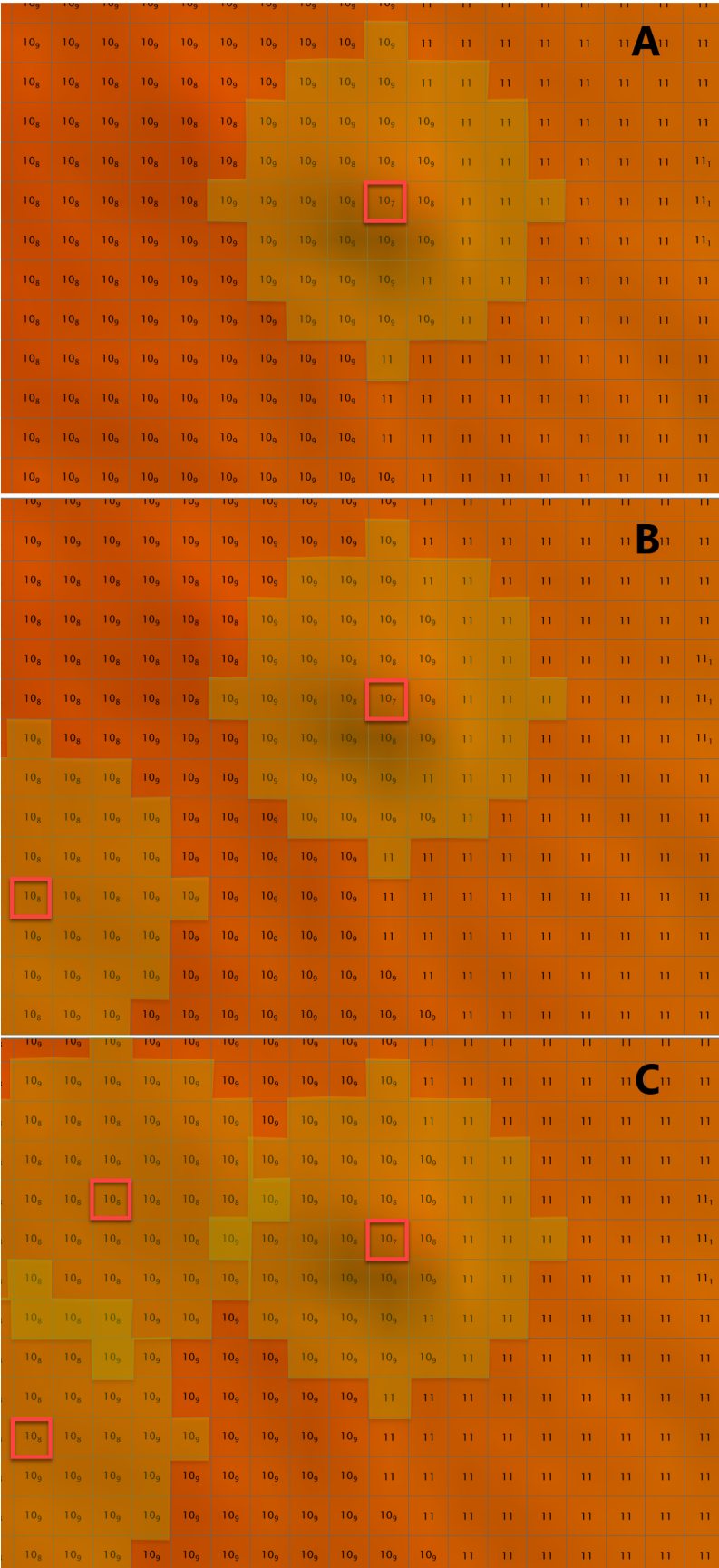


Fig. 2.6: Example of Point Additive sounding selection algorithm.

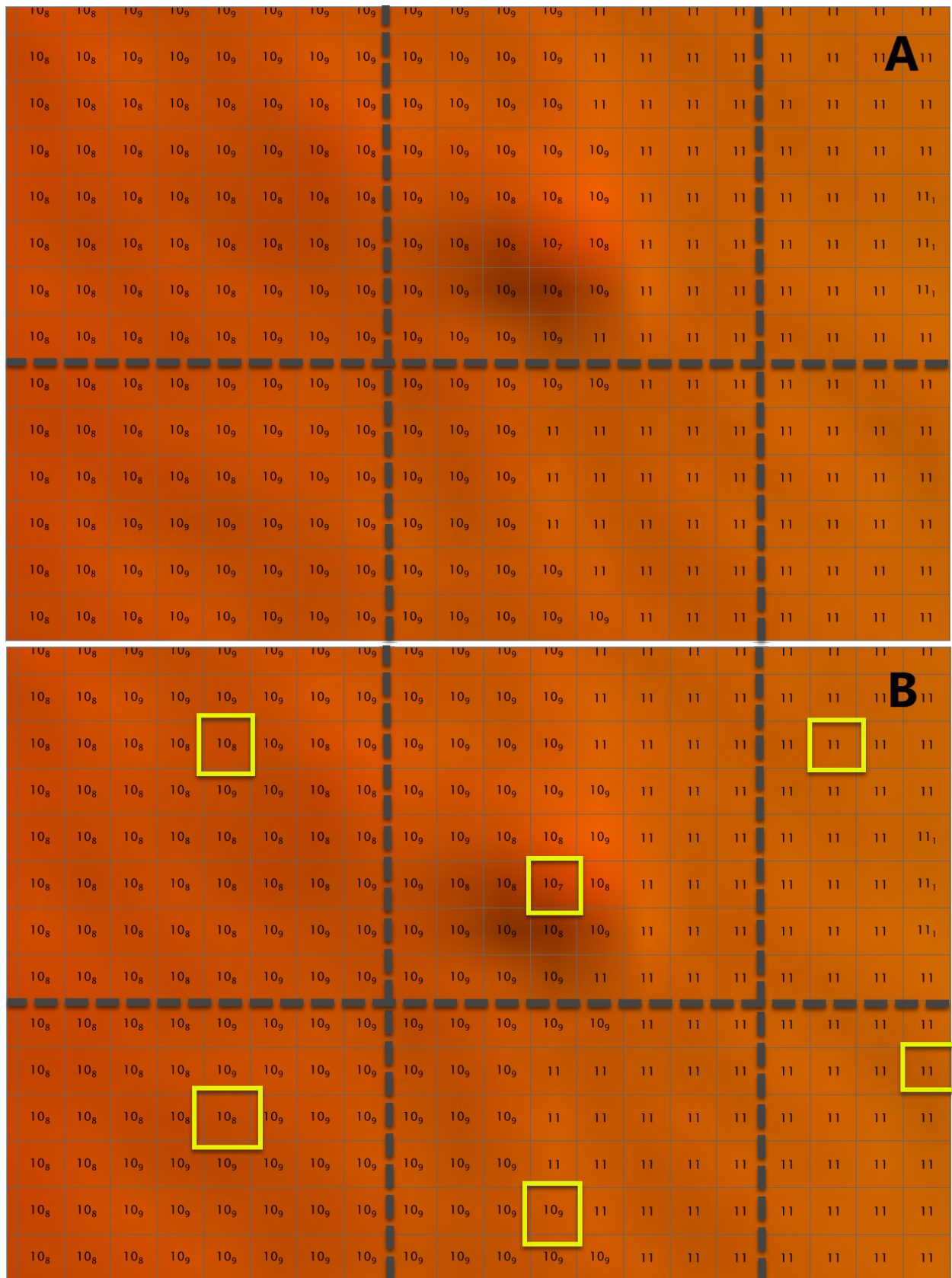


Fig. 2.7: Example of Moving Window sounding selection algorithm.

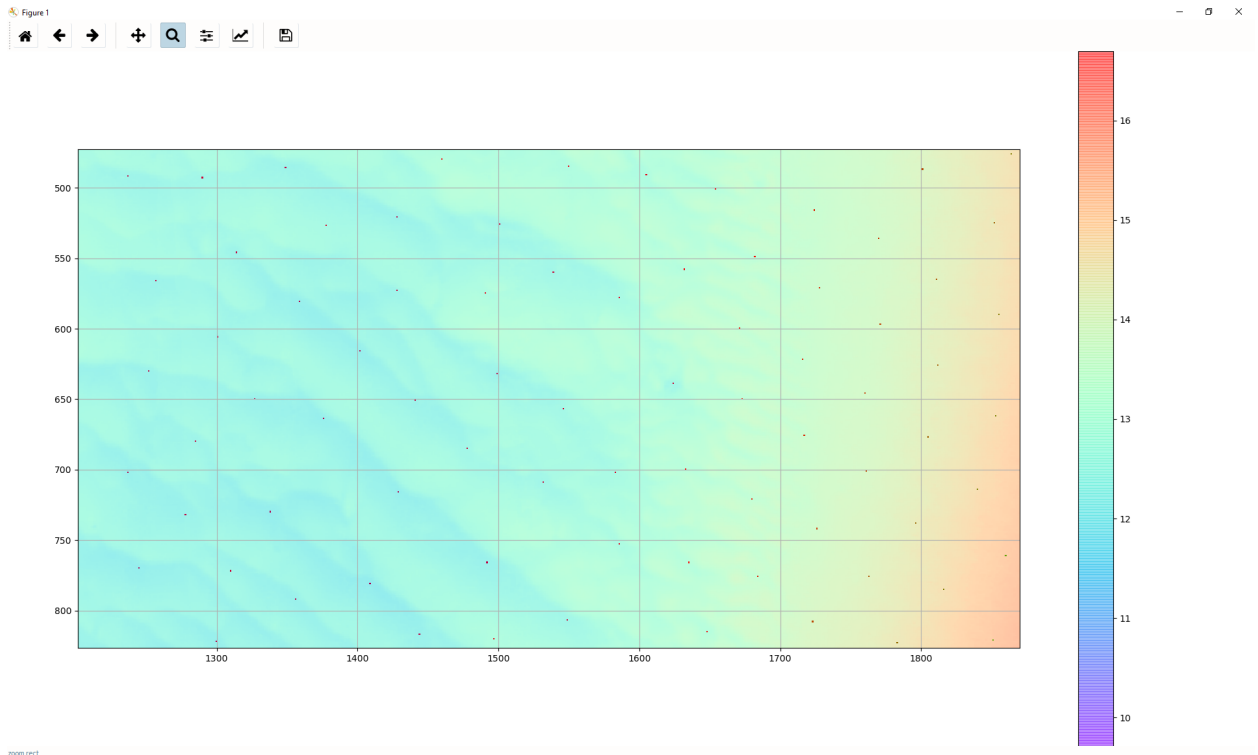


Fig. 2.8: Plot produced at the end of sounding selection.

- Set the **DtoN threshold** values to set a threshold for DtoN, in meters and in percentage of water depth.
- Set the **Discrepancy threshold** values to set a threshold for chart discrepancy, in meters and in percentage of water depth.
- Modify the **Threshold depth** value if you want to modify the default threshold depth of 20 meters.
- Check the **Set Shoreline Depth** checkbox if you wish to define a specific depth value to be paired with SLCONS and COALNE features.
- Check the **Force Compilation Scale** checkbox if you want to manually set the compilation scale to use for the interpolation of long edges (i.e., 1cm at the compilation scale).
- Set a testing method between **Shoalest Depth** and **Tilted Triangle**.
- Check the **Save used TIN** checkbox if you want to also save the Triangulated Irregular Network (TIN) used by the algorithm.
- In **Execution** (Fig. 2.9, right side), click **SS vs. Chart v1**.
- After executing, the output window opens automatically, and the results are shown by textbox (Fig. 2.10).
- After executing, the results are also shown graphically (Fig. 2.11). ENC soundings are colored by depth, and flagged survey soundings shoal of the ENC soundings are colored by their discrepancy.
- From the output window, drag-and-drop the output into the processing software to guide the review.
- Note the output consists of up to 4 distinct files: DtoN, discrepancies, deeps, and untested features.
- If shapefile or kml output is selected, the TIN (triangulated irregular network) used by the algorithm is also generated.

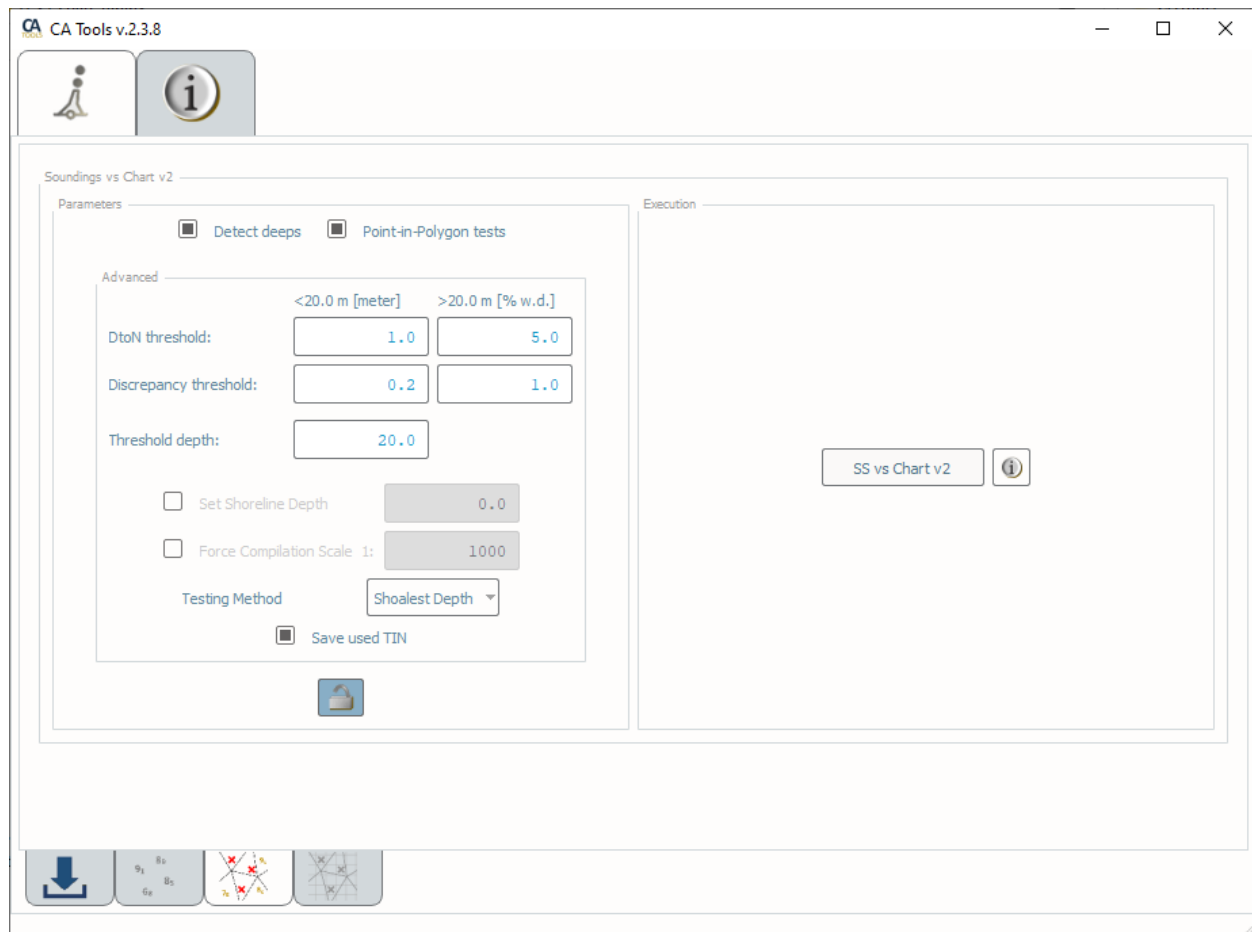


Fig. 2.9: Chart Comparison interface.

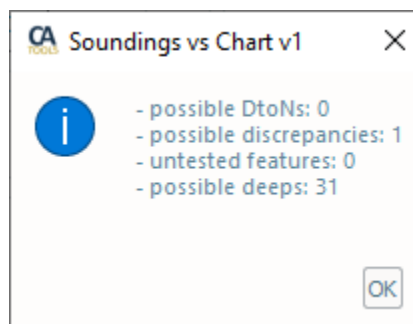


Fig. 2.10: Chart Comparison's output message.

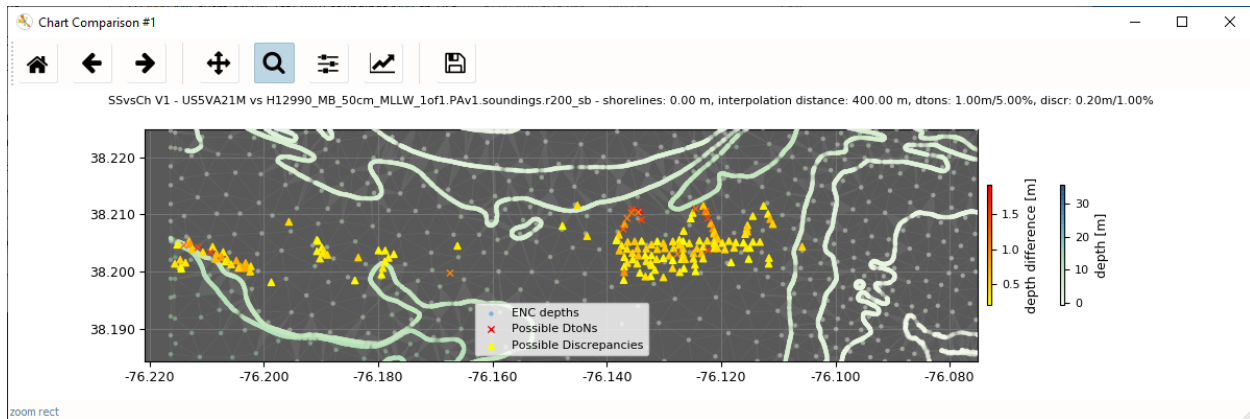


Fig. 2.11: Chart Comparison's output plot.

- For easy sorting and identification of potential DTONs, the magnitude of the discrepancy against the chart is stored both as:
 - Blue notes (within the S57 attribute NINFOM).
 - Delta values (storing the discrepancy value as the depth coordinate).
 - Soundings (storing the original depth value of each identified discrepancy).

Note: To visualize the NOAA S-57 features in CARIS software installs the [NOAA S-57 Support Files for CARIS](#).

How Does It Work?

A TIN is created from several features present in the input ENC:

- SOUNDG points.
- DEPCNT lines with valid VALDCO attribute.
- DRGARE polygons with valid DRVAL1 attribute.
- Point features with valid VALSOU attribute.
- COALNE and SLCONS lines.
- DEPARE polygons (only for ENC cell boundaries).

The input nodes are augmented by interpolating the linear feature based on the compilation scale (the length corresponding to 1cm at the compilation scale). The compilation scale is retrieved from the ENC unless the **Force Compilation Scale** checkbox is checked. If such a checkbox is checked, a valid scale denominator value is entered in the corresponding field).

The survey soundings are categorized, within the tilted triangles of the TIN, using the vertical distance.

The flags alert both for dangers to navigation (DtoNs) or chart discrepancies.

It is possible to customize the DtoN and discrepancy thresholds that are used by the algorithm to categorize the survey soundings.

In the example in [Fig. 2.12](#), a 10.1-meter survey sounding is flagged (black circle) since it represents a DtoN candidate. In fact, it is at 5 meters of vertical distance from the underline tilted triangle (in magenta).

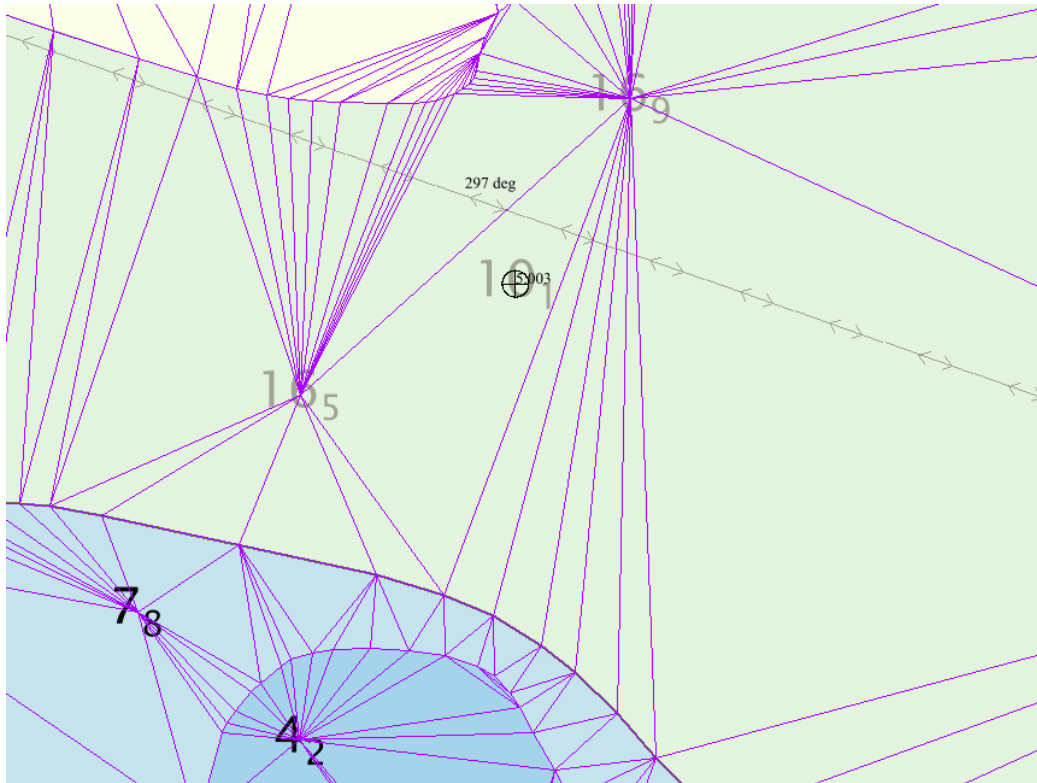


Fig. 2.12: Example of DtoN identification.

If a survey sounding is within a “flat” triangle, it is initially categorized as untested. Then, an attempt to its categorization is performed by looking at the underlining DEPARTURE (if available).

For more details, see [Section 2.5](#).

To better understand the difference between the “Tilted Triangle” and “Shoalest Depth” methods, see the examples in [Fig. 2.13](#) and [Fig. 2.14](#).

Survey DTM vs. Chart

How To Use?

Survey DTM vs. Chart is designed to be one interface for doing a chart comparison from a DTM with one click! You are required to have a DTM (.bag, .tif, or .tiff) and an ENC loaded into input data.

The interface is split up into two sections which correspond to the other tabs within the ENC Adequacy tab.

- The **sounding selection** portion of the manual has more instructions on how to set the settings in the [How To Use?](#) section.

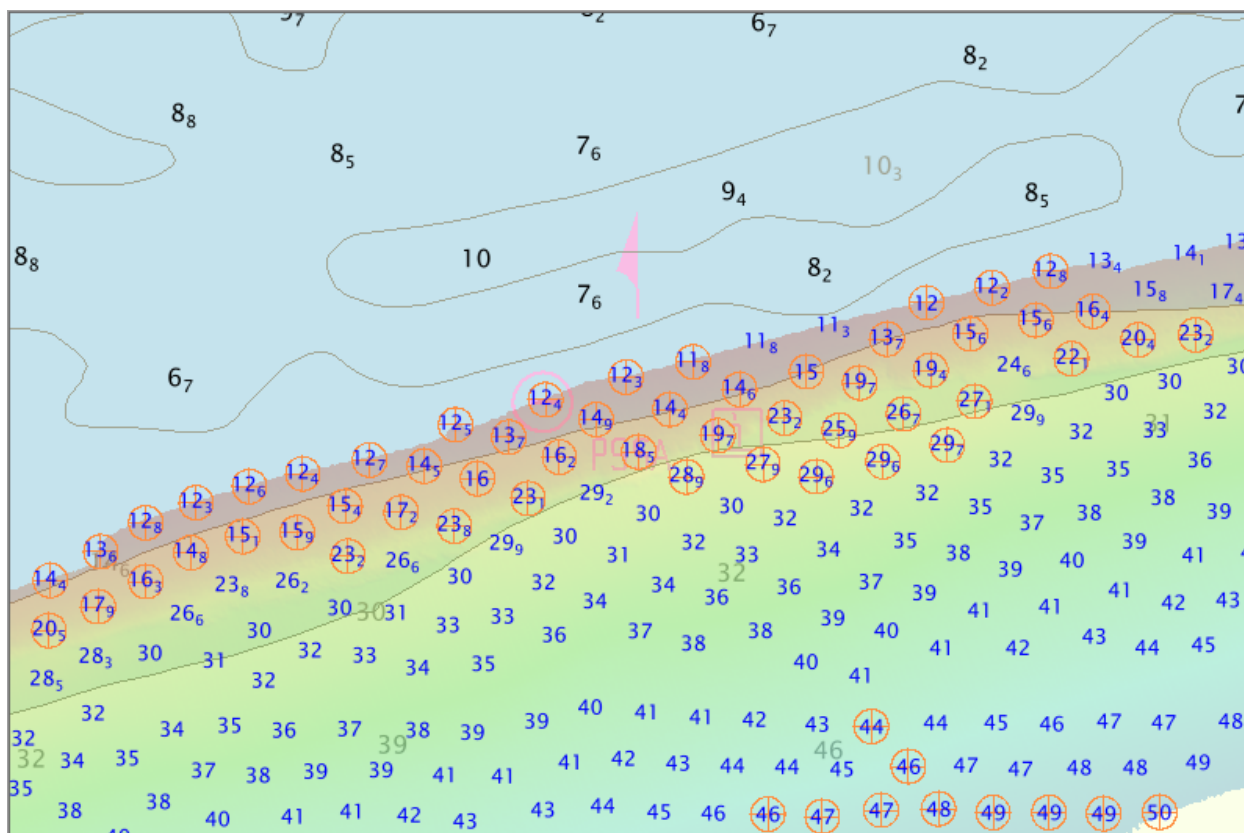


Fig. 2.13: The output from the Tilted Triangle method flags shoal soundings that exceed the thresholds set in the user parameters when evaluated against a tilted triangle. It will result in more flags, in this case depicting the overall shoaling trend. This method is useful in change detection and assessing chart adequacy.

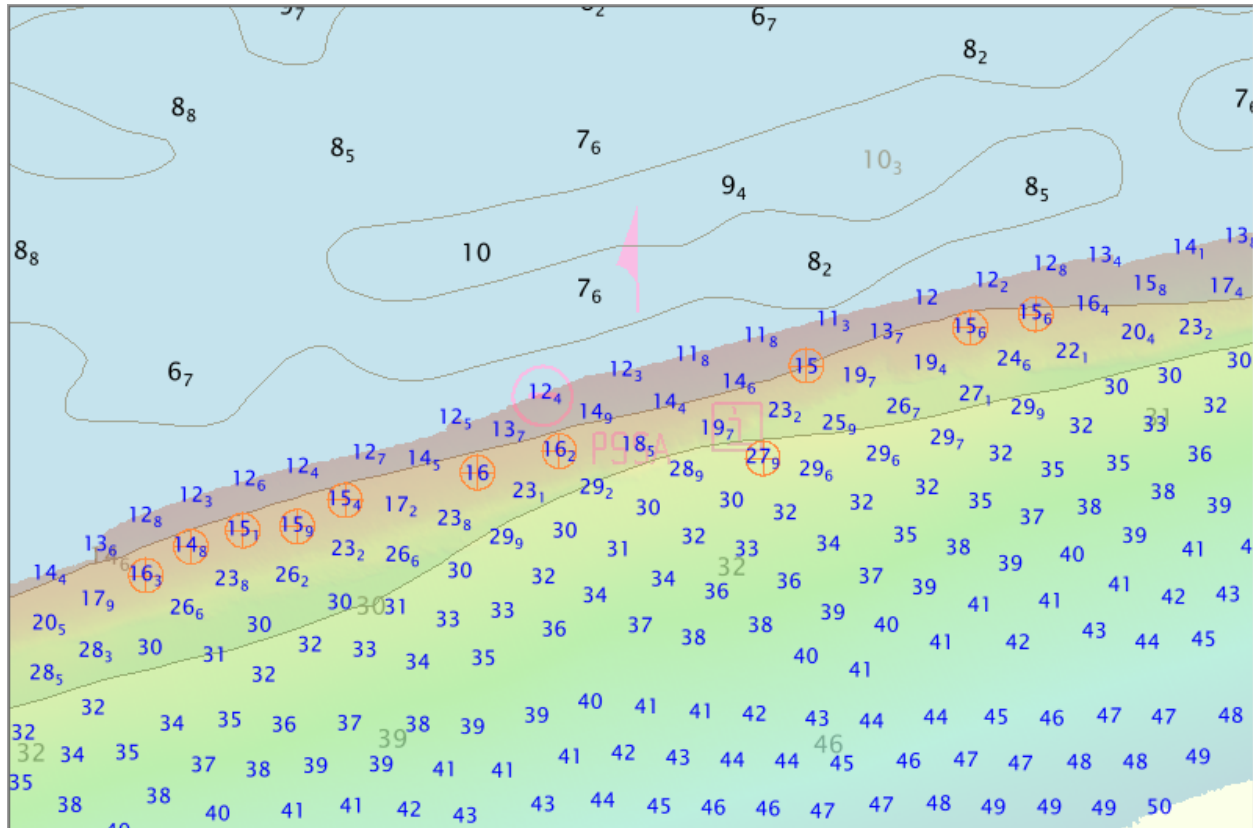


Fig. 2.14: The output from the Shoalest Depth method flags shoal soundings that exceed the thresholds set in the user parameters when evaluated against the most shoal of the three vertices of the triangle it resides within. It will result in less flags, in this case only those shoal soundings on the deep side of the contours. This method is useful in the identification of specific dangers to navigation.

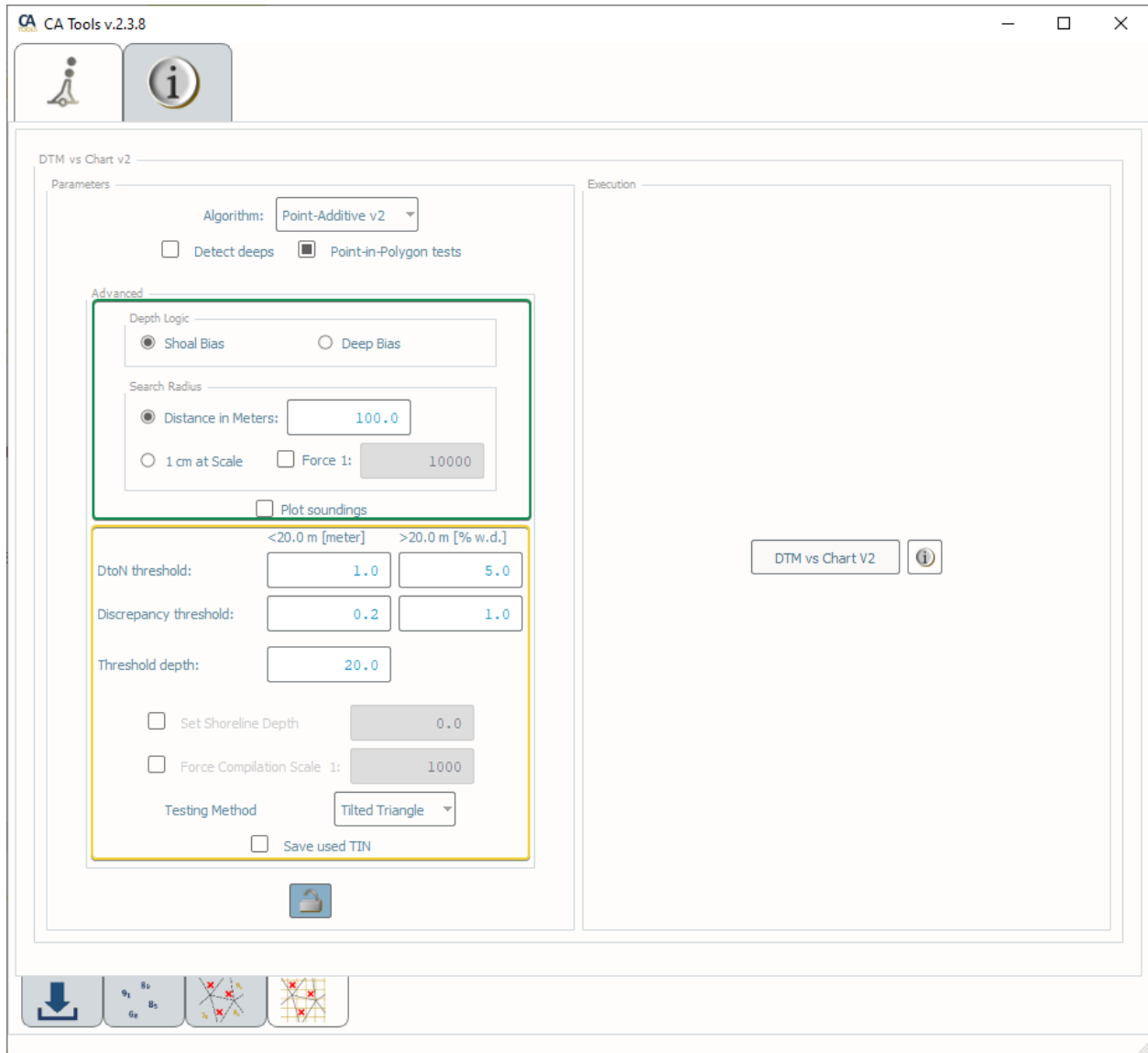


Fig. 2.15: Survey DTM vs. Chart interface: sounding selection's parameters are in the green area, while the settings for the chart comparison are in the yellow area.

- The **chart comparison** portion of the manual has more instructions on how to set the settings in the *How To Use?* section.
-

How Does It Work?

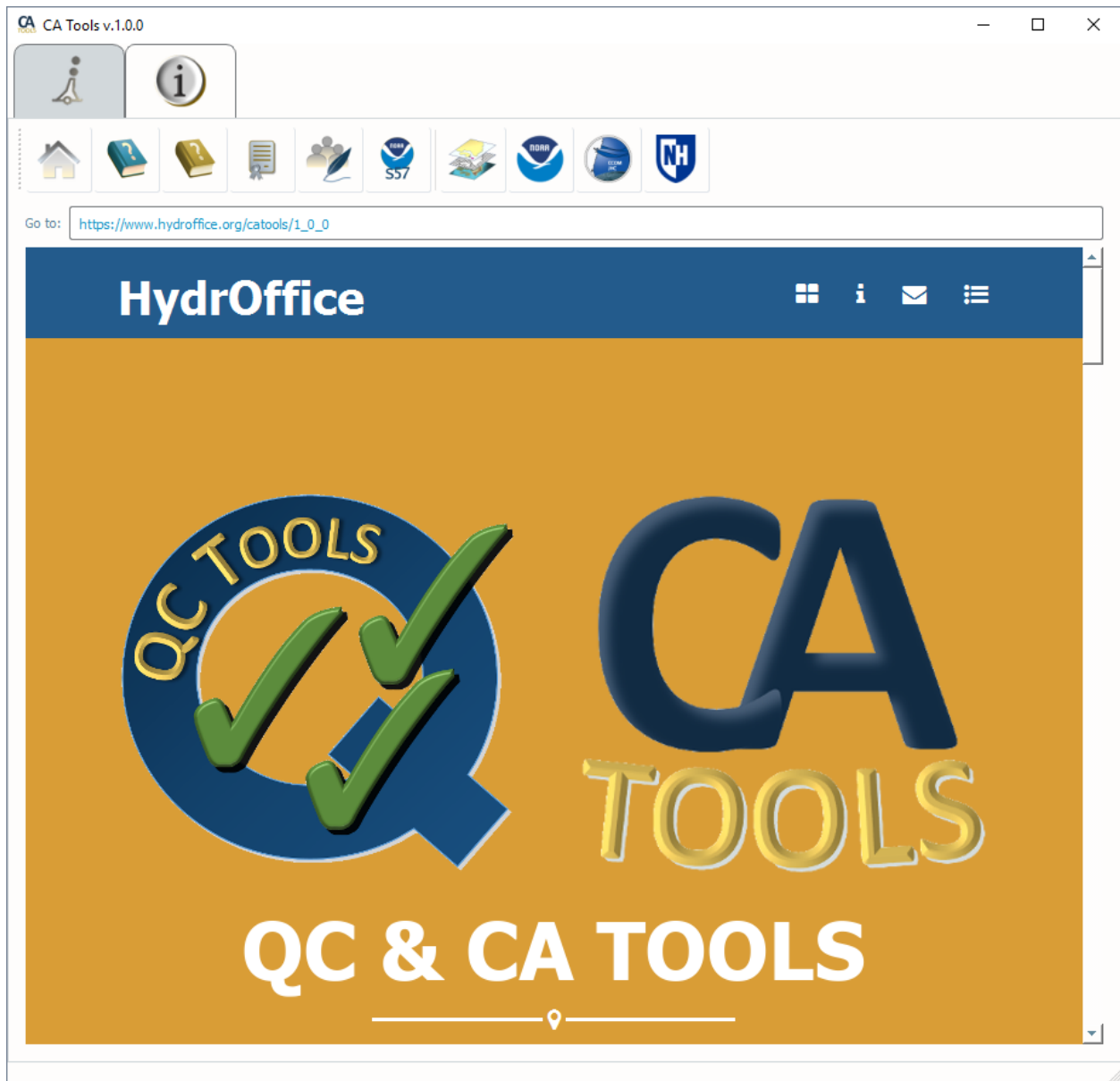
See the following sections on how the tools within **Survey DTM vs. Chart** works:

- **Sounding Selection:** *How Does It Work?*
- **Chart Comparison::** *How Does It Work?*

2.3 Info Tab

The Info Tab contains numerous helpful links and utilities:

- The home page
- The Online User Manual
- The Offline User Manual (PDF)
- License Information
- Authors List
- [NOAA S-57 Support Files for CARIS](#)
- The HydrOffice Main Page
- The Center for Coastal and Ocean Mapping Main Page
- The University of New Hampshire Main Page



2.4 Supported Formats

Format	Read	Write
Bathymetric Attributed Grid (.bag)	X	
Caris CSAR (.csar)	X	
S-57 (.000)	X	X
Shapefile (.shp)		X
KML (.kml)		X

2.5 List of references

- Masetti, G.; Faulkes, T.; Kastrisios, C. Automated Identification of Discrepancies between Nautical Charts and Survey Soundings. *ISPRS Int. J. Geo-Inf.* **2018**, 7, 392.
- Masetti, G.; Faulkes, T.; Wilson, M.; Wallace, J. Effective Automated Procedures for Hydrographic Data Review. *Geomatics* **2022**, 2(3), 338-354.

COMMAND LINE INTERFACE

3.1 General Commands

```
usage: CATools [-h] [--version] {SurveySoundingsVsChart,SurveyDTMVsChart} ...
```

3.1.1 Named Arguments

--version show program's version number and exit

3.2 Survey Soundings Vs Chart

```
usage: CATools SurveySoundingsVsChart [-h] [--th_depth TH_DEPTH] [--dton_value_less DTON_
↪VALUE_LESS]
                                     [--dton_pct_more DTON_PCT_MORE] [--discr_value_
↪less DISCR_VALUE_LESS]
                                     [--discr_pct_more DISCR_PCT_MORE] [-l SHORELINE_
↪DEPTH] [-c COMPILATION_SCALE]
                                     [-d] [-t] [-s] [-k] [-p]
                                     input_ss input_chart output_folder
```

3.2.1 Positional Arguments

input_ss The input file (\$57 .000) containing survey soundings
input_chart The input file (\$57 .000) containing an ENC
output_folder The output folder for the results of the search

3.2.2 Named Arguments

--th_depth	Set the threshold depth between fixed value and percentage of water depth Default: 20.0
--dton_value_less	Set the difference value for DTON (when depth less than threshold) Default: 1.0
--dton_pct_more	Set the percentage of water depth for DTON (when depth more than threshold) Default: 5.0
--discr_value_less	Set the difference value for chart discrepancies (when depth less than threshold) Default: 0.2
--discr_pct_more	Set the percentage of water depth for chart discrepancies (when depth more than threshold) Default: 1.0
-l, --shoreline_depth	Set the depth for the shoreline
-c, --compilation_scale	Force a compilation scale
-d, --detect_deeps	Enable detection of deep chart discrepancies Default: False
-t, --point_in_polygon_test	Disable the point-in-polygon test Default: False
-s, --write_shp	Enable shapefile as output format Default: False
-k, --write_kml	Enable kml as output format. Default: False
-p, --save_plot	Enable saving of a plot with the analysis Default: False

3.3 Survey DTM Vs Chart

```
usage: CATools SurveyDTMVsChart [-h] [--ss_algo {POINT_ADDITIVE_v2,MOVING_WINDOW_v2}]
                                [--ss_search_meters SS_SEARCH_METERS] [--ss_use_scale]
                                [--ss_compilation_scale SS_COMPILATION_SCALE] [--th_
↪ depth TH_DEPTH]
                                [--dton_value_less DTON_VALUE_LESS] [--dton_pct_more_
↪ DTON_PCT_MORE]
                                [--discr_value_less DISCR_VALUE_LESS] [--discr_pct_more_
↪ DISCR_PCT_MORE]
                                [-l SHORELINE_DEPTH] [-c COMPILATION_SCALE] [-d] [-t] [-
↪ s] [-k] [-p]
                                input_dtm input_chart output_folder
```

3.3.1 Positional Arguments

input_dtm	The input file (BAG, geotiff) containing a survey DTM
input_chart	The input file (S57 .000) containing an ENC
output_folder	The output folder for the results of the search

3.3.2 Named Arguments

--ss_algo	Possible choices: POINT_ADDITIVE_v2, MOVING_WINDOW_v2 The algorithm used for sounding selection Default: "POINT_ADDITIVE_v2"
--ss_search_meters	Set the search radius for sounding selection (alternatively, --ss_use_scale) Default: 100.0
--ss_use_scale	Calculate the search radius for sounding selection based on compilation scale Default: False
--ss_compilation_scale	Force a compilation to calculate the search radius for sounding selection
--th_depth	Set the threshold depth between fixed value and percentage of water depth Default: 20.0
--dton_value_less	Set the difference value for DTON (when depth less than threshold) Default: 1.0
--dton_pct_more	Set the percentage of water depth for DTON (when depth more than threshold) Default: 5.0
--discr_value_less	Set the difference value for chart discrepancies (when depth less than threshold) Default: 0.2
--discr_pct_more	Set the percentage of water depth for chart discrepancies (when depth more than threshold) Default: 1.0
-l, --shoreline_depth	Set the depth for the shoreline
-c, --compilation_scale	Force a compilation scale
-d, --detect_deeps	Enable detection of deep chart discrepancies Default: False
-t, --point_in_polygon_test	Disable the point-in-polygon test Default: False
-s, --write_shp	Enable shapefile as output format Default: False
-k, --write_kml	Enable kml as output format. Default: False

-p, --save_plot Enable saving of a plot with the analysis
Default: False

DEVELOPER'S GUIDE

4.1 How to contribute

Every open source project lives from the generous help by contributors that sacrifice their time and this is no different. To make participation as pleasant as possible, this project adheres to the [Code of Conduct](#) by the Python Software Foundation.

Here are a few hints and rules to get you started:

- Add yourself to the [AUTHORS.txt](#) file in an alphabetical fashion. Every contribution is valuable and shall be credited.
- If your change is noteworthy, add an entry to the [changelog](#).
- No contribution is too small; please submit as many fixes for typos and grammar bloopers as you can!
- Don't *ever* break backward compatibility.
- *Always* add tests and docs for your code. This is a hard rule; patches with missing tests or documentation won't be merged. If a feature is not tested or documented, it does not exist.
- Obey [PEP 8](#) and [PEP 257](#).
- Write [good commit messages](#).
- Ideally, [collapse](#) your commits, i.e. make your pull requests just one commit.

Note: If you have something great but aren't sure whether it adheres – or even can adhere – to the rules above: **please submit a pull request anyway!** In the best case, we can mold it into something, in the worst case the pull request gets politely closed. There's absolutely nothing to fear.

Thank you for considering to contribute! If you have any question or concerns, feel free to reach out to us (see [Credits](#)).

4.2 How to build the documentation

4.2.1 Requirements

The documentation is built using `sphinx`, so you need to have it:

- `pip install sphinx sphinx-autobuild`

4.2.2 First-time creation of documentation template

Just once for each project, you can create the documentation template as follows:

- `mkdir docs`
- `cd docs`
- `sphinx-quickstart`

4.2.3 Generate the documentation

To create the html:

- `make html`

To create the pdf, you first need to install a latex distribution, then:

- `make latexpdf`

LICENSE

Copyright Notice and License Terms for: hyo2.catools - CA Tools package for HydrOffice Copyright (c) 2018, University of New Hampshire, Center for Coastal and Ocean Mapping

Released under a dual license: - Community license (under LGPL v3) - Industrial Associate license

For more info, visit: <http://www.hydrooffice.org/license/>

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Version 3, 29 June 2007

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If you modify a copy of the Library, and, in your modifications, a facility refers to a function or data to be supplied by an Application that uses the facility (other than as an argument passed when the facility is invoked), then you may convey a copy of the modified version:

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CA Tools is based on an ongoing joint development between the NOAA's [Ocean of Coastal Survey](#) and UNH's [Center for Coastal and Ocean Mapping](#).

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